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RESEARCH ARTICLE

Production and Some Quality Parameters of Sugar Beet Sweets (Pestil and Köme)

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Abstract Pestil and köme are popular Turkish sweets produced from different fruit juices/concentrates/pekmez, honey, different nuts and flour/starch. These products are very appetizing and have high nutritional value. Pestil and köme are produced especially from mulberry and grapes for thousands of years by traditional methods. In the recent times, they have started to be produced from beet pekmez after the start of the sugar beet cultivation in Turkey. In the study, these products were prepared from sugar beet and some physical (moisture, crude fiber, protein, total sugar, invert sugar, raw oil and thickness), chemical (HMF, TPC, TFC, FRAP and aflatoxin) and sensory properties of the sweets were investigated. Total phenolic contents and total antioxidant capacities of samples were analyzed by Folin-Ciocalteu's method and FRAP, respectively. Aflatoxin analyses were determined with HPLC-FLD, and phenolic compositions of products were quantified with RP-HPLC-UV-Vis. Our results revealed that pestil and köme produced were having different properties ranged from 14.42 to 17.31% for moisture, 0.98–1.62% for crude fiber, 4.98–6.91% for protein, 22.08–25.64% for total sugar, 14.79–16.15% for invert sugar and the thickness, raw oil, HMF ranged from 0.92 to 1.12 mm, 10.35–14.34% and 15.24–22.37 mg/kg, respectively. The results indicated that the quality of sweets produced from sugar beet was as high as those produced from mulberry or grapes. Additionally, using sugar beet as raw material in pestil and köme production would be a good alternative source of income for farmers around the world.

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Introduction

Today, there is increasing interest of consumers in natural products for the nutritional and health properties (Viswanath et al. 2018). This trend enabled the industry to bring traditional products and the design of new foods. Snack sweets have been widely produced by many different processes due to their sugar and rich nutritional components as an alternative to sweetened products (Paris 2015; Radia et al. 2018; Viswanath et al. 2018; Yildiz 2013). Sugar beet is believed to have originated from Asia and widely cultivated in temperate climate. However, it is grown under irrigation in arid-semi-arid regions (Baran and Gokdogan 2016; Karadeniz 2016). Konya is the largest producer of sugar beet crop in Turkey. Sugar beet is cultivated in more than 50 provinces, especially in Yozgat, Eskişehir, Aksaray, Kayseri, Afyonkarahisar, Gümüşhane, Erzincan in Turkey (Anonymous 2018). Although sugar beet is used for sugar production, it is also used in pekmez, pestil and köme productions in some regions in Turkey.

Pestil and köme are reported as traditional sweets with high nutrient contents such as mineral and vitamin in Turkey (Taş et al. 2018). Pestil is a natural product of various fruits that is commonly produced in Anatolia, Armenia, Lebanon, Syria, Arabia, Persia and the USA. Similar products to the pestil are produced in these countries named as "fruit leather", "bas-tegh", "lavashak" and "qamar al deen" (Sengül et al. 2010; Tontul and Topuz 2019; Yılmaz et al. 2017).

Many types of fruits such as grape, mulberry, apricot, apple, rosehip, plum, pear, fig, peach and kiwi are used in

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pestil production around the world (Tontul and Topuz 2018; Yildiz 2013; Yılmaz et al. 2017). In addition to, pestil is defined as "concentration of grape, plum, apricot and mulberry juice or pulps with the addition of edible starch, sugars and additives and dried in thin layer form" according to Turkish Standards. Pestil is produced in different production steps and by using different ingredients like sugar or starch according to the geographical regions (Sengül et al. 2010; Yildiz 2013). Unlike the general recipe, Gümüşhane pestil and köme contain honey, wheat flour and milk. Gümüşhane pestil is a softer and brighter feature compared to other pestils. Due to these differences in prescribing, in order to protect traditional foods, "Geographical Registration Certificate (GRC)" was obtained to Gümüşhane pestil and köme from the Turkish Patent Institute (Gümüşhane Governorate 2004a, b).

Köme is a traditional sausage-shaped sweet of Gümüşhane produced from white mulberry (*Morus alba*). There are some similar products produced from different fruits in the world. They are known as orcik, walnut candy and walnut sujuk, churchkhela. String nuts are dipped into the hot fruit juice concentrate then waited approximately 10–15 s and dried by hanging at normal room conditions (Golge et al. 2016; Yildiz 2013).

The mold problem can be observed in köme during shelf life. This is usually due to the microbial load from the walnut. As mold is in the walnut, it can be seen only when the köme cut (Erdogan et al. 2003). Aflatoxin is a toxin produced by molds and possesses a risk for pestil and köme due to the content of walnuts and nuts.

An agricultural product affects the culture in the region where it grows. Sugar beet has contributed to the sociocultural habits of Anatolian societies for 100 years. It has an important role in the development of sweet culture. Sugar beet replaced fruit juices which are the main raw material of pestil/köme in time. Thus, sugar beet pestil/köme was produced.

