GIDA
THE JOURNAL OF FOOD
E-ISSN 1309-6273, ISSN 1300-3070

Research / Araştırma
GIDA (2020) 45 (1): 81-91
doi: 10.15237/gida.GD19125

PHYSICAL, CHEMICAL AND SENSORY PROPERTIES OF FRESH ORANGE JUICE FORTIFIED WITH REISHI (*Ganoderma lucidum*) EXTRACT

Gizem Kuşçu, Bengü Öztürk*
Yeditepe University, Faculty of Engineering, Department of Food Engineering, Kayisdagi Cad., Istanbul, Turkey

Received / Geliş: 01.09.2019; *Accepted* / Kabul: 11.12.2019; *Published online* / Online baskı: 21.01.2020

Kuşçu, G., Öztürk, B. (2020). Physical, chemical and sensory properties of fresh orange juice fortified with reishi (Ganoderma lucidum) extract. GIDA (2020) 45 (1): 81-91 doi: 10.15237/gida.GD19125

Kuşçu, G., Öztürk, B. (2020). Reishi (*Ganoderma lucidum*) ekstraktı katkılı taze portakal suyunun fiziksel, kimyasal ve duyusal özellikleri. *GIDA* (2020) 45 (1): 81-91 doi: 10.15237/gida.GD19125

ABSTRACT
In this study, fresh orange juice fortified with reishi (*Ganoderma lucidum*) extract was produced and its quality parameters were investigated. 330 mL and 200 mL of fresh orange juice samples containing different amounts (5 or 10 mL) of reishi extract were formulated. Brix and pH of the samples ranged from 10.9±0.8 to 11.5±1.2, and 3.66 to 3.68, respectively. Ascorbic acid content (mg/100mL) of the samples was between 54.5±2.2 and 64.8±8.5, and total carbohydrate contents (g/L) were found as 12.96±4.19 - 17.34±4.94. Total phenolic contents of the samples were determined as 313.6±3.3 - 329.5±3.3 μg GAE/100 mL. Color measurements indicated no significant difference between the control and fortified samples. Five-point hedonic scale (65 volunteers) and ranking tests (29 volunteers) showed that an alternative functional beverage with acceptable quality properties was produced when recommended daily intake dose of reishi extract (10 mL/day) was added to 330 mL of orange juice.
Keywords: Functional orange juice, reishi extract, physicochemical properties, sensory properties.

REISHI (*Ganoderma lucidum*) EKSTRAKTI KATKILI TAZE PORTAKAL SUYUNUN FİZİKSEL, KİMYASAL VE DUYUSAL ÖZELLİKLERİ

ÖZ
Bu çalışmada reishi (*Ganoderma lucidum*) ekstraktı içeren taze sıkılmış fonksiyonel portakal suyu üretilmiş olup kalite özellikleri araştırılmıştır. Farklı miktarlarda (5 and 10 mL) ekstrakt içeren 330 mL ve 200 mL hacminde taze sıkılmış portakal suları hazırlanmıştır. Ürünlerin askorbik asit miktarları 54.5±2.2 ve 64.8±8.5 mg/100mL, toplam karbonhidrat miktarları 12.96±4.19 ve 17.34±4.94 g/L arasında değişmiştir. Folin-Ciocalteu metodu ile analiz edilen toplam fenolik madde içerikleri 313.6±3.3 - 329.5±3.3 μg GAE/100 mL olarak bulunmuştur. Ürünlerin Brix ve pH değerleri sırasıyla 10.9±0.8 - 11.5±1.2 ve 3.66 - 3.68 olarak ölçülmüştür. Ekstrakt içermeyen kontrol ürün ile fonksiyonel ürünler arasında denk değerleri arasında önemli fark görülmemiştir. Duyusal analiz çalışmalarına göre, 5-noktalı hedonik skala (65 gönüllü) ve sıralama testleri (29 gönüllü) sonucunda, tavsiye edilen günlük tüketim miktarı 10 mL olan ekstrakt, 330 mL'lik örneklere eklendiğinde kabul edilebilir tatta olduğu bulunmuştur. Reishi içeren fonsiyonel portakal suyunun kalite özellikleri bakımından tüketime uygun alternatif bir içecek olduğu gözlenmiştir.
Anahtar kelimeler: Fonksiyonel portakal suyu, reishi ekstraktı, fizikokimyasal özellikler, duyusal özellikler.

* *Corresponding author* / Yazışmalardan sorumlu yazar;
✉ benguozturk@gmail.com, ✆ (+90) 216 578 0480, 🖷 (+90) 216 578 0400

Bengü Öztürk; ORCID no: 0000-0002-4925-6678
Gizem Kuşçu; ORCID no: 0000-0002-1474-5885

INTRODUCTION

Trends in the consumption of foods that have good health benefits increases in the last decades due to higher demand on a better life quality. Consumers become more aware about the functional foods with health promoting effects to prevent disease risks, improve body functions, and boost immune system (Siro et al., 2008). Functional foods should consist of some bioactive compounds, such as antioxidants, probiotic microorganisms and prebiotic substances that they affect health in a positive manner (Roberfroid, 1999; Meral and Doğan, 2009; Dayısoylu et al., 2014). According to Turkish Food Law (5179), in addition to their nutritional effects, functional foods have health-protective, corrective or disease- reducing effect due to one or more effective components that are scientifically and clinically proven (Anonymous, 2004).

