Composition of volatile aromatic compounds and minerals of tarhana enriched with cherry laurel (*Laurocerasus officinalis*)

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Abstract Different concentrations of cherry laurel pulp (0, 5, 10, 15 and 20%) were used to produce tarhana samples. Volatile aromatic compounds and minor mineral content were investigated. Volatile aromatic compounds were analyzed by using GC–MS with SPME fiber and minor mineral values were evaluated with inductively coupled plasma optical emission spectrometer. The statistical analysis showed that addition of pulp affected volatile aromatic compounds and minor mineral content significantly. Thirty five volatile aromatic compounds were found in tarhana samples. The octanoic acid from acids, benzaldehyde (CAS) phenylmethanal from aldehydes, 6-methyl-5-hepten-2-one from ketones, octadecane (CAS) *n*-octadecane from terpenes, ethyl caprylate from esters and benzenemethanol (CAS) benzyl alcohol from alcohols had the highest percentage of volatile aromatic compounds. Tarhana samples were rich source of Mn, Cu and Fe content.

Keywords Tarhana · Cherry laurel · Volatile aromatic compounds · Minor minerals · ICP-MS · GC–MS

Introduction

Fruits are raw material and used by people for food, either as edible products, or for culinary ingredients, for medicinal use or ornamental and aesthetic purposes. They are genetically very diverse group and play a major role in modern society and economy (Hricova et al. 2016). Cherry laurel (*Laurocerasus officinalis*), a popular fruit, mainly distributed in the coasts of the Black Sea Region of Turkey and locally called “Taflan” or “Karayemiş” is commonly consumed food-plant with delicious fruits (Alasalvar et al. 2005). It is mostly consumed as fresh fruit in local markets although it may also be dried, pickled, and processed into pekmez, jam, marmalade, and fruit juice products (Islam 2002). Its leaves and fruits contain a wide range of phenolic compounds such as phenolic acids, flavonoids, anthocyanins, tannins, lignans, and catechin, among others and used in tea form by local people in Anatolia against some neurological disorders (Liyana-Pathirana et al. 2006; Orhan and Akkol 2011).

Besides its use for food, both fruit and seeds of cherry laurel are well known as traditional medicines in Turkey and have been used for many years for the treatment of stomach ulcers, digestive system complaints, bronchitis, eczemas, hemorrhoids, and as a diuretic agent, among others (Kolaylı et al. 2003; Liyana-Pathirana et al. 2006; Karabegovic et al. 2014; Yıldız et al. 2014). In addition, the nutritional value of cherry laurel fruit arises from its phenolic acid, fatty acid and sugar contents. The ripe fruit of the plant was reported to contain high levels of glucose and fructose as sugars, especially vanillic acid, as a phenolic acid, and linoleic acid, as an unsaturated fatty acid (Colak et al. 2005). The antioxidant activity of the cherry laurel fruits using *N,N*-dimethyl-*p*-phenyldiamine (DMPD)

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scavenging activity and iron-chelating capacity is reported by Orhan and Akkol (2011).

Fruits are important sources of major and minor elements and considered to be the primary source of minerals needed in the human diets. Also mineral contents of fruits provide much of the RDA value of the human. There are a lot of references on the mineral contents of cherry laurel fruit. Mg, Ca, Na, Mn, Fe, Zn and Cu contents of cherry laurel were determined as 179, 153, 55, 24.2, 8.3, 1.9 and 0.8 mg/kg, respectively by Kolaylı et al. (2003). In another study, P, Ca, Na, Mg, Pb, Fe, Mn, Zn and Cu contents of cherry laurel were determined as 882.57, 1158.85, 72.40, 1242.18, 0.00, 15.12, 6.87, 7.31 and 4.32 mg/kg, respectively by Kalyoncu et al. (2013). The composition of cherry laurel marmalade is detected as 80.32 g/kg moisture, 15.31 g/kg soluble solids, 112.6 g/kg total sugar, 108.7 g/kg invert sugar, 3.7 g/kg sucrose, 4.69 pH, 0.47 g/kg crude fiber, 0.23 g/kg pectin, 2139.6 mg/kg total phenolic matter, 0.53 g/kg ash, and 90.19 mg/100 g potassium (Üstün and Tosun 2003).