Pestil and köme are industrialized and produced in small and medium-scale factories for decades. They are value-added products alternative to fruits that a source of various nutritional elements including dietary fibers, carbohydrates, minerals, vitamins and antioxidants (Chen and Martynenko 2018; Suna and Özkan-Karabacak 2019). Thus, it is necessary to investigate the physical and biochemical compositions as well as the consumer's desirableness of these products.

In the light of this information, the purposes of the current study are to produce and evaluate the some physical, chemical and sensory properties of pestil and köme from sugar beet.

Up to now, other researchers focused primarily on the chemical composition, farming and sugar production process of beets. However, to the authors' knowledge, no study has been made on sugar beet pestil and köme. Therefore, the paper will encourage further researches about the processing of sugar beet to new foods and creating alternative sources of income for farmers.

Materials and Methods

Ingredients

Sugar beets were provided by local farmers from Siran, Gumushane, Turkey in 2018. Beets were stored as fresh. Other ingredients used in production such as honey, nuts and milk were supplied from local village market. Flour (Ulusoy Flour Factory Inc., Samsun, Turkey) were purchased from markets.

Chemicals and Reagents

Methanol, acetonitrile and the other chemicals used in the study were purchased from Merck Co. (Darmstadt, Germany). Standard solutions of AFB1, AFB2, AFG1, AFG2, Quercetine, Gallic acid, Trolox® (6-Hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid) and TPTZ (2,4,6-tripyridy-s-triazine) were supplied from Sigma Chemical (St. Louis, MO, USA). All the chemicals used were analytical grade.

Production Process

The coarse sludge of sugar beet was washed with pressurized water in containers. The remaining foreign materials and dirtiness in beets were washed away in universal washing machine (Kerimoglu Food Machine, Trabzon, Turkey). Beets were minced using a grater machine (Kurtsan, Bursa, Turkey) and conveyed to boiler with water nearly 3 times of fruits (Boiler, Kurtsan) and boiled for 60 min with constant stirring. The must was separated using a two-stage sieve (1 and 0.3 mm) extractor (Turboextractor, Kurtsan). Obtained must (Şıra in Turkish) was boiled to a viscose structure in the vacuum boiler (− 560 mmHg). Thus, pekmez was obtained (Yildiz et al. 2015). Both pekmez and must can be used in the production of sweets. While syrup can be used in beet season, pekmez can be used in other seasons because shelf life is long. Local prescription for products contents 200 kg of must, 20 kg of honey, 7 L of milk and 20 kg of flour. About 50 L warm must and all milk were mixed well, added to the remaining ingredients and taken to the boiler for production, boiled with stirring about 2 h, allowed to stand hot for 1 h (Boiler, Kurtsan). The local name of obtained hot mixture is herle. Half of the mixture was used

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in pestil production and the other half was used in köme production.

About 10% hazelnut or walnut of the final mixture was added to mixture. These mixtures were thinly spread over the clothes and allowed to dry under the sun in summer (Fig. 1). The temperature was 25–30 degrees. About 5 h later, cloths of pestils were turned wrong side and wet. Pestils were peeled from the clothes and dried again under the sun for 10 min (Yildiz 2013).

Köme was made by repeatedly dipping a long string of walnuts in mixture. It was threaded to needle with about 40–50 cm length of strong thread. Walnut halves were threaded onto the thread with the flat side of the nuts facing up. The ropes were removed from the needle and knotted the end. It was kept hold of one end of the thread, carefully placed a strand of threaded walnuts into the mixture (herle), waited 10–15 s, hung up to a high place and allowed to dry under the sun for 2 days. The same procedure was repeated three times (Fig. 2).

Physical and Chemical Analysis

The methods detailed by AOAC (2010) were used to determine total dry matter, moisture, total soluble solid (TSS), ascorbic acid, pH, total acidity, crude fiber, fat, ash, protein of raw materials and product. Total dry matter and moisture were analyzed using the air oven method; total soluble solid was determined with hand refractometer; pH was obtained using the digital pH meter calibrated with pH 4 and 7 buffers; total acidity was expressed as percentage of citric acid. Protein and fat content were analyzed as per the Kjeldahl method and Soxhlet extraction method, respectively. Also, total sugar and invert sugar analysis of samples were carried out using the method suggested by Cemeroglu (2007). The walnuts and hazelnuts in pestil were separated before the thickness of pestils is measured using micrometer to get more correct results.

Hydroxymethylfurfural (HMF) contents of samples were analyzed quantitatively following the procedure described by Aliyazicioglu et al. (2009) with a spectrophotometer (Shimadzu UV-2450, Shimadzu Corporation, Kyoto, Japan) at 550 nm. Spectrophotometric methods based on the reaction between HMF, barbituric acid and *p*-toluidin and HMF, occurring a red-colored complex (Sengül et al. 2005).