Mushrooms are food species with more than 2000 types known for centuries but only about 25 types can be consumed. Because of the high nutritional value of the mushroom and its medicinal properties, it is accepted as a functional and nutraceutical food and attracts great attention (Chang, 1996; Cheung, 2008). One of the fungus species with therapeutic properties is Reishi mushroom, also known as *Ganoderma lucidum*. It is widely used in the far eastern countries and it is a species of *Basidiomycetes* fungi comes from the family *Ganodermataceae* (Wachtel-Galor et al., 2011). Some pharmacological properties of the active components of Reishi mushroom -triterpenoids and polysaccharides- were determined as the result of several studies. The effects of polysaccharides, amino acids, triterpenes, ascorbic acid, sterols, lipids, alkaloids and trace elements in the immune system were extensively studied. For example, beta-D-glucans -one group of the polysaccharides- are widely used in the formulation of cancer preventive drugs (Wasser and Weiss, 1999). Reishi mushroom is not edible due to its hard structure. For this reason, it is consumed in two different forms either in the extract or powder form. Ganoderma extracts have numerous therapeutic effects including analgesic, anti-allergic, anti-bronchitis, anti-bacterial, anti-oxidant, antitumor, blood pressure lowering effects. Therefore, it is widely used in the treatment of many diseases including migraine and headache, high blood pressure, arthritis, bronchitis, asthma, anorexia, gastritis, hemorrhoids, high cholesterol, nephritis, constipation, skin tuberculosis, hepatitis, cardiovascular problems and leukemia (Wachtel-Galor et al., 2005; Tang et al., 2006). Because of its health promoting effects, *Ganoderma lucidum* has been used for many nutraceutical and medicinal purposes for years (Deepalakshmi and Mirunalini, 2011; Bishop et al., 2015).

Orange juice is widely consumed beverage all over the world. There are some functional orange juice development studies carried out in the literature. Prebiotics, probiotic bacteria and vitamin fortified orange juice products were formulated and their physicochemical and sensory evaluation studies were performed (Luckow and Delahunty, 2004; Costa et al., 2017). In Pesti et al., 2014, it was explained that fungal extracts would give benefit to the human health by showing anti-cholesterol activity (Gil-Ramírez and Soler-Rivas, 2014). Reis et al., 2017 summarized health benefits of various types of mushroom extracts and mentioned that either mushrooms themselves could be listed as functional foods or their extracts could be incorporated into various nutraceutical formulations (Reis et al., 2017). To our knowledge, there is no any food or beverage formulation including *Ganoderma lucidum* mushroom extracts. Therefore this will be the first study to analyze the quality parameters of functional beverage which is fresh orange juice fortified with *Ganoderma lucidum* extracts.

The aim of this study was to develop a functional orange juice fortified with reishi (*Ganoderma lucidum*) extract and examine the quality parameters of the newly formulated orange juice samples and perform sensory analyses to compare with the control fresh orange juice without the extract.

MATERIALS AND METHODS

Materials

Ganoderma lucidum extract solutions in 10 mL of dark brown bottles were purchased from Erkel Food Company Ltd. Şti. Oranges were purchased from Carrefour Supermarket, in Istanbul. All chemicals used in the analyses were purchased from Sigma –Aldrich and they were of analytical grade. Double distilled water was taken from Milli-Q Gradient A10 water purification system (Bedford, MA, USA).

Methods

Preparation of fortified orange juice samples

The oranges purchased from the supermarket in Istanbul were freshly squeezed using household portable juice squeezer, and the pulp was immediatley filtered using glasswool. The control sample was defined as freshly squeezed orange juice with no added extract, and the functional juices were prepared according to the commercial serving sizes of canned (330 mL) and tetra-packed (200 mL) fruit juices. Daily consumption of 3 g reishi extract in 10 mL solution is mentioned as the required dose to get benefit from the health promoting effects of the mushroom. Therefore, 5 mL and 10 mL of ready to consume extract solution was added to the freshly squeezed orange juices as to be consumed once or twice with a fruit juice to get the beneficial health effect from the extract (Table 1). These juice samples were freshly prepared prior to the analyses.

Table 1. Formulation of fresh orange juice samples fortified with reishi extract

Sample names	Freshly squeezed orange juice (mL)	Reishi extract (mL)	Concentration of reishi in juices (%, v/v)
Control sample	330 or 200	0	0
Sample 1	325	5	1.52
Sample 2	320	10	3.03
Sample 3	190	10	5

Determination of total soluble solids (Brix) and pH

The pH of fresh orange juice with reishi extract was measured by pH meter (Radiometer Analytical PHM210, USA). The amount of total soluble solids (Brix°) in fruit juices was measured using a portable refractometer (Bellingham + Stanley DR103L, UK).

Determination of vitamin C (ascorbic acid) content

Vitamin C (ascorbic acid) analysis of the control and fortified orange juice samples was performed using 2,6-dichloroindophenol titrimetic method (AOAC Method 967.21, 2016).

