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Research Article

Evaluation of quality parameters in liquid grape pekmez (Molasses) from different brands available in the market

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ABSTRACT

This study examined the physicochemical properties of industrial and traditionally produced pekmez samples available on the market and compared them with the Turkish Grape Pekmez Notification (2017/8) standards. Significant variability was observed in parameters such as °Brix, pH, ash content, HMF concentration, titratable acidity, water activity, and colour. °Brix values ranged from 69.03% to 80.73%, in consistent with Codex standards. One traditional sample had a pH of 4.76, placing classifying it as sour pekmez. Four industrially produced pekmez samples exceeded the 2.5% ash limit, but HMF concentrations varied widely, with one traditional sample surpassing the regulatory limit of 75 mg/kg limit. Titratable acidity ranged from 0.19% to 1.95%, and water activity values were between 0.59 and 0.74, indicating moderate to low water activity. Colour analysis revealed a spectrum from dark to lighter shades, with a shift from greenish to reddish hues, typical of grape pekmez. These findings underscore the impact of production methods on pekmez quality and variability.

Keywords: Grape pekmez, Molasses, Codex, Pekmez quality, HMF

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Introduction

Concentrated grape juice or pekmez (a type of molasses) is a traditional Turkish food product that has been consumed for centuries. The consumption of grape pekmez has been increasing in recent years, making it a significant subject of study for the food industry due to its health benefits. Pekmez is rich in essential nutrients, including calcium, iron, potassium, and magnesium, which meet daily requirements for these minerals (Kalaycıoğlu, 2023). Additionally, grape pekmez exhibits antioxidant properties, with high levels of phenolic compounds and vigorous DPPH scavenging activity (Kalili et al., 2023). Furthermore, grape pekmez consumption has been linked to improved metabolic profiles, including enhanced glucose tolerance, insulin sensitivity, and reduced ectopic fat deposition (Narkabulova & Jabborov, 2023). Grape pekmez can be a valuable addition to the diet, offering nutritional benefits and potential health improvements. The quality parameters of pekmez products sold in the market encompass various aspects. These include the determination of physical and chemical properties such as water-soluble dry matter content, pH level, titratable acidity, density, ash content, phenolic compounds, antioxidant activity, total phenolics, mineral contents, and 5-hydroxymethyl furfural (HMF) levels (Yavuz-Küçük & Duraklı-Velioğlu, 2022; Salık et al., 2021; Gamlı, 2022; Basaran et al., 2021). Additionally, assessing parameters like glucose, fructose, protein, colour, and acrylamide levels is crucial for evaluating the overall quality of pekmez. These analyses provide insights into the nutritional values, antioxidant properties, and compliance with the Turkish Food Codex, contributing to the promotion and appreciation of traditional pekmez varieties in the market. Understanding the conformity of commercial grape pekmez products to the Turkish Food Codex Grape Pekmez Official Notification is important for ensuring the safety and quality of this food product.

This study aims to determine the characteristics of pekmez and investigate their conformity to the Turkish Grape Pekmez Official Notification. Furthermore, it investigates important quality parameters such as titratable acidity, colour, and water activity that are not currently specified in the notification. Additionally, the quality parameters of two different types of traditionally produced liquid pekmez have been compared with those of commercial types.

Materials and Methods

Material

Ten different brands of industrially produced liquid molasses were purchased from well-known national supermarkets (Gaziantep, Türkiye). Two traditionally produced molasses were obtained from a local bazaar (Gaziantep, Türkiye). All the samples used in this study were produced during the 2023 season. Industrially produced samples were coded I1–I10, whereas traditional samples were coded T1 and T2. Chemicals used in this study were of analytical grade (Sigma-Aldrich, Merck, and ISOLAB, Germany).