Tarhana, a traditional Turkish fermented food product, is produced by mixing cereal flours, yoghurt, yeast (*Saccharomyces cerevisiae*), peppers, onions, tomatoes and salt (Ibanoğlu and Maskan 2002; Erkan et al. 2006). The type of ingredients might vary from region to region in Turkey (Çolak et al. 2012). The mixture is fermented for 1–7 days after than dried under the sun or at oven (Köse and Çağındı 2002; Tarakçı et al. 2004; Kilci and Gocmen 2014a; Kurtulmuş et al. 2014). Lactic acid bacteria and yeast are responsible for the fermentation and at the end of fermentation is formed an acidic and sour taste (Şengün et al. 2009; Özdeştan and Üren 2013). Tarhana can be stored for 2–3 years because of it has low moisture (about 10%) and pH 3.8–4.4 (Tamer et al. 2007; Uçar and Çakiroğlu 2011; Özel et al. 2015). The amount and type of ingredients used in tarhana production may affect its nutritional content aromatic compounds (Hayta et al. 2002; Bozkurt and Gürbüz 2008; Gürbüz et al. 2010; Kilci and Gocmen 2014b). The important nutrients such as organic acids, ascorbic acid, niacin, folic acid, pantothenic acid, minerals and different amino acids are produced during tarhana fermentation (Turantas and Kemahlioglu 2012). Some minor minerals are most important for human healthy and absorbed daily a certain amount with foods. Many factors affected the minerals and volatile aromatic composition of tarhana including production methods and ingredients. Therefore, compounds present either higher concentration or lower concentrations. Aroma active compounds are also extremely important for consumer taste.

For improving nutritional and physical properties of tarhana, some resources have been used by Ibanoğlu et al.

(1999), Bilgiçli (2009), Bilgiçli and Ibanoğlu (2007), Gocmen et al. (2004), Değirmencioğlu et al. (2005), Erbaş et al. (2006), Yılmaz et al. (2010), Settanni et al. (2011) and Tarakçı et al. (2013), but minor and aromatic compositions of tarhana have not been studied. Therefore, the objectives of this study were to investigate the effects of cherry laurel pulp on minor mineral contents and volatile aromatic compounds of the Tarhana samples.

Materials and methods

White commercial wheat flour with the protein content of 12% on dry basis, tomato paste (double concentrated to a content of 30%), compressed bakers' yeast in wet form, yogurt (3% fat), onion, and green peppers were used in production of tarhana. All components were purchased from local markets of Ordu, Turkey. The cherry laurel fruits were harvested in fully ripe state from Ordu province of Turkey in June and packed in polyethylene bags (500 g portions) and stored at -20°C until used. After than fruits were processed to pulp (dry matter 16.00%, pH 3.9 and titratable acidity 0.63).

Production of tarhana

The tarhana dough is prepared with 300 g flour, 300 g yoghurt, 30 g tomato paste, 60 g green pepper, 75 g onion, 3 g yeast. Tomato, onion, and green peppers were chopped before addition to the tarhana dough. The cherry laurel pulp concentrations 0% (control), 5, 10, 15 and 20% were added to the tarhana dough, respectively. The resulting dough was fermented at 30°C for 24 h. The fermentation time–temperature combination can be sufficient for formation of volatile aromatic compounds. Therefore, optimal fermentation time is important in sensory and functional properties of tarhana. Over fermentation process (72 h) was increased fermentation losses and decreased functional properties (Demir 2014). At the end of fermentation, the dough was dried in an air oven at $55 \pm 2^{\circ}\text{C}$. The drying process was continued until the moisture content of 10%. Moisture content was determined by oven-drying at 5 g tarhana, taken from air oven during drying, at 105°C until a constant weight was obtained. It is typically believed that the temperature–time combination applied during drying can damage nutrients and bioactive compounds, such as ascorbic acid, vitamin E, and carotenoids, phenol compounds, and flavonoids (Değirmencioğlu et al. 2016). The dried samples were milled in a hammer mill up to the particle size of 1 mm to standardize the sizes and then were stored in glass jars at room temperature in a dark cupboard. All analysis was carried out at dried tarhana.