Determination of total carbohydrate content

The total carbohydrate content of the juice samples were determined by the phenol-sulfuric acid method. Glucose standard solutions (0-100 μg glucose/2 ml) were first prepared. Then the freshly squeezed fortified and control orange juice samples were diluted to 1:2000 ratio with ddH_20 and 0.05 ml 80% phenol was added to 2 mL of each sample and standart solution and then 5 mL H_2SO_4 was added to the tubes and total volume was vortexed and held in the water bath at 25 °C for 10 min. The absorbances of the samples were measured at 490 nm using UV-VIS spectrophotometer (Thermoscientific, Genesys 10S UV-Vis, USA). The total carbohydrate concentration of each sample was calculated using the equation obtained by calibration curve of standart glucose solutions, and expressed in units of g/L of sample (Nielsen, 2017).

Determination of total phenolic content

Total phenolic content of fresh orange juices fortified with reishi extract were determined by using Folin - Ciocalteu Method (Singleton and Rossi (1965). 0.5 mL of each fruit juice was mixed with 2.5 mL of distilled water. 0.5 mL of F-C reagent was added and incubated for 30 minutes in the dark. 2 mL of sodium carbonate (10% w/v) was added to each tube, and then the tubes were vortexed and the absorbances of reaction mixture were read at 725 nm in UV-Vis spectroscopy (Thermoscientific, Genesys 10S UV-Vis, USA). A standard curve was plotted using different concentrations of gallic acid standard (0-10 µg/mL). Total phenolic content was estimated as µg gallic acid equivalents (GAE)/mL of fruit juice.

Color measurements

The color characteristics of the control and fortified fresh orange juices were determined using a color analyzer (Konica Minolta CM-5, Japan). L* (lightness), a* (+ redness; - greenness) and b* (+ yellowness; - blueness) values were recorded for each sample of three replicates.

Sensory analyses

Sensory analyses were performed to compare the sensory properties of the control and fortified fresh orange juices with different concentrations of reishi extract. Four samples were coded with three-digit numbers randomly. A panel group of 65 voluntary consumers at the ages of 20 to 45, were asked to rate the taste, odor, appearance, color and overall liking of the samples using 5-point hedonic scale of which level of liking was correlated with the numbers as the followings; 1: Dislike, 2: Like a little, 3: Like moderately, 4: Like, 5: Like very much (Stone et al., 2012). A preference ranking test was applied to express the overall acceptance of the samples by a group of 29 voluntary consumers as in the order from the most liked to the least liked (BS ISO 8587: 2006 + A1: 2013). A group of 36 voluntary consumers were asked to evaluate the taste and aftertaste attributes of 4 samples in terms of unrecognized, sweet, salty, sour and bitter and for whom 'unrecognized' row was checked for any of the sample, description of the taste that they felt were asked to be written. Taste and after taste profiles of the fortified orange juices and the control sample were constructed using radar graphs (Microsoft Office Excel 2010) for comparison.

Statistical analysis

All experiments were performed in triplicate, and the results were expressed as mean ± standart deviation, significant difference analyses at 95% confidence interval were conducted using one-way ANOVA statistical tool of Microsoft Office Excel 2010.

RESULTS AND DISCUSSION

Physicochemical properties of orange juice samples

Total soluble solid content (Brix°) of the fresh orange juice samples were measured using refractometer and determined as 11.53, 10.97, 11.43 and 11.07, in the control, sample 1, 2, and 3, respectively (Table 2). According to the Turkish Food Codex Legislation 2014/34, the Brix value should be at least 11.2° (Anonymous (2014). In our study, *pH values* of the samples were also measured using a pH-meter to characterize the fortified orange juice samples, and there was no significant difference between the control and fortified samples that had the pH range of 3.66-3.68 (Table 2). Tüfekçi Benli (2008) investigated the pH values of different commercial orange juices ranged between 3.81 and 4.01. Furthermore, the Brix values changed between 11.23 and 12.27. Brix values of fortified orange juices were very consistent to the limit in the legislation and the findings in the literature as well (Tüfekçi Benli, H., 2008; Anonymous, 2014). Topuz et al. (2005) also indicated that there might be differences in the chemical properties of juices of different orange varieties and they found different pH (3.19 to 3.84), Brix values (11.00-12.82), and vitamin C contents (34.27 - 51.51 mg/100mL) in different orange varieties.

Table 2. pH, Brix, total carbohydrate, ascorbic acid and total phenolic contents of orange juice samples

Sample name	pH	Total soluble solids (Bx°)	Total carbohydrate (g/L)	Ascorbic acid (mg/100mL)	Total phenolics (µg GAE/100 mL)
Control sample	3.68±0.12	11.5±1.2	17.34±4.94	54.47±2.22	313.6±3.3
Sample 1	3.66±0.14	11.4±1.0	16.65±6.25	64.80±8.49	315.7±4.6
Sample 2	3.66±0.13	10.9±0.8	12.96±4.19	56.60±5.23	318.6±3.3
Sample 3	3.68±0.13	11.1±1.1	12.62±5.97	62.83±10.17	329.5±3.3