Methods

Determination of Total Soluble Dry Matter (°Brix), pH and Titratable Acidity

°Brix values of pekmez samples were determined by an Abbe refractometer (A. Kruss optronic, Germany). 5 grams of pekmez samples were diluted in 50 mL of distilled water, and pH values were measured with a pH meter (Hanna HI 2211, Italy) at 20°C (AOAC, 2000). The potentiometric method was used for the determination of titratable acidity. In this method, the pH was adjusted to 8.1 using 0.1 N NaOH and a pH meter, and the acidity was expressed as a percentage of tartaric acid. The calculation followed the formula given below.

$$Titratable\ acidity\ (\%) = V \text{x} N \text{x} E \text{x} 100\ /m \qquad (1)$$

V: Volume of NaOH used (mL)

N: Normality of NaOH

E: The equivalent acid amount of 1 mL 0.1 N NaOH (for tartaric acid as 0.007505 g)

m: Sample weight (g)

Determination of Ash Content

The ash content in the samples was determined using the method specified by AOAC (2000). Firstly, the crucibles were weighed constantly (m_1). Approximately 2 g of the sample was weighed (m2) into the crucible, and after that, preburning, it was burned in a muffle furnace at 550°C until white ash was obtained. After that, the samples cooled in the desiccator were weighed on a precision scale, and their ash content (m_3) was calculated using Equation 1.

$$Ash\ content\ (\%) = (m3 - m1/m2\ )\ \text{x}\ 100 \qquad (2)$$

Hydroxymethyl Furfural Content (HMF)

The HMF content in pekmez samples was quantified using the Winkler method (Zappala et al., 2005). Approximately 10 g of pekmez was dissolved in 20 mL of water and transferred to a 50 mL volumetric flask. Four separate test tubes were prepared, with 2 mL of the solution and 5 mL of p-toluidine solution added to three tubes. In one test tube, 1 mL of distilled water (blank) was introduced, while in the others, 1 mL of 0.5% barbituric acid solution (sample) was added. The absorbance of the solutions was measured at 550 nm using a spectrophotometer (T60, PG Instrument, Italy). The HMF concentrations were subsequently calculated using the following formula:

$$HMF\ (mg\ kg^{-1}) = Absorbance \times 192 \quad (3)$$

Determination of Water Activity and Colour Measurements

The water activity (aw) of the samples was measured using a Rotronic AG HygroPalm HP23 (Rotronic AG, Switzerland), which was calibrated with various salt solutions at 25 °C prior to use. Colour measurements were performed using a HunterLab Colorflex EZ colourimeter with standard illumination D65, and a colourimetric normal observer angle of 10°. Colour values were evaluated as L*, a* and b*.

Statistical Analysis

All experiments were performed in triplicate, and the results are presented as the mean ± standard deviation. The data were analysed using the SPSS 22 statistical software (SPSS Inc., Chicago, IL, USA), with Duncan's multiple comparison test.

Results and Discussion

The Evaluation of Some Parameters Provided in the Codex

Brix, pH, ash content and HMF values were presented in Table 1. High Brix values indicate a higher concentration of sugars and other soluble solids, which can affect the taste, texture, and shelf life of pekmez. These values are essential for standardising pekmez quality, ensuring consumer satisfaction, and meeting regulatory requirements. Consistent Brix values are crucial for maintaining product quality and consumer expectations, as they directly influence sweetness and viscosity (Narkabulova & Jabborov, 2023). Although high °Brix values are typically favourable in pekmez, they may also lead to issues such as overly intense sweetness for some consumers and health concerns due to elevated sugar content. Additionally, variations in °Brix values due to different fruit sources or processing methods may complicate standardisation efforts, necessitating careful regulation and quality control measures to ensure product consistency and safety across the market. According to the Turkish Pekmez Notification (2017/8), the minimum soluble dry matter content of liquid molasses should be at least 68%. °Brix values observed in the industrial pekmez samples ranged from 69.03% to 73.92% and traditional samples were found to be 73.83% and 80.73%. These results indicated that all samples were found in accordance with the Codex. The same findings, ranging from 66.16% to 80.57% were observed in previous research (Türkben et al., 2016; Narkabulova & Jabborov, 2023).