Fig. 1 Spread pestil



Fig. 2 Köme in different production stages

Antioxidant activities of samples were determined by total phenolic content (TPC), total flavonoid content (TFC) and ferric reducing antioxidant power (FRAP) assay.

A modified version of the Foline Ciocalteu assay was used to determine the total phenolics content in the samples as mg gallic acid per 100 grams' sample (Sharma et al. 2016; Slinkard and Singleton 1977). In briefly, 0.1 g of samples were dissolved in 1 mL of pure water to prepare extract. Extract (20 µL), a pure water (1.58 mL), sodium carbonate (300 µL) and Folin–Ciocalteau reagent (100 µL) were added to test tube and the mixture was vortexed. The mixture was incubated for 30 min at 40 °C. The absorbance was read against the blank at 760 nm using a spectrophotometer (Shimadzu UV-2450, Shimadzu Corporation, Kyoto, Japan). Total flavonoid contents of samples were quantified with the spectrophotometric method (415 nm) reported Fukumoto and Mazza (2000). The results were calculated using quercetin (Q) as standard

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flavonoid and presented mg quercetin equivalent (QE) per 100 grams' sample.

Total antioxidant capacities were determined by using FRAP assay (Benzie and Strain 1999) based on the reduction in a ferric-tripyridyltriazine complex to its ferrous, colored form in the presence of antioxidants. Samples extracts' filtrates (40 µL) were mixed with 200 µL water and 1.8 mL FRAP reagent contained 1.67 mM Fe(III) and 0.83 mM TPTZ. The mixtures were waited at 37 °C for 10 min and measured absorbance with spectrophotometer at 593 nm. Trolox® solution was used as reference antioxidant. The results were expressed as the concentration of antioxidants having a ferric reducing ability equivalent to that of 1 mM Trolox ® equivalent/g.

Phenolic compositions of samples were measured according to Çakir et al. (2018) with slight modifications using HPLC–UV. 5 grams of each pestil and köme samples were mixed 50 mL of methanol and stirred with a shaker. Mixture was centrifuged at 3000 × g (Hettich model 320 R, Tuttlingen, Germany) for 10 min at 4 °C and evaporated by rotary evaporator (IKA-Werke, Staufen, Germany) at 40 °C.

For redissolve, 20 mL acidified water at pH 2 with HCl was added to residue. Liquid–liquid extraction was performed successively using diethyl ether and ethyl acetate. Both the diethyl ether and ethyl acetate phases were dried by rotary evaporation at 35 °C. The pellets were redissolved in 2 mL of methanol, filtered through syringe filters (0.45 µm) and injected into system. Elite LaChrom Hitachi HPLC system (Hitachi, Japan), Kyoto, Japan) consisted of UV–Vis detector equipped with a pump system with an auto sampler. The mobile phase consisted of (A) 2% acetic acid in water and (B) acetonitrile: water (70:30). The sample injection volume was 20 µL, the column temperature 30 °C and the flow rate 0.75 mL/min. The programmed solvent used began with a linear gradient held at 95% A for 3 min, decreasing to 80% A at 10 min, 60% A at 20 min, 20% A at 30 min and finally 95% A at 50 min. Three injections were performed for each sample. The authentic standards such as gallic acid, protocatequic acid, *p*-OH benzoic acid, catechin, caffeic acid, syringic acid, epicatechin, *p*-Cumaric acid, ferulic acid, rutin, myricetin, resveratrol, daidzein, luteolin, *t*-cinnamic acid, hesperetin, chrisin, pinosembrin and CAPE (Caffeic acid phenethyl ester) were used for quantification. The phenolic components were quantified by comparison with peak areas of each standard (Fig. 3).

Analysis for Aflatoxin

The modified AOAC Official Method 991.31 (1994) and Official Method 999.07 (1999) were used to detect total aflatoxins (AFs) levels and aflatoxin B1 (AFB_1) levels in products using HPLC-FLD (HP1100 Series, Agilent Technologies, United States).

50 g sample from ground representative sample and 5 g of NaCl were blended with methanol/deionized water (125 mL/100 mL) using a Waring blender at high speed for 2 min after which the extract was filtered using a filter paper (Whatman No. 4). After filtration, 20 ml of the extract were diluted with 20 ml deionized water and filtered through glass microfiber filter.

An immunoaffinity column (IAC AflaTest Ò,Vicam, USA) was used for clean up the diluted extract. The diluted filtrate (20 mL) was passed through the IAC column flow rate of about 1–2 drop/s, following the column was washed 20 ml water at a flow rate less than 5 ml/s and then dried with air. Next, aflatoxin was slowly eluted which based on 1 mL of methanol was applied on the column and collected into the vial. Finally, the eluate was diluted with 1.5 mL deionized water and stored at 18 C for analysis by HPLC.