Ascorbic acid content of orange juice samples

Ascorbic acid content of the functional orange juices and the control sample were analysed by titrimetric method and the values for the control and fortified orange juice samples were given in Table 2. There was no significant difference (P >0.05) between the ascorbic acid contents of the samples. However fortified orange juices had higher amounts of vitamin C (56.60±5.23 to 64.8±8.5 mg/100 mL) than the control fresh orange juice (54.5±2.2 mg/100 mL). Thus, fortification with reishi extract increased vitamin C content of the control sample. In the literature, there were studies on the changes of vitamin C content during shelf life of commercial 100% orange juices and fresh squeezed orange juices (Lee and Goates, 1999; Kabasakalis et al., 2000). Lee and Goates (1999) determined that fresh squeezed orange juice had 40.6 mg/100mL when analyzed by HPLC chromatographic method. Moreover, Kabasakalis et al. (2000) used titrimetric method to analyze vitamin C contents of the orange jucie samples, and they found 42.6 mg ascorbic acid/100 mL in commercial 100% orange juice, and 52.3 mg ascorbic acid/100 mL in fresh orange juice. In another study published in 1983, the required amount of ascorbic acid in orange juice was given as 44.5-66.8 mg/100 mL (Park et al., 1983). The results of our study were found similar to the data in the literature.

Total carbohydrate content of orange juice samples

Total carbohydrate contents of the fortified fresh orange juice were analyzed using UV-Vis spectrophotometer and compred with the value of the control orange juice. The values are found as 17.34, 16.65, 12.96, and 12.62 g/L, for the control, sample 1, sample 2, and sample 3, respectively (Table 2). As the concentration of the added reishi extract solution increased, total carbohydrate value of the control fresh orange juice is decreased. It was expected that total carbohydrate level would be increased by the addition of reishi extract to the juice, since reishi was known as the good source of polysaccharides. However, the decrease in total carbohydrate content could be attributed to the dilution of the orange juice by the addition of a diluted reishi extract solution, since the commercial solution that was used to fortify was containing only 3 g active reishi extract per 10 mL of solution. The sucrose, fructose and glucose levels of the fruit juices were investigated and experimental studies were carried out using HPLC. Once the sum of these sugars were considered, orange juice samples contained a total of 8.07 to 10.89 g/L of carbohydrates which had closer values to the fortified orange juice samples in our study (Leopold et al., 2011). Moreover, in the study of Kelebek et al. (2009), sugar contents of fresh bloody orange juice samples were analyzed by HPLC method, and the total sugars were found as 120.19 g/L. The differences in the resulted values might be derived from the production method of fresh orange juices since almost all the fiber was removed in this study and mono- and di-saccharides were concentrated, or the difference in orange fruit variety might cause the changes in total sugar content in the juices.

Total phenolic content of orange juice samples

Consuming foods or beverages with higher phenolic compounds are of high interest among the consumers since they have great contribution to human health and well-being. It is well known that fruits and vegetables are good sources of these compounds (Crozier et al., 2006). *Ganoderma lucidum* had many functional bioactive compounds, such as polysaccharides, triterpenoids, and the phenolics as well (Ahmad, 2018). Therefore, in order to investigate the quality of the fortified orange juice as the functional beverage, total phenolic content analysis was carried out using Folin-Ciocalteu method. The control, sample 1, 2 and 3 had 313.6 ± 3.3, 315.7 ± 4.6, 318.6 ± 3.3, and 329.5 ± 3.3 µg GAE/100 mL of total phenolics, respectively (Table 2). When the concentration of the extract in the orange juice increased, total phenolic content of the sample increased which might be due to the contribution of added reishi extract. However, there was no significant difference observed between the phenolic compound contents in the fortified orange juices (P >0.05). Phenolics of several fruit juices were studied in Gardner et al. 2000, and orange juice sample had total phenolics of 755 µg GAE/mL. Rekha et al. (2012) investigated the total phenolics in fresh juices of ripe and unripe oranges, and the values were found as 820 and 960 µg GAE/mL in ripe and unripe *Citrus sinensis*, respectively. In another study, fresh orange juice samples obtained from several varieties showed total phenolic content values of 361.4 to 1147.2 µg ferulic acid equivalents/mL (Rapisarda et al., 1999). The differences between the results may be due to the modifications in the methods, such as wavelength in spectrophotometer and variation in the standard solutions.

Color measurements of orange juice samples

According the results of the color analyses (Figure 1), lightness (L*) values were decreased by the increased amounts of added reishi extract. This might be due to the original dark brown color of reishi extract which lead to decrease in lightness of the samples. Other hue characteristics, a* value and b* values of all samples were in the positive range, and these values were prone to be increased by the addition of increasing amounts of reishi extract (a* and b* values of sample 1 < sample 2 < sample 3). Thus, fresh orange juice sample was tended to get more red and yellow color than green or blue when it was fortified with reishi extract. Furthermore, there was no significant difference ($P > 0.05$) in color characteristics of the control and the fortified samples which made it easier to market the newly produced fresh orange juice. In the literature, the color analyses of some orange juice samples were done and the color values were found very compatible with the results of our study. In the study of Tiwari et al. (2008), the effect of sonication parameters on the quality of orange juice was investigated, and L*, a* and b* values of fresh orange juices were changed between 59.69-63.54, 5.04-7.53, and, 56.12-58.94, respectively at different sonication treatments. In another study, color attributes of ultrafrozen orange juice samples were determined as 73.59 ± 1.40 for L*, 13.71 ± 1.10 for a*, and 66.80 ± 2.58 for b* values, which showed similar results to our study with slight changes caused by the treatments applied on the fresh juice (Meleändez-Martiänez et al., 2007).