The optimal pH range for nutritional retention in pekmez is crucial for maintaining its quality and health benefits. In this study, the pH values of pekmez samples ranged from 4.76 to 6.42, indicating a slightly acidic to nearly neutral character. According to the Turkish Pekmez Notification (2017/8), the pH value should generally fall within the range of 5.0 to 6.0 for sweet-type pekmez. Consequently, the pH values observed in some samples were marginally higher than the recommended range, particularly those approaching a pH of 6. On the other hand, only one traditional sample was classified as sour, with a value of 4.76, according to the Pekmez Codex. The pH values reported in this study exhibited both similarities and differences compared to those in previous studies (Türkben et al., 2016; Karataş & Şengül, 2018; Aktaş, 2024). Although the elevated pH values are not detrimental, they may indicate reduced acidity, which could influence the preservation and organoleptic properties of pekmez. Diminished acidity may also attenuate the natural preservative effect, as the acidic environment typically inhibits microbial proliferation and extends shelf life. Therefore maintaining pH within the recommended range is advisable to ensure optimal product quality.

The ash content of pekmez samples ranged from 0.17% to 3.15%, reflecting the inorganic composition of the pekmez. Ash content in pekmez is primarily influenced by the mineral composition of the raw fruit and any residual minerals remaining from the concentration process. Elevated ash content may be associated with increased mineral richness, contributing to the nutritional value of pekmez, as it contains essential minerals such as potassium, calcium, and magnesium. However, excessively high ash content may be indicative of impurities or suboptimal raw materials used in production, which necessitates careful monitoring during the processing stage. According to the Turkish Pekmez Notification (2017/8), the ash content of pekmez should generally not exceed 2.5%. This study's findings suggested that the ash content of the analysed samples was within acceptable ranges except for four industrial pekmez samples. According to Kaya et al. (2012), the analysis of grape pekmez revealed a total ash content ranging from 0.61% to 3.69%. Salameh et al (2024) reported that the average ash content of the grape molasses mixture was 4.44%. They emphasised that higher ash content in samples was related to the clarification process.

HMF is a byproduct formed during the thermal processing and serves as an indicator of thermal degradation. The Turkish Pekmez Notification (2017/8) stipulates a maximum HMF content of 75 mg kg^{-1} for pekmez, and values exceeding this threshold suggest that the pekmez may have been subjected to excessive thermal treatment during production. The quantification of HMF in the pekmez samples revealed a spectrum ranging from 1.86 mg/kg to 136.36 mg/kg, reflecting notable diversity among the samples. The observed HMF values in this study indicated that one of the traditional samples surpassed this limit, potentially reflecting process conditions. HMF concentrations in pekmez can vary significantly, with reported levels ranging from 7.8 to 204.0 mg kg^{-1} (Elmastaş et al., 2022). In contrast, some studies suggest that certain pekmez types, such as carob pekmez, maintain lower HMF levels despite their high sugar content, indicating that formulation and processing methods can mitigate safety concerns (Tetik et al., 2010). This highlights the importance of both ingredient selection and production techniques in ensuring the quality and safety of pekmez.

The Evaluation of Titratable Acidity, Water Activity and Colour Properties

Specific properties of pekmez, which are outside the scope of the Codex, were presented in Table 2. The titratable acidity values of the samples, ranging from 0.19% to 1.95%, indicated noticeable variation in the acidity of the samples. Pekmez samples with lower acidity could indicate a smoother, sweeter taste. This might be more characteristic of pekmez made from fruits with naturally lower acid content. The lower acidity may also suggest minimal fermentation or a more controlled production process. Higher acidity could be a result of natural variations in fruit ripeness, storage, or fermentation, which may contribute to an increase in organic acids such as citric or tartaric acid. Türkben et al. (2016) reported that grape pekmez samples had acidity values ranging from 0.3% to 1.81%. The 1.95% acidity observed in this study was slightly above the standard range typically seen in grape pekmez studies, which usually range from 0.3% to 1.81%. It was suggested that the pekmez sample, produced using the traditional method, may have undergone more fermentation, been made from grapes with higher natural acidity, or been subjected to extended boiling or overripe fruit.

The water activity (aw) values in pekmez samples ranging from 0.59 to 0.74, indicated a relatively moderate to low a_w within this range. These results suggested that the samples exhibited good microbial stability, as they fell below the threshold that typically allows significant microbial growth (typically a_w greater than 0.85). A study on grape pekmez found that a_w values typically range from 0.55 to 0.78 (Salameh et al., 2020), which is consisted with the findings of this.