The determination of aflatoxins in samples was based on high-performance liquid chromatography (HPLC) with fluorescence detection (FLD) with a flow rate of 1.0 ml/min, and the column temperature (C18, 5 µm, 4.5 × 250 mm) was adjusted to 22 °C. The retention times of AFB1, AFB2, AFG1 and AFG2 were 12.159; 10.054; 8.951; and 7.556 min, respectively. The average recoveries for total AFs and AFB1 were found 85.4% and 84.7%. 100 µL of the sample was injected onto the column.

The isocratic mobile phase was methanol/water/acetonitrile (300:550:200, v/v/v), containing 120 mg/L KBr and 350 µL HNO_3 and pumped at a flow rate of 1 $ml.min^{-1}$. The determination of AFs was performed by scanning with a fluorescence detector at A 365 nm excitation wavelength.

Color Analysis

The measurements of the colors of samples were obtained with a Minolta CR-10 colorimeter (CR-10, Minolta, Osaka, Japan) by using the method suggested by Çakmak et al. (2016). Hunter *L*, *a*, *b* color space was obtained as the mean of three replicates. *L* is scaled from 0 (black) to 100 (white); *a* indicates green ($-a$) and red ($+a$); *b* indicate blue ($-b$) and yellow ($+b$).

Sensory Evaluation

The sensory characteristics of the pestil and köme were estimated using the 9-point hedonic scale applied by Patil et al. (2017). A total of 40 semi-trained panel member (20 females and 20 males), which are student and academic staff in Department of Food Technology, Macka Vocational School, between the ages of 18 and 35, were selected for this analysis. The evaluated attributes included odors

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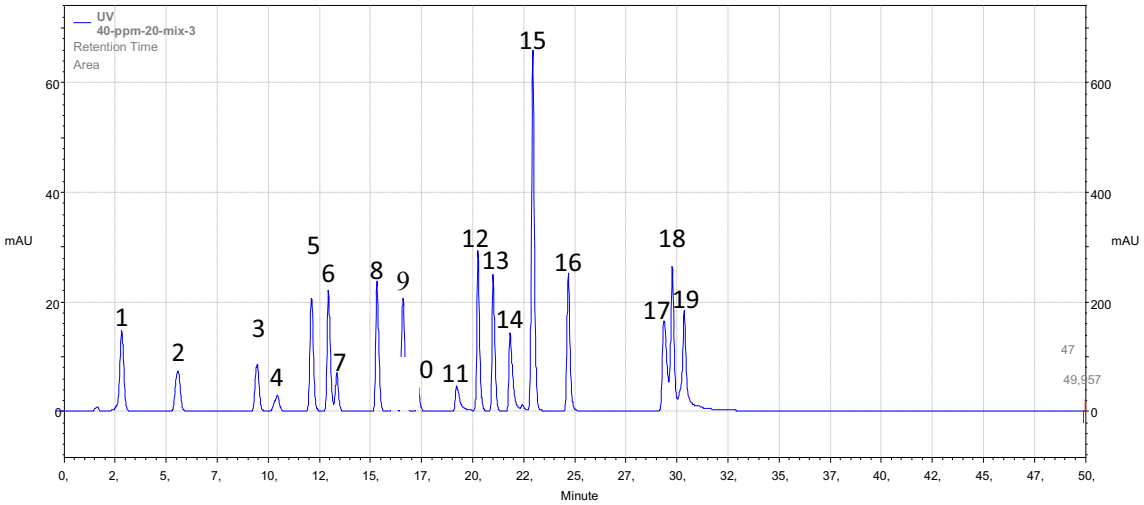


Fig. 3 HPLC-UV chromatograms of phenolic compounds. 1. Gallic acid, 2. Protocatequic acid, 3. p-OH benzoic acid, 4. Catechin, 5. Caffeic acid, 6. Syringic acid, 7. Epicatechin, 8. *p*-Cumaric acid, 9. Ferulic acid, 10. Rutin, 11.Myricetin, 12.Resveratrol, 13. Daidzein, 14. Luteolin, 15. t-cinnamic acid, 16. Hesperetin, 17.Chrisin, 18. Pinosembrin, 19. CAPE (Caffeic acid phenethyl ester)

and tastes, brightness (bright or undertone), hardness–softness, dispersion in the mouth and overall acceptability. The acceptance tests were performed at room temperature illuminated with fluorescent lights and crackers and water were provided to the panelists for use in transitions between samples. The panelists scored through rating of product on a 9-point Hedonic Scale, where 1 expresses extremely disliked, 5 expresses neither dislike nor like and 9 expresses extremely liked.

Statistical Analysis

Results of all analyses were statistically analyzed SPSS software 20.00 (SPSS Inc., Chicago, IL, USA). All results were expressed as the mean and standard deviation of the three independent determinations. The one-way analysis of variance (ANOVA) with a Duncan multiple range tests ($p \leq 0.05$) was carried out to determine differences between the mean values. The statistical differences between the characteristics of different products on the same line were shown in lower case.