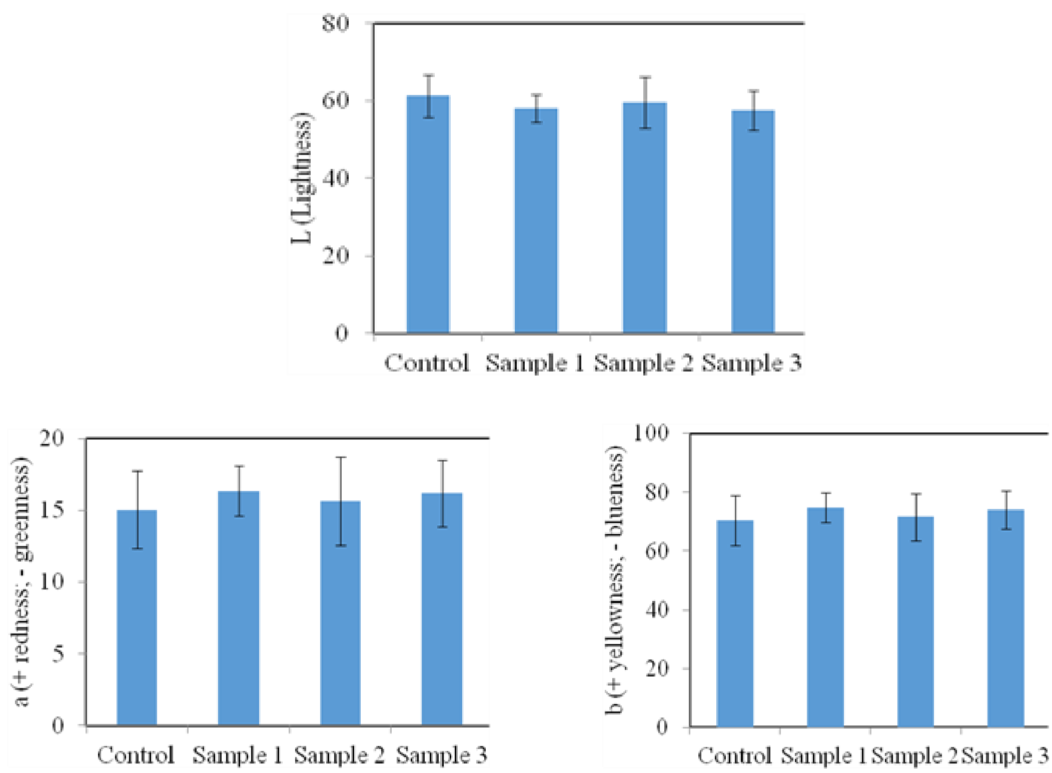

Figure 1. Color values of the control and fortified fresh orange juice samples; L* (Lightness); a* (+ redness; - greenness); b* (+ yellowness; - blueness)

Sensory evaluation of consumer preference and taste profiling of the samples

Overall acceptance values of the samples analyzed by consumer preference tests; 5-point hedonic scale and ranking test were given in Table 3. The control sample got the highest score of odor, appearance and overall liking, whereas Sample 3 which contained app. 5 % (v/v) of reishi extract had the lowest scores in overall attributes. Sample 1 was rated as closest sample which had the most similar taste, odor, appearance to the control sample. Sample 1 and 2 showed very similar overall liking results, however odor scores indicated that the odor had changed a little when the added amount of the resihi extract was increased to 3 and 5 % (v/v) as in Sample 2 and 3 (Table 3). 6 out of 36 people rated for the unrecognized taste which were perceived as 'tart', 'medicinal', 'acidic', 'woody', and 'earthy' tastes in the fortified orange juices. These attributes might be derived from the incorporation of resihi mushroom extract. Furthermore, sour and bitter tastes could be perceived more in Sample 3 that contained 5% (v/v) of reishi extract. According to the results of the preference ranking test for which 29 people joined for rating, orange juices fortified with 1.5 and 3 % (v/v) reishi extract were liked moderately, wheras Sample 3 containing 5% (v/v) extract was not liked when compared to the control orange juice sample (Table 3).

Table 3. Consumer preference test results

Attributes \ Samples	125 [a]	762 [a]	427 [a]	328 [a]
Appearance [b]	3.81±1.08	3.39±1.11	3.39±1.09	3.03±1.30
Odor [b]	3.86±1.08	3.25±1.09	2.08±1.09	2.08±1.09
Overall liking [b]	4±1.22	3.09±1.24	3.06±1.11	2.08±1.13
Rank totals [c]	52	69	76	103

[a] 3-digit codes for sensory analyses; control sample: 125; fortified orange juice samples 762: Sample 1, 427: Sample 2, 328: Sample 3.

[b] 5-point hedonic scale for odor, appearance and overall liking attributes (1: Dislike, 2: Like a little, 3: Like moderately, 4: Like, 5: Like very much)

[c] Rank totals as a result of ranking test for 29 persons: <59 Like, 59-86: Like moderately, >86 Dislike.

A five-point hedonic scale evaluation of the orange juices fortified with probiotics and prebiotics were performed in the study of da Costa et al. (2017), and they found that the sensory attributes of functional beverages showed no significant diiference with the pure orange juice. Luckow and Delahunty (2004) conducted consumer preference ranking tests to evaluate the conventional and functional orange juices, and the results indicated that a small group of consumers liked the functional orange juices fortified with probiotic/prebiotics. Moreover, functional juices revealed 'dirty', 'medicinal', and 'dairy' which could be attributed to the added probiotics.