Table 1. Brix, pH, ash and HMF contents in pekmez samples

Samples	Brix (%)	pH	Ash content (%)	HMF (mg kg^{-1})
I1	72.77±0.19^a	5.56±0.01^a	1.99±0.01^a	28.45±1.71^a
I2	71.00±0.01^b	5.67±0.01^b	2.74±0.02^b	12.74±0.75^b
I3	70.93±0.05^b	5.57±0.00^a	3.15±0.06^c	10.46±2.02^b
I4	73.92±0.09^c	6.12±0.01^c	2.24±0.04^d	5.20±0.85^c
I5	70.33±0.08^b	6.05±0.02^c	1.69±0.03^e	1.86±0.33^d
I6	70.43±0.05^b	6.42±0.00^d	1.28±0.01^f	17.57±1.66^e
I7	70.53±0.04^b	5.85±0.01^e	2.79±0.05^b	24.54±1.21^f
I8	72.93±0.07^c	5.43±0.09^e	2.35±0.06^d	25.48±1.15^f
I9	69.03±0.12^d	5.48±0.01^e	2.70±0.01^b	29.05±0.55^a
I10	71.83±0.4^b	5.65±0.01^e	1.20±0.01^f	28.20±1.62^a
T1	73.83±0.24^c	5.34±0.02^e	1.65±0.02^e	43.22±0.75^g
T2	80.73±0.17^e	4.76±0.04^f	0.17±0.02^g	136.36±1.45^h

Different letters (a. b., etc.) in each column indicate statistical difference ($p < 0.05$). Data are means of triplicate.
±: Standard Deviation (n=3).

Table 2. Titratable acidity, water activity and colour properties in pekmez samples

Samples	Titratable acidity (%)	Water activity	L*	a*	b*
I1	1.48±0.05[a]	0.70±0.01[a]	2.23±0.14[a]	-0.15±0.09[a]	2.14±0.01[a]
I2	1.02±0.02[b]	0.73±0.01[b]	3.49±0.06[b]	2.23±0.27[b]	4.66±0.17[b]
I3	1.04±0.03[b]	0.72±0.00[b]	5.68±0.36[c]	5.75±0.18[c]	7.11±0.15[c]
I4	0.42±0.01[c]	0.68±0.01[c]	1.68±0.08[d]	-0.41±0.05[d]	1.73±0.10[d]
I5	0.74±0.04[d]	0.72±0.02[b]	6.46±0.43[e]	3.33±0.21[e]	7.15±0.39[c]
I6	0.19±0.01[e]	0.68±0.00[c]	1.97±0.09[d]	-0.52±0.05[f]	2.14±0.19[a]
I7	1.21±0.03[f]	0,72±0.01[b]	2.26±0.11[a]	-0.42±0.10[d]	1.98±0.08[e]
I8	1.16±0.05[f]	0.69±0.09[c]	1.77±0.08[f]	-0.50±0.05[f]	1.86±0.16[d]
I9	1.39±0.08[a]	0.74±0.01[b]	3.65±0.14[b]	2.14±0.04[b]	4.52±0.14[b]
I10	1.06±0.02[b]	0.73±0.01[b]	1.93±0.17[d]	-0.48±0.14[d]	1.69±1.62[d]
T1	1.63±0.01[a]	0.65±0.02[c]	1.91±0.15[d]	-0.06±0.02[e]	2.49±0.08f
T2	1.95±0.07[g]	0.59±0.04[d]	1.48±0.08[g]	-0.16±0.05[g]	2.11±0.01[a]

Different letters (a. b., etc.) in each column indicate statistical difference (p <0.05). Data are means of triplicate.
±: Standard Deviation (n=3).