Volatile aromatic compound analysis

For volatile aromatic compounds analyses, 1 g dried-ground tarhana sample was placed to a 20 mL glass vial together with 5 mL water. The contents were boiled with shaking and immediately cooled to 60 °C. The SPME fiber (2 cm–50/30 mm DVD/Carboxen/PDMS Stable Flex Supelco, Bellefonte, PA, USA) was inserted in a vial for sampling process according to the protocol given by Plessas et al. (2008). The vials were held in a water bath at 60 °C for 50 min. Then, SPME fiber was transferred to the GC–MS (Mode GC-2010; Shimadzu corporation, Kyoto, Japan) with a chromatographic column, 60 m, 0.32 mm i.d., 0.25 µm film thickness (Restek Stabilewax, Polyethylene glycol, USA) with helium as carrier gas at a flow rate of 3 mL/min, pressure of 124.2 kPa and the injector port 250 °C. The split used was 10.0. The temperature of the column was held at 40 °C for 1 min, raised by 7 °C/min to 100 °C held for 5 min, increased by 4 °C/min to 130 °C held for 1 min, increased by 2 °C/min to 180 °C held for 1 min and then, increased by 15 °C/min to 250 °C held for 4 min. Total run time 57.74 min. The interface temperature was 230 °C, the mass range m/z 35–450. The identification of volatiles was done by comparison of data with those of in WILEY 229, NIST and FFNSCN (Flavor and Fragrance Natural and Synthetic Compounds) libraries. Each sample was analyzed triplicate and the mean data are presented. The final concentrations were reported as the percentage of total volatile aroma compounds.

Minor mineral elements analysis

In order to determine the mineral contents of the samples, 5 g of each sample was ashed and solubilized with 10 mL of 6 N HCl. And then, diluted with double-deionized water and filtered after 5–6 h with blue-band filter paper. The volume was again completed to 50 mL. Concentrations of iron (Fe), copper (Cu), manganese (Mn), zinc (Zn), nickel (Ni), molybdenum (Mo), lead (Pb), Selenium (Se) cobalt (Co), cadmium (Cd) and chromium (Cr) were measured by inductively coupled plasma optical emission spectrometer (ICP-OES, Varian Vista-Pro, Australia). For each of the minerals in the tarhana samples, calibration curves were drawn with standard calibration solutions at wavelength take place in the software of the ICP-OES and appropriate for analysis of the device. These curves were plotted according to concentrations the calculated by the device against five different concentrations of the standard solution given to the device. For each metal was done the reading against the blind in the specified wavelength. All the analyses were performed in triple and the results reported as mean values.

Statistical analysis

The data obtained from twice replications were analyzed using the general linear model procedure of the SPSS statistical package program (SPSS, 2000, Inc., Chicago, IL). Duncan's multiple range test was used to detect significant differences between means. P values of <0.05 were considered to be significant, $P > 0.05$ were considered to be insignificant. The data reported in this paper represent means of values from two replicated experiments in which all analyses were performed in duplicate.

Results and discussions

The changes in the aroma active compounds of tarhana samples were determined using SPME–GC–MS. 35 volatile compounds known to contribute to tarhana aroma were detected and grouped according to chemical functional groups (Table 1). It is clear that the acids form the largest single group, followed by aldehydes, ketones, terpenes, esters and alcohols. The total percentage of acids, aldehydes, ketones, terpenes, esters and alcohols varied with 92.33–89.19, 5.52–3.17, 2.03–1.25, 1.66–1.21, 1.24–0.92, and 1.16–0.77%, respectively. Acid fermentation occurred together with the volatile acids and ethanol production. Although these compounds were removed by the drying process, they contributed to the formation of the desired taste and flavor of tarhana (Çelik et al. 2005). Table 1 showed that acid percentages changed significantly between samples and the higher changes were detected in tetra-deconic acid. Increasing cherry laurel concentration and a decrease in tetra-deconic acid value. The octanoic acid had the largest effect on total volatile acids of samples, followed by hexanoic acid, capric acid and tetra-deconic acid and nononic acid had the lower effect on total volatile acids of tarhana samples.