Taste and after taste attributes of the samples in four basic tastes (sweet, salty, sour, bitter) were illustrated by taste profiles and a unrecognized category was added in order to allow the panelists to evaluate the taste they could describe (Figure 2a and 2b). It was observed that the taste profiles of the control sample and Sample 1 which contained 320 mL fresh orange juice plus 5 mL reishi extract were very similar with the highest rating of sweet taste, however Sample 3 which contained app. 5% (v/v) of reishi extract had the lowest scores in overall attributes. When the taste difference in the mouth during tasting and after tasting was examined, the taste profiles of the products were found as similar. As a result of these analyses, fruit juices containing 1.25 g (Sample 1) and 3 g of active extracts (Sample 2 and 3) were compared and it was observed that the amount of added extract had no significant effect on the overall quality characteristics of the fruit juice.

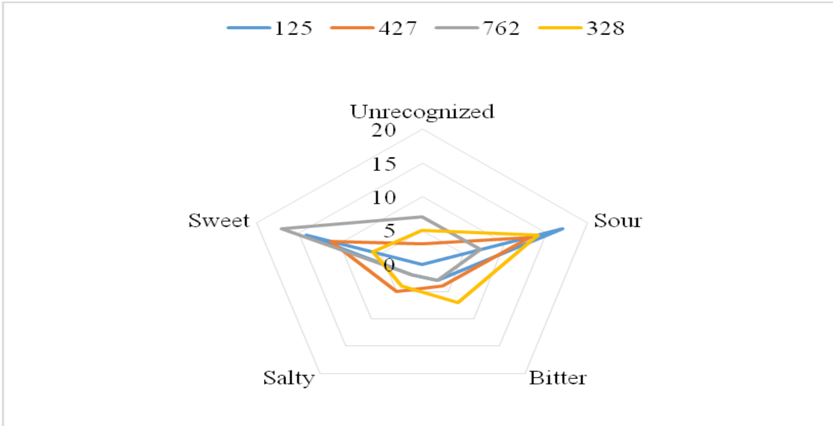

Figure 2a. Taste profiles of the control (125) and fortified orange juice samples (Sample 1: 762; Sample 2: 427; Sample 3: 328)

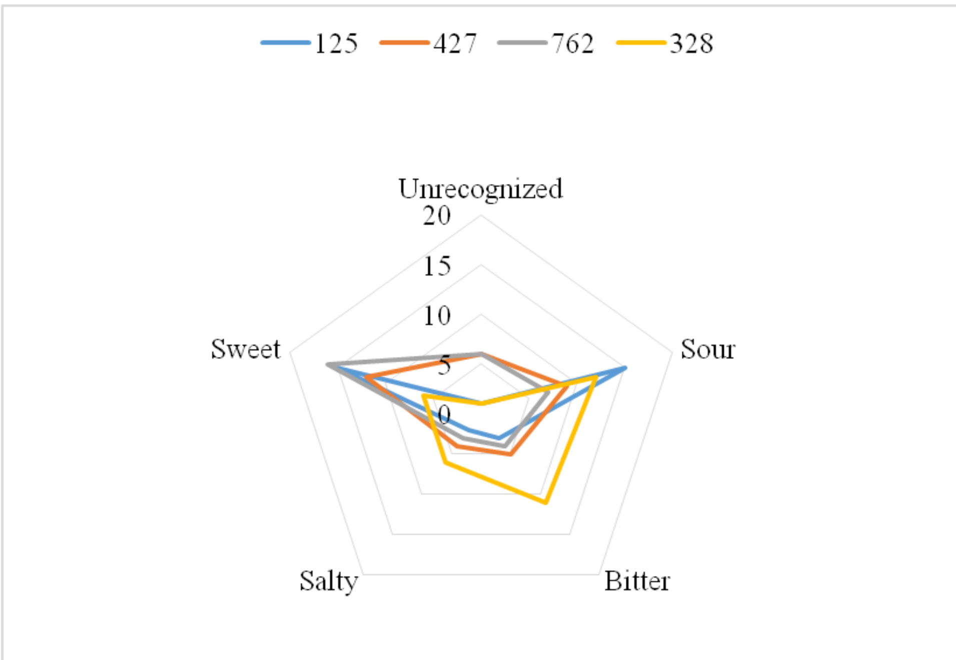

Figure 2b. After taste profiles of the control (125) and fortified orange juice samples (Sample 1: 762; Sample 2: 427; Sample 3: 328)

CONCLUSION

In this study, the effect of addition of health-beneficial reishi extract on the quality properties of fresh orange juice was investigated. Incorporation of reishi extract did not significantly alter the quality characteristics of natural fresh orange juice ($P > 0.05$). However, the most important parameter that distinguished four different samples was the sensory analysis. The result of 5-point hedonic scale consumer preference study showed that the functional orange juices were moderately appreciated and arised a slight taste difference compared to the fresh orange juice. According to these results, the recommended daily intake dose of the extract (10 ml / day) was acceptable when added to 320 mL of packed orange juice, which could be drunk once a day. When 5 mL extract was added to 325 mL orange juice, 80% of the panelists found it acceptable for consumption, in that way consumers could drink fruit juice twice a day to get suggested amount of the extract for health promoting effects. However, when both the extract's unique bitter taste and the orange juice's own taste were combined, bitter taste of 10 mL extract was perceived more in 200 mL than 330 mL of fruit juice and thus less appreciated by the panelists. Finally, freshly squueezed orange juice may be a very good candidate to mask the bitter taste of reishi extract and consumers can prefer this functional drink as an alternative for their daily diet. Additonally, therapeutic effects of the recommended dose of the extract in functional orange juice would be better to be analyzed in the further studies.