Since grape molasses is typically dark in colour and ranges from red to brown tones, a low L* value, positive a* value, and positive b* value are generally expected. However, factors such as the production method, grape variety, and degree of ripeness can influence these values. L* values observed in this study ranged from 1.48 to 6.46, indicating colour variation from very dark to slightly lighter shades. These values reflect the typical deep brown to reddish-brown colour expected in grape molasses, resulting from sugar concentration and caramelisation during production. Similar findings have been reported in studies of other types of pekmez. For example, Yıldız et al. (2020) found that grape pekmez typically has lower L* values, ranging from 2.5 to 6. Toker et al. (2013) also noted a lower L* value of 1.41 in grape pekmez, which aligns with the colour characteristics observed in this study. Other studies on fruit molasses also show higher colour profiles, where L* values were generally above 10 (Bilgiçli & Akbulut, 2009; Aktaş, 2024). The a* values were found to range from −0.06 to 5.75 for grape molasses, indicating a slightly greenish to strongly reddish colour spectrum, which is typical for this product. When compared to other studies, the a* values for a few samples were in line with expectations for grape molasses, which often ranges from 1 to 5. Studies on grape molasses typically report a reddish-brown colour with moderate red (positive a∗) values; mostly negative a* values were determined in this study. However, negative a* values were reported in the literature (Aktaş, 2024). The greenish end of the spectrum could be due to small amounts of chlorophyll. At the same time, the reddish tones are likely attributable to anthocyanins and the caramelisation of sugars during the boiling process. The range of b∗ values from 1.69 to 7.15 suggested that the grape molasses exhibited a moderate yellowish colour, with a slight increase in the intensity of yellow as the b∗ values increased. This is typical for molasses made from grapes, where the colour ranges from golden to amber depending on the processing conditions, grape variety, and concentration levels. When compared with other studies, findings in this study align well with the typical colour profiles of grape molasses, which generally fall in the 1 to 5 range for b∗ values (Aktaş, 2024). The yellowish tones in molasses are not overly intense, which may suggest that it is not excessively caramelised or concentrated. However, it retains some of the natural yellowish hues from the grapes.

Conclusion

In this study, the analysis of both industrial and traditional pekmez samples demonstrated considerable variability in their physicochemical properties. These findings were carefully compared with the standards outlined in the Turkish Pekmez Codex (2017), highlighting discrepancies and variations across the samples. The °Brix values ranged from 69.03% to 80.73%, which are in accordance with the standards outlined in the Turkish Pekmez Codex. It was observed that one of the traditional samples (T2), with a pH of 4.76, falls within the sour pekmez group. It was determined that the pH values of the other samples were within the limits specified in the Codex. As a result of the ash analysis, it was determined that four industrially produced pekmez samples exceeded the limits. Notably, HMF concentration varied widely, ranging from 1.86 mg/kg to 136.36 mg/kg. It was found that the traditional pekmez sample, T2, exceeded the limit value of 75 ppm, characterised by a very high HMF concentration. Furthermore, the titratable acidity values (0.19%

to 1.95%) illustrated notable variation in the acidity levels. Water activity values ranging from 0.59 to 0.74 suggested that pekmez samples possess moderate to low water activity. The colour analysis, as indicated by L*, a*, and b* values, revealed a broad spectrum from very dark to slightly lighter shades, with a suitable shift from greenish to reddish hues, typical of grape pekmez. Additionally, the moderate yellowish hue observed, indicated by the b* values, further underscores the characteristic colour range of pekmez. These findings provide valuable insights into the quality and variability of pekmez, highlighting factors such as the production method, raw material composition, and processing conditions that contribute to the observed differences in physicochemical properties. Such data are crucial for understanding the product's overall quality, stability, and sensory attributes.

Compliance with Ethical Standards

Conflict of interest: The author(s) declare that they have no actual, potential, or perceived conflicts of interest related to this article.

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References

Aktaş, N. (2024). An improved differential scanning calorimetry study for thermal properties of pekmez samples adulterated with sugar syrup. *Gıda*, 49(1), 132-141. https://doi.org/10.15237/gida.GD23123

AOAC International (2000). *Official methods of analysis of AOAC International* (Vol. 17, No. 1-2).