Total aldehyde contents varied with 5.22–3.17% and was statistically significant between samples ($P > 0.05$). Hexanal (CAS) *n*-hexanal, nonanal (CAS) *n*-nonanal and benzaldehyde (CAS) phenylmethanal did not change while butanal, 2-methyl- (CAS) 2-methylbutanal, butanal 3-methyl- (CAS) 3-methylbutanal, 2-heptenal (E)- (CAS) *trans*-2-heptenal and furfural was significant at between samples ($P < 0.05$). The benzaldehyde (CAS) phenylmethanal had the largest effect on total volatile aldehyde, followed by butanal 3-methyl- (CAS) 3-methylbutanal and butanal, 2-methyl- (CAS) 2-methylbutanal had the lower effect on total volatile aldehyde of tarhana samples (Table 1). No significant differences were detected in total keton, terpen and ester contents at between samples ($P > 0.05$). 6-methyl-5-hepten-2-one from ketones, octadecane (CAS) *n*-octadecane from terpenes and

Table 1 Changes in volatile aroma compositions (%) of cherry laurel pulp added tarhana

	Control	5% cherry laurel	10% cherry laurel	15% cherry laurel	20% cherry laurel
<i>Alcohols</i>					
1 Hexanol <n>	0.05 ± 0.00 ^a	0.07 ± 0.02 ^a	0.07 ± 0.01 ^a	nd	nd
2 2-Furanmethanol (CAS) furfuryl alcohol	0.10 ± 0.00 ^a	0.02 ± 0.03 ^b	0.09 ± 0.01 ^a	0.08 ± 0.01 ^a	0.08 ± 0.02 ^a
3 1-Octanol (CAS) Octilin	0.08 ± 0.00 ^a	0.07 ± 0.04 ^a	nd	nd	nd
4 Benzenemethanol (CAS) benzyl alcohol	0.41 ± 0.08	0.31 ± 0.13	0.37 ± 0.03	0.35 ± 0.03	0.41 ± 0.00
5 Benzeneethanol (CAS) phenethyl alcohol	0.31 ± 0.03 ^a	0.20 ± 0.01 ^b	0.24 ± 0.01 ^b	0.23 ± 0.01 ^b	0.22 ± 0.03 ^b
6 1-Octen-3-ol (CAS) Oct-1-en-3-ol	0.19 ± 0.02 ^a	0.12 ± 0.00 ^{bc}	0.17 ± 0.02 ^{ab}	0.10 ± 0.00 ^c	0.09 ± 0.03 ^c
Toplam	1.16 ± 0.08 ^a	0.82 ± 0.18 ^b	0.97 ± 0.04 ^{ab}	0.77 ± 0.04 ^b	0.81 ± 0.09 ^b
<i>Acids</i>					
7 Butanoic acid (CAS) <i>n</i> -butyric acid	4.31 ± 0.12 ^{ab}	4.22 ± 1.22 ^{ab}	5.38 ± 0.52 ^a	3.26 ± 0.75 ^b	3.68 ± 0.04 ^{ab}
8 Hexanoic acid (CAS) <i>n</i> -hexanoic acid	23.24 ± 1.00	21.71 ± 1.85	24.16 ± 0.43	20.25 ± 3.66	19.24 ± 1.29
9 Octanoic acid	27.17 ± 0.34 ^{ab}	26.89 ± 3.15 ^{ab}	26.22 ± 2.20 ^b	30.64 ± 0.47 ^{ab}	31.22 ± 0.36 ^a
10 Nonanoic acid (CAS) nonoic acid	0.20 ± 0.04	0.22 ± 0.13	0.20 ± 0.00	0.31 ± 0.08	0.33 ± 0.00
11 Capric acid	17.53 ± 1.03	17.13 ± 4.37	15.11 ± 1.94	21.99 ± 5.30	22.55 ± 1.12
12 9 Decenoic acid	1.33 ± 0.09 ^{ab}	1.01 ± 0.27 ^b	0.97 ± 0.10 ^b	1.80 ± 0.29 ^a	1.64 ± 0.02 ^a
13 Dodecanoic acid (CAS) lauric acid	4.90 ± 0.32	5.59 ± 0.18	4.21 ± 0.14	4.85 ± 1.18	5.05 ± 0.12
14 Tetradecanoic acid (CAS) myristic acid	11.23 ± 0.12 ^{ab}	12.46 ± 0.04 ^a	12.82 ± 1.88 ^a	9.21 ± 0.30 ^{bc}	8.27 ± 0.17 ^c