The authors declare no conflict of interest.

REFERENCES

Ahmad, M. F. (2018). *Ganoderma lucidum*: Persuasive biologically active constituents and their health endorsement. *Biomed Pharmacother*, 107: 507-519, doi: 10.1016/j.biopha.2018.08.036.

Anonymous (2004). Gıdaların üretimi, tüketimi ve denetlenmesine dair kanun hükmünde kararnamenin değiştirilerek kabulü hakkında kanun (5179). TBMM Genel Kurul. 5 Haziran 2004 tarih ve 25483 sayılı Resmi Gazete, Ankara.

Anonymous (2014). Türk gıda kodeksi. Meyve suyu ve benzeri ürünler tebliği (2014/34). Gıda, Tarım ve Hayvancılık Bakanlığı. 06 Agustos 2014 tarih ve 29080 sayılı Resmi Gazete, Ankara.

AOAC International (2016). Official Methods of Analysis. 20th Edition (On-line). Method 976.21, Rockville, MD., the USA.

Bishop, K. S., Kao, C. H., Xu, Y., Glucina, M. P., Paterson, R. R. M., Ferguson, L. R. (2015). From 2000 years of Ganoderma lucidum to recent developments in nutraceuticals. *Phytochemistry*, 114: 56-65, doi: 10.1016/j.phytochem.2015.02.015.

BS ISO 8587:2006+A1:2013. Sensory analysis-Methodology-Ranking, BSI Standards Limited 2013.

Chang, R. (1996). Functional properties of edible mushrooms. *Nutr Rev*, 54(11): 91-93.

Cheung, P. C. K. (2008). Nutritional value and health benefits of mushrooms. In:Mushrooms as functional foods, Cheung, P. C. K. (chief ed.), John Wiley & Sons, Inc., Hoboken, New Jersey, pp.71-99.

Crozier, A., Yokota, T., Jaganath, I. B., Marks, S. C., Saltmarsh, M., Clifford, M. N. (2006). Secondary metabolites in fruits, vegetables, beverages and other plant based dietary components. In Plant Secondary Metabolites: Occurrence, structure and role in the human diet, Crozier, A., Clifford, M. N., Ashihara, H. (chief eds), Blackwell: Oxford, U.K., pp 208-302.

da Costa, G. M., de Carvalho Silva, J. V., Mingotti, J. D., Barão, C. E., Klososki, S. J., Pimentel, T. C. (2017). Effect of ascorbic acid or oligofructose supplementation on L. paracasei viability, physicochemical characteristics and acceptance of probiotic orange juice. *LWT - Food Sci Technol*, 75: 195-201, doi: 10.1016/j.lwt.2016.08.051.

Dayısoylu, K.S., Gezginç, Y., Cingöz, A. (2014). Fonksiyonel Gıda mı, Fonksiyonel Bileşen mi? Gıdalarda Fonksiyonellik. *The Journal of Food*, 39 (1): 57-62.

Deepalakshmi, K., Mirunalini, S. (2011). Therapeutic properties and current medical usage of medicinal mushroom: Ganoderma lucidum. *Int J Pharm Sci Res*, 2(8): 1922-1929.

Gardner, P. T., White, T. A., McPhail, D. B., Duthie, G. G. (2000). The relative contributions of vitamin C, carotenoids and phenolics to the antioxidant potential of fruit juices. *Food Chem*, 68(4): 471-474, doi:10.1016/S0308-8146(99)00225-3.

Gil-Ramírez, A., Soler-Rivas, C. (2014). The use of edible mushroom extracts as bioactive ıngredients to design novel functional foods with hypocholesterolemic activities. In: Mushrooms: Biological characterization, antioxidant properties and interactions with human health, Grigoire Pesti, G. (chief ed.), Chapter 2, Nova Science Publishers, Inc., New York, USA, pp. 43-73.

Kabasakalis, V., Siopidou, D., Moshatou, E. (2000). Ascorbic acid content of commercial fruit juices and its rate of loss upon storage. *Food Chem*, 70(3): 325-328, doi:10.1016/S0308-8146(00)00093-5.

Kelebek, H., Selli, S., Canbas, A., Cabaroglu, T. (2009). HPLC determination of organic acids, sugars, phenolic compositions and antioxidant capacity of orange juice and orange wine made from a Turkish cv. Kozan. *Microchem J*, 91(2): 187-192, doi: 10.1016/j.microc.2008.10.008.

Lee, H. S., Coates, G. A. (1999). Vitamin C in frozen, fresh squeezed, unpasteurized, polyethylene-bottled orange juice: a storage study. *Food Chem*, 65(2): 165-168, doi:10.1016/S0308-8146(98)00180-0.