Results and Discussion

Physicochemical Parameters of Products

The results of physicochemical parameters are presented in Table 1. There were statistically differences among samples in terms of all parameters except total sugar and invert sugar ($p < 0.05$). Moisture contents (%) of pestil and köme samples were found to be between 14.42 and 17.31. Moisture content is one of the most important properties in pestil and köme, so that this value is desired to be low for a long-time storage of products without spoilage. In a research carried by Kamiloglu and Capanoglu (2014), the moisture contents of white apricot and plum pestil were determined in the range of 10–18 g/100 g. In another study (Suna et al. 2014), the moisture contents in apricot pestil samples were found between 13.12 ± 1.35 and 14.39 ± 0.41 g/100 g, which are similar to our results. Statistically the lowest ash content (0.49%) was in pestil with walnut while the highest ash content (0.71%) was in köme because they contain more shells. Cagindi and Otles (2005) investigated some chemical properties of different types of pestil obtained from local markets in Turkey. The ash contents of grape (three varieties), mulberry (three varieties) and apricot (three varieties) pestils were between 0.2 and 0.7, 1.6–2.0 and 3.1–3.6%, respectively. In another study, Sengül et al. (2010) found that mulberry with peanut and mulberry with walnut pestil had an ash content of 0.46 and 0.30%.

Considering pestil as edible film and very thin sweets, the other important physical parameter is thickness. It was observed that the thickness values of sugar beet pestils varied between 0.92 mm and 1.12 mm but there was no statistically significant difference ($p < 0.05$) in both the samples. Earlier, thicknesses of pestils was determined similar to our findings to be between 0.5 and 1.2 mm (Kaya and Maskan 2003).

The acidity values of pestils with hazelnut and pestils with walnut were found 0.25% and 0.20%, respectively, and they were statistically in the same group. It is thought that the highest acidity value of köme was caused by high walnut content. Similar results were observed in the study of Eksi and Artik (1984). Total acidity of mulberry, plum,

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Table 1 Physicochemical parameters of samples

Studied parameters	Pestil with hazelnuts	Pestil with walnuts	Köme
Moisture %	14.42 ± 1.12^{a}	16.48 ± 1.32^{ab}	17.31 ± 2.11^{b}
Total dry matter %	85.58 ± 1.12^{b}	83.52 ± 1.32^{ab}	82.69 ± 2.11^{a}
Ash %	0.69 ± 0.09^{b}	0.49 ± 0.08^{a}	$0,71 \pm 0,12^{b}$
Acidity (citric acid) %	0.25 ± 0.05^{a}	0.20 ± 0.08^{a}	0.33 ± 0.04^{b}
Crude fiber %	1.62 ± 0.14^{a}	$2,18 \pm 0.12^{b}$	1.60 ± 0.30^{a}
Protein %	4.98 ± 0.32^{a}	5.77 ± 1.10^{b}	6.91 ± 0.33^{c}
Raw oil %	11.72 ± 0.65^{a}	10.35 ± 0.38^{a}	14.34 ± 0.45^{b}
Total sugar %	25.64 ± 4.32^{a}	25.55 ± 4.21^{a}	22.08 ± 2.35^{a}
Invert sugar %	16.15 ± 1.25^{a}	16.09 ± 1.49^{a}	14.79 ± 1.58^{a}
Thickness (mm)/diameter	$0,92 \pm 0.15^{a}$	1.12 ± 0.18^{a}	$25,66 \pm 3.22^{b}$
HMF (mg/kg)	17.26 ± 1.72^{a}	15.24 ± 1.44^{a}	22.37 ± 1.39^{b}
Aflatoxin B_1 (μg/kg)	ND	ND	ND
Total aflatoxin (μg/kg) (B_1,B_2,G_1,G_2)	ND	ND	ND

All findings show mean of six determinations and ± SD (standard deviation); means followed by the same letter in line are not statistically different ($p < 0.05$). HMF: Hydroxymethylfurfural; ND: not detectable

apricot and grape pestil types were found 0.2, 2.3, 6.2 and 0.7%, respectively. The raw fiber contents of the products were low because sugar beet must (in Turkish "Şira") was separated from the fibers. The fiber content of the product can be enriched with less filtration. Raw oil (%) of pestils and köme are mostly caused by nuts and walnut. Therefore, the highest crude oil value was found in the köme as 14.34%. Total protein contents of köme (6.91%) were higher than those of pestil types. Yildiz (2013) stated in previously study that, crude oil and protein content of pestil and köme samples were ranged from 13.24 to 16.04% and 5.74–7.42%, respectively. Conversely, Cagindi and Otles (2005) determined the fat and protein content of pestil produced from different fruits. Their results showed that the fat content was 0.2–3.4% and protein content was 3.0–4.6%. Our results are higher than those values, this differences may be originated from the difference product composition and processes types. All products' sugar contents were quite high and a significant portion of the sugar was in the form of invert sugar. Yildiz et al. (2015) studied properties of sugar beet pekmez and found the amount of total sugar and invert sugar to be 29.3% and 15.5%, respectively. As stated in the study of Sengül et al. (2010), total and reducing sugar contents of mulberry pestil were found between 30.91 and 54.60 (%) and 21.38–41.05 (%). Our findings were lower than the researchers' findings because our product did not contain additional sugar.