Toplam	90.94 ± 0.06	89.29 ± 4.41	89.19 ± 1.52	92.33 ± 1.68	92.01 ± 0.17
<i>Aldehydes</i>					
15 Butanal. 2-methyl- (CAS) 2-methylbutanal	0.10 ± 0.01 ^b	0.29 ± 0.11 ^a	0.18 ± 0.06 ^{ab}	0.07 ± 0.00 ^b	0.08 ± 0.00 ^b
16 Butanal. 3-methyl- (CAS) 3-methylbutanal	0.54 ± 0.08 ^{ab}	0.74 ± 0.24 ^{ab}	1.08 ± 0.38 ^a	0.42 ± 0.11 ^b	0.46 ± 0.01 ^b
17 Hexanal (CAS) <i>n</i> -hexanal	0.59 ± 0.06	1.05 ± 0.43	1.07 ± 0.30	0.44 ± 0.12	0.36 ± 0.01
18 2-Heptenal. (E)- (CAS) <i>trans</i> -2-heptenal	0.21 ± 0.00 ^a	0.11 ± 0.01 ^b	0.15 ± 0.00 ^b	0.10 ± 0.02 ^c	0.09 ± 0.00 ^c
19 Nonanal (CAS) <i>n</i> -nonanal	0.14 ± 0.04	0.16 ± 0.00	0.21 ± 0.05	0.20 ± 0.06	0.19 ± 0.11
20 Furfural	0.49 ± 0.00 ^c	0.44 ± 0.18 ^c	0.79 ± 0.01 ^a	0.49 ± 0.02 ^c	0.58 ± 0.02 ^b
21 Benzaldehyde (CAS) phenylmethanal	1.73 ± 0.23	1.52 ± 0.18	2.03 ± 0.24	1.43 ± 0.20	1.54 ± 0.01
Toplam	3.80 ± 0.33 ^{ab}	4.35 ± 1.02 ^{ab}	5.52 ± 1.06 ^a	3.17 ± 0.54 ^b	3.49 ± 0.09 ^b
<i>Esters</i>					
22 Hexanoic acid, methyl ester (CAS) methyl caproate	0.31 ± 0.02	0.35 ± 0.11	0.37 ± 0.08	0.22 ± 0.05	0.25 ± 0.01
23 Hexanoic acid, ethyl ester (CAS) ethyl <i>N</i> -caproate	0.11 ± 0.01	0.14 ± 0.05	0.12 ± 0.01	0.11 ± 0.03	0.11 ± 0.00
24 Octanoic acid, ethyl ester (CAS) ethyl caprylate	0.41 ± 0.08	0.41 ± 0.08	0.45 ± 0.05	0.37 ± 0.06	0.28 ± 0.02
25 Decanoic acid, methyl ester (CAS) methyl caprate	0.22 ± 0.02	0.19 ± 0.00	0.28 ± 0.05	0.21 ± 0.00	0.26 ± 0.00
Toplam	1.06 ± 0.04	1.10 ± 0.24	1.24 ± 0.21	0.92 ± 0.15	0.96 ± 0.04
<i>Ketones</i>					
26 2-Propanone (CAS) acetone	nd	0.04 ± 0.01 ^b	0.07 ± 0.00 ^a	nd	nd
27 2-Nonanone (CAS) methyl heptyl ketone	0.30 ± 0.04	0.32 ± 0.07	0.33 ± 0.10	0.25 ± 0.05	0.27 ± 0.05
28 Nonyl methyl ketone	0.14 ± 0.02	0.10 ± 0.00	0.15 ± 0.02	0.12 ± 0.02	0.14 ± 0.00
29 6-Methyl-5-hepten-2-one	1.04 ± 0.06 ^a	0.99 ± 0.33 ^{ab}	1.10 ± 0.13 ^a	0.57 ± 0.10 ^c	0.50 ± 0.02 ^{bc}
30 Ethanone, 1-(1 <i>H</i> -pyrrol-2-yl)- (CAS) 2-acetylpyrrole	0.27 ± 0.06	0.22 ± 0.09	0.19 ± 0.01	0.29 ± 0.03	0.27 ± 0.04
31 2-Heptanone (CAS) heptan-2-one	0.18 ± 0.00 ^a	0.17 ± 0.06 ^a	0.18 ± 0.04 ^a	0.03 ± 0.03 ^b	0.09 ± 0.00 ^{ab}
Toplam	1.95 ± 0.01	2.01 ± 0.76	2.03 ± 0.32	1.25 ± 0.15	1.36 ± 0.10
<i>Terpenes</i>					
32 Octane. 5-ethyl-2-methyl- (CAS)	0.15 ± 0.02	0.10 ± 0.03	0.19 ± 0.02	0.19 ± 0.09	0.22 ± 0.01
33 Octadecane (CAS) <i>n</i> -octadecane	0.49 ± 0.12	0.50 ± 0.20	0.49 ± 0.04	0.74 ± 0.40	0.60 ± 0.13
34 Tetradecane (CAS) <i>n</i> -tetradecane	0.25 ± 0.08	0.20 ± 0.05	0.22 ± 0.00	0.31 ± 0.15	0.30 ± 0.01