Leopold, L. F., Leopold, N., Diehl, H-A., Socaciu, C. (2011). Quantification of carbohydrates in fruit juices using FTIR spectroscopy and multivariate analysis. *Spectrosc,* 26 (2): 93-104.

Luckow, T., Delahunty, C. (2004). Consumer acceptance of orange juice containing functional ingredients. *Food Res Int*, 37(8): 805-814, doi: 10.1016/ j.foodres.2004.04.003.

Meléndez-Martínez, A. J., Vicario, I. M., Heredia, F. J. (2007). Carotenoids, color, and ascorbic acid content of a novel frozen-marketed orange juice. *J Agric Food Chem*, 55(4): 1347-1355, doi:10.1021/jf063025b.

Meral, R., Doğan, İ.S. (2009). Fonksiyonel öneme sahip doğal bileşenlerin unlu mamullerin üretiminde kullanımı. *GIDA*, 34 (3): 193-198.

Nielsen, S. S. (2017). Total carbohydrate by phenol-sulfuric acid method. In: *Food analysis laboratory manual*, Nielsen, S. S. (chief ed.), Springer International Publishing, Cham, Switzerland, pp. 137-141.

Park,G.L., Byers, J.L, Pritz, C.M., Nelson, D.B., Navarro, J.L., Smolensky, D.C., Vandercook, C.E. (1983). Characteristics of california navel orange juice and pulpwash. *J Food Sci*, 48(2): 627-632, doi: 10.1111/j.1365-2621.1983.tb10805.x.

Rapisarda, P., Tomaino, A., Lo Cascio, R., Bonina, F., De Pasquale, A., Saija, A. (1999). Antioxidant effectiveness as influenced by phenolic content of fresh orange juices. *J Agric Food Chem*, 47(11): 4718-4723, doi:10,1021 / jf990111l.

Reis, F. S., Martins, A., Vasconcelos, M. H., Morales, P., Ferreira, I. C. (2017). Functional foods based on extracts or compounds derived from mushrooms. *Trends Food Sci Technol*, 66: 48-62, doi: 10.1016/j.tifs.2017.05.010.

Rekha, C., Poornima, G., Manasa, M., Abhipsa, V., Devi, J. P., Kumar, V. H. T., Kekuda, T. R. P. (2012). Ascorbic acid, total phenol content and antioxidant activity of fresh juices of four ripe and unripe citrus fruits. *Chem Sci Trans*, 1(2): 303-310, doi:10.7598/cst2012.182.

Roberfroid, M. B. (1999). What is beneficial for health? The concept of functional food. *Food Chem Toxicol*, 37(9-10): 1039-1041, doi: 10.1016/S0278-6915(99)00080-0.

Singleton, V. L., Rossi, J. A. (1965). Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. *Am J Enol Viticult*, 16(3): 144-158.

Siro, I., Kápolna, E., Kápolna, B., Lugasi, A. (2008). Functional food. Product development, marketing and consumer acceptance—A review. *Appetite*, 51(3), 456-467, doi:10.1016 / j.appet.2008.05.060.

Stone, H., Bleibaum, R. N., Thomas, H. A. (2012). *Sensory Evaluation Practices*. 4th Edition, Academic Press Elsevier Inc., Oxford, the UK, 438 p.

Tang, W., Liu, J. W., Zhao, W. M., Wei, D. Z., Zhong, J. J. (2006). Ganoderic acid T from Ganoderma lucidum mycelia induces mitochondria mediated apoptosis in lung cancer cells. *Life Sci*, 80(3): 205-211, doi:10.1016 / j.lfs.2006.09.001.

Tiwari, B.K., Muthukumarappan, K., O' Donnell, C.P., Cullen, P.J. (2008). Modelling colour degradation of orange juice by ozone treatment using response surface methodology. *J Food Eng*, 88: 553–560, doi: 10.1016 / j.jfoodeng.2008.03.021.

Topuz, A., Topakci, M., Canakci, M., Akinci, I., Ozdemir, F. (2005). Physical and nutritional properties of four orange varieties. *J Food*

Eng, 66(4): 519-523, doi: 10.1016 / j.jfoodeng.2004.04.024.

Tüfekçi Benli H. (2008). Piyasada Satılan Bazı Meyve Sularının Özelliklerinin Gıda Mevzuatına Ugunluğunun Araştırılması. (Yayımlanmış Yüksek Lisans Tezi). Çukurova Üniversitesi/ Fen Bilimleri Enstitüsü, Adana.

Wachtel-Galor, S., Choi, S. W., Benzie, I. F. F. (2005). Effect of Ganoderma lucidum on human DNA is dose dependent and mediated by hydrogen peroxide. *Redox Rep*, 10 (3):145–149, doi:10.1179 / 135100005X57355.

Wachtel-Galor, S., Yuen, J., Buswell, J. A., Benzie, I. F. F. (2011). Ganoderma lucidum (Lingzhi or Reishi)A Medicinal Mushroom. In: Herbal Medicine: Biomolecular and clinical aspects, Benzie, I. F. F., Wachtel-Galor S. (chief ed.), CRC Press/Taylor & Francis, Boca Raton, FL, USA, pp. 175-199.

Wasser, S., P., Weis, A., L., (1999). Medicinal properties of substances occurring in higher Basidiomycetes mushrooms: current perspectives (review). *Int J Med Mushrooms*, 1(1): 31–62.