Basaran, B., Kanbur, E.D., Birinci C., Aydin, F. (2021). Determination of acrylamide and 5-hydroxymethyl-2-furfural (HMF) levels and related parameters in Turkish pekmez (A traditional fruit product). *Journal of Food Quality and Hazards Control*, 8(4), 169-177. https://doi.org/10.18502/jfqhc.8.4.8258

Bilgicli, N., Akbulut, M. (2009). Effects of different pekmez (fruit molasses) types on chemical, nutritional content and storage stability of cake. *Journal of Food Quality*, 32(1), 96-107. https://doi.org/10.1111/j.1745-4557.2008.00238.x

Elmastaş, A., Aydin, F., Umaz, A., Kılınç, E., Arslan, Y., Aydin, I. (2022). Determination of hydroxymethylfurfural in Turkish honeys, pekmez (grape molasses) and jam samples by high-performance liquid chromatography with diode array detection. *Journal of Food Processing and Preservation,* 46(4). https://doi.org/10.1111/jfpp.16462

Gamlı, Ö.F. (2022). Physicochemical properties of pine cone molasses (pekmez) from Pinus nigra and Pinus brutia in Osmaniye. *Journal of Food Processing and Preservation*, *46*(12), e17264. https://doi.org/10.1111/jfpp.17264

Kalaycıoğlu, Z. (2023). Characterisation of pekmez samples produced with different fruits according to sugar, organic acid, antioxidant activities, and moisture contents. *Journal of the Institute of Science and Technology*, *13*(1), 458-467. https://doi.org/10.21597/jist.1176404

Kalili, A., El Ouafi, R., Aboukhalaf, A., Naciri, K., Tbatou, M., Moujabbir, S., Belahsen, R. (2023). Nutritional composition and bioactive compounds in a local grape variety Vitis Vinifera L. cultivated in Morocco. *Roczniki Państwowego Zakładu Higieny*, 74(1).

Karataş, N., Şengül, M. (2018). Dut pekmezinin bazı kimyasal ve fiziksel özellikleri ile antioksidan aktivitesi üzerine depolamanın etkisi. *Türk Tarım ve Doğa Bilimleri Dergisi*, *5*(1), 34-43. https://doi.org/10.30910/turkjans.471333

Kaya, C., İyibil, M.D.A., Esin, Y. (2012). Bazı ticari sıvı ve katı üzüm pekmezlerinin özellikleri. *Akademik Gıda*, 10(3), 32-39.

Narkabulova, N., Jabborov, Z. (2023). Physico-chemical analysis of pekmez products made from grape varieties grown in the conditions of Uzbekistan. *E3S Web of Conferences*, 381, 01019. https://doi.org/10.1051/e3sconf/202338101019

Salameh, C., Abi Khalil, A., Kassouf, A. (2024). Multivariate investigation of physicochemical, nutritional and sensory

attributes of traditional Lebanese grape molasses. *Discover Food* 4(48).
https://doi.org/10.1007/s44187-024-00111-w

Salık, M.A., Arslaner, A., Çakmakçı, S. (2021). Determination of some physical, chemical and antioxidant properties of Erzincan traditional mulberry pekmez (molasses). *Turkish Journal of Agriculture - Food Science and Technology*, 9(1), 181-190.
https://doi.org/10.24925/turjaf.v9i1.181-190.3802.

Tetik, N., Turhan, İ., Karhan, M., Öziyci, R.H. (2010). Characterization of, and 5-hydroxymethylfurfural concentration in carob pekmez. *Gıda*, 35(6),417-422.

Toker, O.S., Dogan, M., Ersoz, N.B., Yılmaz, M.T. (2013). Optimization of the content of 5-hydroxymethylfurfural (HMF) formed in some molasses types: HPLC-DAD analysis to determine effect of different storage time and temperature levels. *Indutrial Crops and Products*, 50, 137–144.
https://doi.org/10.1016/j.indcrop.2013.05.030

Türkben, C., Suna, S., İzli, G., Uylaşer, V., & Demır, C. (2016). Physical and chemical properties of pekmez molasses produced with different grape cultivars. *Journal of Agricultural Sciences*, 22(3), 339-348.
https://doi.org/10.1501/Tarimbil_0000001392

Yavuz-Küçük, A., Duraklı-Velioğlu, S. (2022). Keçiboynuzu Özü adı altında satışa sunulan ürünün bazı kimyasal özelliklerinin belirlenmesi ve keçiboynuzu pekmezi ile karşılaştırılması. *Gıda*, 47(5), 889-903.
https://doi.org/10.15237/gida.GD22033

Zappala, M., Fallico, B., Arena, E., Verzera, A. (2005). Methods of determination of HMF in honey: A comparison. *Food Control*, 16, 273–277.
https://doi.org/10.1016/j.foodcont.2004.03.006