Table 1 continued

	Control	5% cherry laurel	10% cherry laurel	15% cherry laurel	20% cherry laurel
35 Heptadecane, 8-methyl- (CAS) 8-methylheptadecane	0.31 ± 0.04	0.43 ± 0.10	0.36 ± 0.03	0.42 ± 0.13	0.37 ± 0.00
Toplam	1.21 ± 0.27	1.26 ± 0.38	1.27 ± 0.03	1.66 ± 0.79	1.49 ± 0.16

Values are means ± standard deviations of three replicates

nd not detected

^{a,b,c} Means within the same factor and the same row with different superscript letters are different ($P < 0.05$)

Table 2 Mineral contents of cherry laurel pulp added tarhana (mg/kg dry matter)

Minerals	Control	5% cherry laurel	10% cherry laurel	15% cherry laurel	20% cherry laurel
Fe	139.00 ± 1.55 ^a	136.10 ± 4.52 ^a	114.12 ± 0.14 ^b	133.71 ± 4.04 ^a	140.96 ± 0.94 ^a
Cu	35.18 ± 0.77 ^a	27.60 ± 0.15 ^c	22.44 ± 0.09 ^d	35.80 ± 0.02 ^a	29.92 ± 0.50 ^b
Mn	339.24 ± 1.13 ^b	346.60 ± 13.72 ^c	281.11 ± 13.10 ^d	451.08 ± 27.23 ^a	460.61 ± 13.79 ^a
Zn	35.57 ± 2.06 ^a	29.50 ± 1.13 ^b	25.03 ± 0.84 ^c	28.84 ± 0.57 ^b	28.48 ± 0.52 ^b
Ni	0.94 ± 0.01 ^a	0.54 ± 0.00 ^c	0.49 ± 0.00 ^d	0.74 ± 0.00 ^b	0.70 ± 0.01 ^c
Mo	0.37 ± 0.00 ^a	0.31 ± 0.00 ^b	0.28 ± 0.00 ^d	0.31 ± 0.00 ^{bc}	0.30 ± 0.00 ^c
Pb	0.03 ± 0.00	0.03 ± 0.00	0.02 ± 0.00	0.03 ± 0.00	0.02 ± 0.00
Se	0.40 ± 0.02	0.33 ± 0.03	0.34 ± 0.03	0.40 ± 0.02	0.45 ± 0.03
Co	0.36 ± 0.00	0.33 ± 0.00	0.31 ± 0.00	0.34 ± 0.00	0.33 ± 0.00
Cd	1.19 ± 0.01 ^a	1.11 ± 0.00 ^b	1.13 ± 0.01 ^b	1.10 ± 0.00 ^b	1.04 ± 0.00 ^c
Cr	1.09 ± 0.00 ^a	0.97 ± 0.00 ^d	0.78 ± 0.00 ^c	0.99 ± 0.00 ^c	1.07 ± 0.00 ^b