Our results clearly indicated that physicochemical parameters of pestil and köme had some differences compared with other studies in the literature. It is thought that these differences may arise from used different fruits, ingredients and the difference in production of the pestil and köme.

HMF formation is an important risk in foods that contain sugar and protein (Maillard, 1912). HMF is an indicator of heat treatment in foods and is limited to standards. For example, maximum HMF contents in pekmez and honey are 75 mg/kg and 40 mg/kg, respectively (Turkey Food Codex 2000, Codex Alimentarius 1981). HMF concentrations of sugar beet pekmez were found as 78.2 mg/kg by researchers (Yildiz et al. 2015). In addition, in another study, researchers (Higginbotham and McCarthy, 1998) found that beet molasses contains about 20 mg/kg HMF and sugar cane molasses contains 40 mg/kg HMF. In current study, HMF content of all studied samples was between 15.24 and 22.37 mg/kg. HMF contents of pestil and köme collected from Trabzon and Gümüşhane have been determined as being in the range from 1.3 to 45.3 mg/kg (Baltaci and Aksit 2016). Additionally, it has been reported that HMF value in mulberry and date pestil were found as 23.29 and 123.71 mg/kg, respectively. HMF contents of all samples in our study were less than those of standards and pestil or köme studied in the literature.

The antioxidant activity results of the in studied samples were given in as total phenolic content (TPC), total flavonoid contents (TFC) and ferric reducing antioxidant power (FRAP) (Table 2). There were significant differences among TPC, TFC and FRAP values of pestil types and köme ($p < 0.05$). All assays revealed that the highest level of TPC, TFC and FRAP values were found in pestil with walnut, while the lowest were in köme. Pestil with walnut had phenolic content of 38.34 mg GAE/100 g; total flavonoid content of 3.76 mg QE/100 g; FRAP vales of

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Table 2 Antioxidant activities of products

Sample	TP (mg GAE/100 g)	TF (mg QE/100 g)	FRAP (mM TE/g)
Pestil with hazelnuts	35.50 ± 3.12[b]	3,11 ± 0.82[b]	112,45 ± 13.22[b]
Pestil with walnuts	38.24 ± 2.95[b]	3,76 ± 0.77[b]	132,17 ± 15.14[b]
Köme	30.56 ± 2.35[a]	2,17 ± 0.17[a]	93.87 ± 9.63[a]

All findings show mean of six determinations and ± SD (standard deviation); means followed by the same letter in column are not statistically different ($p < 0.05$). TP: total phenolic; TF: total flavonoids; FRAP: the ferric reducing antioxidant power

132.17 mM TE/g. Earlier, sugar beet pekmez's antioxidant activity as total phenolic content, flavonoid content, FRAP value and DPPH activities were found as 185.0 mg GAE/100 g, 1.3 mg QE/100 g, 11.245 mM TE/g and 5.108 mg/mL, respectively (Yildiz et al. 2015). As it is seen, by processing molasses into the product and adding different ingredients, it has turned into highly antioxidant products.

Kamiloglu and Capanoglu (2014) reported that total phenolics content of grape and white mulberry leather were 72.0 and 28.0 mg GAE/100 g, respectively. Besides, total phenolic content of apricot pestil (Suna et al. 2014) was determined as between 110.03 and 121.24 mg GAE/100 g. Another study revealed that TPC in mulberry pestil ranged from 27.42 to 32.24 mg GAE/100 g (Yildiz 2013). These studies showed that TPC in the current work was found similar compared to grape and mulberry leather in other literature work.

The total flavonoid contents (TFC) of samples were found between 2.17 and 3.76 mg QE/100 g. Kamiloglu and Capanoglu (2014) studied on total flavonoid contents of pestil produced from different fruits. Their analyses' result showed that grape, white mulberry and apricot pestil was determined in the range of 16–69 mg CE/100 g.

FRAP is frequently used to determine the antioxidant activities of foods which is a simple assay that gives reproducible results (Benzie and Strain 1996). Pestil and köme samples in our study showed considerable antioxidant activity in FRAP assay, and their values were ranged from 93.87 to 132.17 mM TE/g. Pestil samples showed higher antioxidant activities than köme sample. In previously performed study, FRAP activities of pestil with hazelnuts, pestil with walnuts and köme produced from mulberry were reported 86.2, 88.4 and 81.2 mM TE/g, respectively. In fact, this difference in antioxidant activity can be attributed to processing conditions and sugar beet contained in the product.

Phenolic compounds have proven antioxidant capacity via various actions such as hydrogen donation, free radical scavenging, metal ion chelation. The phenolic compounds identified are presented in Table 3. Rutin, myricetin, resveratrol, daidzein, luteolin, hesperetin, chrisin, pinosembrin and CAPE (Caffeic acid phenethyl ester) weren't detected in the studied samples but gallic acid, catechin, syringic acid and ferulic acid were found in significant amounts in all samples. Among the studied samples, phenolic compound content of köme statistically differed from pestil samples which was the richest in terms of phenolic content. This is thought to be due to the excess walnut content. Some phenolic compounds, i.e., gallic acid, vanillin, hydroxybenzoic acid, syringic acid and ferulic acid were determined by HPLC–DAD-MS/MS in sugar beet molasses in a previous study (Chen et al. 2015). In addition, Filipčev et al. (2016) reported in a study that gallic acid, vanillic acid, syringic acid, *p*-hydroxybenzoic acid, ferulic acid, *p*-coumaric acid and catechin were important component in the sugar beet. The findings show that these products are a good source of phenolic substances. However, the source of the phenolic compounds detected in these products is not only sugar beet but also honey and other ingredients entering the product composition. There are many studies on phenolic substances in the structure of honey in the literature (Can et al. 2015; Çakır et al. 2018; Kıvrak and Kıvrak 2017; Vasic et al. 2019). Further studies should be carried out to determine whether a phenolic substance comes from honey or sugar beet. The phenolic profile should also be tested at the raw material stage.

Aflatoxin Contents of Products

Aflatoxins (B1, B2, G1, G2), which are serious risk especially in hazelnut and walnut-containing products, were not detected in our samples after a month shelf life at room temperature. The absence of aflatoxins, produced by some Aspergillus species, shows that there is content against the growth of Aspergillus species in our products. The aflatoxin (B1 (AFB1), B2 (AFB2), G1 (AFG1), G2 (AFG2)) contents of 24 different fruit leather samples (10 grape, 8 plum, 6 apricot) obtained from the Aegean region were determined HPLC-FLD. Total aflatoxins (AFs), AFB2 and AFB1 contents of fruit leathers changed between 0.20 and 5.83, 0.20–1.88, and 0.48–4.96 µg/kg, respectively (Cagindi and Talay 2017). Erdogan et al. (2003) researched aflatoxin contents of köme samples produced from

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Table 3 Phenolic compositions of samples

Compounds (μg/g)	Samples		
	Pestil with hazelnuts	Pestil with walnuts	Köme
Gallic acid	1.28 ± 0.25[a]	1.33 ± 0.39[a]	1.55 ± 0.15[b]
Protocatequic acid	0.89 ± 0.05[b]	0.70 ± 0.09[a]	1.12 ± 0.26[c]
p-OH benzoic acid	0.55 ± 0.02[a]	0.67 ± 0.07[b]	0.97 ± 0.12[c]
Catechin	9.21 ± 0.12[a]	8.35 ± 1.23[a]	11.28 ± 2.26[b]
Caffeic acid	0.65 ± 0.08[a]	0.58 ± 0.08[a]	0.87 ± 0.10[b]
Syringic acid	1.24 ± 0.32[a]	1.30 ± 0.26[a]	1.36 ± 0.21[a]
Epicatechin	0.85 ± 0.14[a]	0.67 ± 0.12[a]	0.98 ± 0.16[b]
p-cumaric acid	0.76 ± 0.12[a]	0.73 ± 0.09[a]	1.13 ± 0.14[b]
Ferulic acid	1.98 ± 0.25[a]	1.85 ± 0.28[a]	2.33 ± 0.38[b]
t-cinnamic acid	0.58 ± 0.24[a]	0.41 ± 0.08[a]	0.89 ± 0.15[b]

All findings show mean of three determinations and ± SD (standard deviation); means followed by the same letter in same line are not statistically different ($p < 0.05$)

mulberry and grape and found that the results were between 1.8 and 13.2 μg/kg. The researchers found aflatoxin in 4 of the studied 18 köme samples. In other study, B1, B2, G1 and G2 content in 48 of walnut sujuk (köme) ranged from 0.58 to 11.80, 20–3.34, 0.82–1.84 and 0–0.31, respectively (Golge et al. 2016). As seen in these studies, aflatoxins are risk in the fruit pestils and köme but they aren't seen in the sugar beet products studied.

Color Parameters of Products

Color in the appearance of foods is a very important parameter. It gives information about production conditions (especially heat treatment) and content of food. The color of the sugar beet pestil and köme can be described as reddish-brown, and this value is very important for the customer's taste. Table 4 shows that pestil samples were in the same statistically group (*b*) in terms of all color values, whereas köme samples were in different statistically groups (*a*) ($p < 0.05$). The darkest products, having lowest *L* values as 28.66 were köme samples while the lightest colored products were pestil with hazelnuts having higher *L* values as 34.25. "a value", which is indicative of redness, was positive and between 3.82 and 7.03. Also, positive *b* values between 3.12 and 7.24 were measured.