Values are means ± standard deviations of three replicates

nd not detected

^{a,b,c} Means within the same factor and the same row with different superscript letters are different ($P < 0.05$)

octanoic acid ethyl ester (CAS) from esters had the highest percentage at between of volatile aromatic compounds. Esters are quite important to the flavor of natural and fermented foods. Four esters were found in tarhana samples. Six esters were reported at tarhana samples by Gocmen et al. (2004). Six alcohols were determined in samples and total alcohols contents were significantly ($P > 0.05$) between samples. Hexanol (n) was not determined in tarhana samples containing 15 and 20% cherry laurel pulp while 1-octanol (CAS) octilin from alcohols was only determined in control and 5% cherry laurel pulp containing samples. Benzenemethanol (CAS) benzyl alcohol contributed the highest percentage of alcohols. Phenolic compounds have nutritional and antioxidant properties influence multiple sensorial food properties, such as flavor, astringency, and color. Phenolic compounds contribute to the aroma and taste of numerous food products. The contribution of phenolic compounds to aroma is mainly due to the presence of volatile phenols (Rodriguez et al. 2009).

Table 2 shows the mean concentrations and standard deviation of iron (Fe), copper (Cu), manganese (Mn), zinc (Zn), nickel (Ni), molybdenum (Mo), lead (Pb), Selenium

(Se) cobalt (Co), cadmium (Cd) and chromium (Cr) of the tarhana samples.

Fe content tarhana samples varied with 140.96–114.12 mg/kg and there were significantly differences between samples ($P < 0.05$). The lower value was detected in 10% cherry laurel pulp and the other samples were similar to each others (Table 2). Fe content of tarhana samples were reported as 97.0 mg/kg by Erbaş et al. (2006), 48.9 mg/kg by Demir (2014), 13.7–41.60 mg/kg Tarakçı et al. (2004), 25.2 mg/kg by Bilgiçli (2009), 19.8–78.6 mg/kg by Bilgiçli et al. (2006), 12.5 mg/kg by Bayrakçı and Bilgiçli (2015) and 36.0 mg/kg by Daglioglu (2000). Results of these studies were lower than our study. But the higher Fe content were reported 386–624 mg/kg by Kilci and Gocmen (2014a). Cu content varied between 22.44–35.80 mg/kg and results are shown in Table 2. The lowest value was determined in tarhana sample 10% cherry laurel pulp added. When compared to our results, lower copper values were reported as 10.00 mg/kg by Erbaş et al. (2005), as 0.00–2.00 mg/kg Bilgiçli et al. (2006) and as 2.3 mg/kg by Çağlar et al. (2013) while higher values were reported as 4351 mg/kg by Kilci and Gocmen (2014b) and

Table 3 Contribution to recommended dietary allowances of cherry laurel pulp added tarhana

Minerals	Contribution of 250 mL (15 g dry tarhana) tarhana soup					
	%RDA					
	RDA (mg/day)	Control	5% cherry laurel	10% cherry laurel	15% cherry laurel	20% cherry laurel
Fe	8.00	26.06	25.51	21.39	25.07	26.43
Cu	0.90	58.63	46.00	37.40	59.66	49.86
Mn	5.00	100	100	84.33	100	100
Zn	11.00	4.85	4.02	3.41	3.93	3.88
Mo	0.045	12.33	10.33	9.33	10.33	10.00
Se	0.055	10.90	9.00	9.27	10.90	12.27
Cr	0.12	13.62	12.11	9.75	12.37	13.37