As stated in the study of Cagindi and Otles (2005), the thickness of the fruit leather has a significant effect on color parameters. In the study of Sengül et al. (2010); *L*, *a* and *b* values of mulberry pestil samples were found to vary between 39.37 and 40.77, 4.09–7.63 and 16.34–16.95, separately, respectively. Suna et al. (2014) carried out color analysis of apricot pestil revealing that *L*, *a*, *b* values of sample were found between 44.37 and 49.06, 16.22–20.81, 33.81–41.76, respectively. In the previous study, Yildiz (2013) determined that *L*, *a* and *b* values were 32.42, 2.70 and 1.90 for köme based on mulberry. The differences in color values of pestil or köme is thought to be due to the use of different fruit varieties in production between our study and above-mentioned studies.

Sensory Properties

Consumer sensory evaluations is very important in traditional foods. Especially when a new ingredient such as sugar beet enters the recipe, the total taste of the product comes first in terms of quality. The 9-point hedonic scale was applied to evaluate the intensities of the sensory characteristics of pestil and köme samples. The average scores for all attributes are represented in Table 5. The panelists were informed about the our products which were not widely known. The products were typical fruit pestil and köme in appearance, brownish, slightly caramelized and very tasty. Pestils were easily chewable with teeth while köme was united with the walnut in it and showed a smooth structure. Significant difference was observed between pestil and köme for all attributes, except odors and tastes ($p < 0.05$). On the other hand, there was no statistically significant difference between pestil with hazelnut and pestil with walnut. For hardness–softness and dispersion in the mouth attribute, the highest score was given to the pestil samples. Pestil with hazelnut and pestil with walnut were selected as the best samples according to its highest overall acceptability score.

Some researchers reported a correlation between sensory evaluation and color (Alpaslan and Hayta 2007; Yildiz 2013). Additionally, Torres et al. (2015) indicated sweetness is attributes positively correlated with overall acceptability of fruit leathers. Consumer responses

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Table 4 Color measurement of samples

Sample	*L*	*a*	*b*
Pestil with hazelnuts	34.25 ± 0.85[b]	7.03 ± 0.77[b]	7.24 ± 0.79[b]
Pestil with walnuts	33.71 ± 0.69[b]	6.87 ± 0.62[b]	8.12 ± 0.54[b]
Köme	28.66 ± 0.65[a]	3.82 ± 0.71[a]	3.12 ± 0.80[a]

All findings show mean of six determinations and ± SD (standard deviation); means followed by the same letter in column are not statistically different ($p < 0.05$). *L*, darkness/lightness (0, black; 100, white); *a* (−*a*, greenness; +*a*, redness) and *b* (−*b*, blueness; +*b*,yellowness)

Table 5 Sensory properties of products

Sample	Odors and tastes	Brightness	Hardness–softness	Dispersion in the mouth	Overall acceptability
Pestil with hazelnuts	8.35 ± 0.53[a]	7.65 ± 0.65[b]	8.30 ± 1.15[b]	7.25 ± 1.10[b]	7.88 ± 0.85[b]
Pestil with walnuts	8.63 ± 0.94[a]	6.98 ± 0.95[b]	7.85 ± 0.85[b]	7.40 ± 0.52[b]	7.72 ± 0.82[b]
Köme	8.22 ± 0.65[a]	5.80 ± 0.95[a]	6.15 ± 0.75[a]	5.85 ± 0.55[a]	6.50 ± 0.73[a]

All findings show mean of six determinations and ± SD (standard deviation); means followed by the same letter in column are not statistically different ($p < 0.05$)

revealed that these three products were quite tasty and could be preferred as a snack dessert.

Conclusions

The pestil and köme formulations were quite successfully produced from sugar beet. The sugar beet pestil and köme had a low-moisture content (14.42–17.31%) and hadn't presented aflatoxins risk during a month of storage at room temperature. Furthermore, the sugar beet pestils had shown the highest level of TPC, TFC and FRAP values against köme. The results of the analysis indicated that sugar beet pestil and köme were found to have similar properties compared with the pestil and köme originated from other fruits. They can be considered as a healthy supplementary food, snack food and fast energy source thanks to its high energy and valuable biomolecules. And also, they will be a healthy junk food for children.

Based on the literature studies for fruit leathers, there are limited reports focusing on the production of pestil and köme. This is first scientific report about pestil and köme prepared from sugarbeet.

Another important conclusion, these products can be an alternative source of income for sugar beet farmers and regional entrepreneurs. Small-scale workshops capable of producing these products can be arranged in sugar beet production sites.

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