as 4500 mg/kg by Daglioglu (2000). Mn content was determined between 281.11 and 460.61 mg/kg and addition of cherry laurel pulp had a significant effect on the same ($P < 0.05$). The higher values were obtained in tarhana samples containing 15–20% cherry laurel while the lowest value was detected in the 10% cherry laurel (Table 2). Mn content in tarhana samples were reported as 32.3 mg/kg by Erbaş et al. (2005), 5.9–65.4 mg/kg by Bilgiçli et al. (2006), 6120 mg/kg by Daglioglu (2000) and as 1576 mg/kg by Kilci and Gocmen (2014b). Zn content are shown in Table 2. The higher value was observed for control sample (35.57 mg/kg) while the lowest value was observed for 10% cherry laurel (25.03 mg/kg). The using pulp in the preparation of tarhana indicated a decrease in the final content of Zn. The higher Zn content were reported as 32.00, 44.00 mg/kg, and 498 mg/kg by Daglioglu (2000), Erbaş et al. (2005) and Kilci and Gocmen (2014a), respectively while the lower values were reported as 24.5, 5.6, 15.6, 9.9, 22.1, and 12.1 mg/kg by Tarakçı et al. (2004), Bilgiçli et al. (2006), Bilgiçli (2009), Çağlar et al. (2013), Demir (2014) and by Bayrakçı and Bilgiçli (2015), respectively. Nickel and Mo contents of the tarhana samples are shown in Table 2. Ni and Mo content varied with 0.94–0.49 and 0.37–0.28 mg/kg, respectively and were affected with adding of pulp significantly ($P < 0.05$). The highest values were obtained from control samples while the lower nickel and Mo content were measured in samples containing 5 and 10% cherry laurel pulp. Upper tolerable limits (UL) are 1 mg/day for Ni and 2 mg/day for molybdenum. As shown in Table 2, Ni and Mo content of samples were lower than those UL values. No significant difference ($P < 0.05$) between tarhana samples were observed for Pb, Se and Co content. As shown in Table 1, Pb, Se and Co varied with 0.02–0.03, 0.33–0.45 and 0.36–0.31 mg/kg, respectively. The PTWI value (FAO/WHO 2000) of lead was reported as 0.025 mg/kg. For a person of an average of 60-kg body weight, this would be 0.214 mg/day. Upper tolerable limit (UL) for Se is

0.4 mg/day. As shown in Table 2, Se content of samples are lower than this UL value. Cd and Cr contents varied between 1.19–1.04 and 1.09–0.78 mg/kg. The multiple test revealed significant differences ($P < 0.05$) in tarhana samples. Control samples had higher Cd and Cr when compared to cherry laurel added tarhana. The addition of cherry laurel pulp decreased Cd and Cr content of tarhana. Upper tolerable limit (UL) for chromium is 0.034 mg/day. As shown in Table 2, Cr content of samples are lower than this UL value.

In order to determine the nutritional value in tarhana samples in terms of mineral composition, the percentage of the recommended dietary allowances (RDA) was calculated. Daily consumption of tarhana is a cup of soup and approximately, it is 250 mL soup (15 g dry tarhana). Therefore, RDA values were calculated from over 250 mL tarhana soup. Recommended dietary allowance (RDA) and %RDA values of Fe, Cu, Mn, Zn, Mo, Se and Cr were showed in Table 3. As shown in Table 3, all tarhana samples could nutritionally be important as a good source of Fe, Cu and Mn.

Conclusion

Cherry laurel, as many plants, can synthesize aromatic substances, most of which are phenols or their oxygen-substituted derivatives. The antioxidant activity of phenolics is related to a lot of different mechanisms such as free radical scavenging, singlet oxygen quenching, hydrogen donating, metal ion chelating, and acting as a substrate for radical such as superoxide and hydroxide. Therefore, cherry laurel pulp might be considered as a functional ingredients and nutraceutical of tarhana. Tarhana is one of the most important traditional fermented foods in Turkey. Production of tarhana shows different from region to region in Turkey. At cherry laurel pulp added tarhana samples were determined six alcohols, eight acids, seven aldehydes,

four esters, six ketones and four terpens. Mn and Fe are the highest micro minerals and the highest RDA values of tarhana samples were determined for Mn, Cu and Fe. In conclusion, cherry laurel pulp can be used without any problem in terms of volatile aromatic compounds and minor mineral values. Therefore, it can be develop a new product more functional. But, for improvement of new product, further investigation is needed.

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