PAPER

TURKISH-COFFEE ENRICHED WITH ROSE: A PROMISING COMBINATION

E. KARABUDAK[1], E. AKSOYDAN[2], D. AĞAGÜNDÜZ*[1] and M. ERGÜL[3]

[1]Gazi University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Emniyet Mahallesi, Muammer Yaşar Bostancı Caddesi 16, 06500 Beşevler, Ankara, Turkey

[2]Başkent University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Bağlıca Kampüsü Fatih Sultan Mahallesi, 06790 Etimesgut, Ankara, Turkey

[3]San Francisco State University, College of Business, Hospitality and Tourism Management Department, USA

*Corresponding author: Tel.: +903122162601; Fax: +903122162636

E-mail address: duygu_turkozu@ymail.com

ABSTRACT

The purpose of this study was to develop a new & healthy version of Turkish-coffee enriched with rose. Conventionally roasted *Coffee Arabica L.* beans for Turkish-coffee & dried-*Rosa Damascene Mill.*[7/0,7/0.5,7/1.5,7/2g(w/w)] was grinded. Total-Phenolic Contents (TPC), Total-Antioxidant (TAS) & Oxidant-Status (TOS) were measured and Oxidatif Stress Index (OSI) was calculated. Consumer panel testing was done. TPC of the coffee samples with 1.5 & 2g rose was different according to plain coffee ($p<0.05$). TAS value (mmol/L) of plain-coffee was 2.2±0.11 while the values of the coffees including 0.5g,1.5g,2g rose were 2.4±0.09,2.4±0.05,2.7±0.02, respectively. TOS value (μmol/L) of plain-coffee was 17.6±0.24, while the values of the coffees including 0.5 g, 1.5 g and 2 g rose were 13.0±1.00, 9.4±1.30, 9.4±0.31, respectively ($p<0.05$). OSIs of coffee samples including 0, 0.5, 1.5, 2 g rose were found to be 7.7, 5.2, 3.6, 2.7 respectively ($p<0.05$). The coffees including 1.5 & 2 g rose had the highest sensory-scores. Turkish-coffee including rose will strengthen already existing phenolic & antioxidant features of coffee, and thus contribute the improvement of health & taste.

Keywords: antioxidants, coffee, oxidants, polyphenols, rose, Turkish coffee

1. INTRODUCTION

Recent studies in nutrition & health have focused on more detailed research on the effects of foods on health (KRİS-ETHERTON *et al*., 2002; KRİS-ETHERTON *et al*., 2004; MRC, 2017). These studies are mostly conducted on the components of foods, processing techniques and alternative development (BIER *et al*., 2015; POTİ *et al*., 2015). The food industry has embarked on a consumer-oriented mission with new product development or product modifications matching with scientific nutrition and health recommendations (BIER *et al*., 2015). In particular, many herbal foods have become important raw materials for many fields due to their bioactive compounds, especially phenolic compounds (EL 2008). The bioactive compounds found and defined in foods vary according to their numbers, chemical structures and functions (FİLHO *et al*., 2007; KRİS-ETHERTON *et al*., 2002; KRİS-ETHERTON *et al*., 2004).

Coffee is a globally consumed beverage and recent studies showed that consuming coffee in acceptable amounts have potential health benefits (LİANG *et al*., 2016). It's known to be a natural antioxidant and recent studies comment on antioxidant effects of coffee along with other benefits and linking them to prevent various common diseases (AGUİAR *et al*., 2016). Turkish Coffee, a traditional delicacy for the Turks with its unique flavor and aroma is becoming a popular beverage globally (ÖZGÜR, 2012). *Coffee Arabica L*., which is the most used bean type for Turkish coffee, is widely used in pharmacology, homeopathy, therapeutics and gastronomy due to its health benefits (CAPEK *et al*., 2014).

Rosa damascena is a herb with economical value. Turkey is a leading manufacturer of rose and rose products especially around the city of Isparta (ANON 2003). In addition to its economical value, incorporation of "*Rosa damascena*" into pharmacology, homeopathy, therapeutics and gastronomy demonstrates a broad range of its uses and health benefits (BOSKABADY *et al*., 2011; MAHBOUBİ, 2016). Researchers indicate that rose products are also natural antioxidants, and thus use of rose as nutraceutical foods is useful for both health aspects and adding aesthetic value and taste to make it appealing to consumers (MLCEK AND ROP 2011; KOVATCHEVA-APOSTOLOVA *et al*., 2008). Additionally, there are studies regarding its anelgesic, antimicrobial, antioxidant, anti-inflammatory, antidiabetic and antidepressant features fields (BOSKABADY *et al*., 2011; MAHBOUBİ, 2016). It is considered that antioxidant and antimicrobial effects of *Rosa damascena* originate from its phenolic content and essential fat composition (ÖZKAN *et al*., 2004). Citronellol and geraniol are the two main compounds found in the essential oil of *Rosa damascena* and responsible for its pharmacological activities (MAHBOUBİ, 2016). Moreover, quarcetin, kaempferol and their glycosides are the flavonol glycosides, which are responsible for the high antioxidant activity of *Rosa damascena* flowers, petals and extract (BOSKABADY *et al*., 2011). However, it is reported that further research is required on the use of *Rosa damascena* plant in preclinical and clinical investigations (MAHBOUBİ, 2016).

The purpose of this study is to develop a new and healthy version Turkish coffee with rose through preserving its traditional and nutritional value while investigating consumers' liking and preferences. Besides contributing the efforts for improvement of health and strengthening already existing phenolic content and antioxidant features of coffee which is a widely consumed and traditional beverage in Turkey, this study will ensure that a Turkish-origin healthy beverage will be introduced as an innovative design to the world.

2. MATERIAL AND METHODS

This study was conducted on two stages. The first stage consists of the provision of sample, preparing the samples for chemical analysis and the measurements of phenolic content and antioxidant capacity. The second stage consists of the preparation of Turkish coffees and tasting the coffee samples prepared by using coffee and spent rose, which are mixed in certain amounts [7/0, 7/0.5, 7/1.5, 7/2 g (w/w)].

2.1. Preparation of Rose and Coffee Samples

Fresh (unfaded) petals of unprocessed *Rosa Damascena,* which were harvested in Isparta, were dried at room temperature. Before having been ground, rose petals and coffee beans were stored within closed dark glass jars at room temperature until analysis and/or tasting panel day so that they preserved their compound and freshness.
The most consumed coffee in the world (85-90%), *Coffee Arabica L.* beans were selected for the study. Raw coffee beans were roasted in the coffee shop for 4 minutes at 220 °C. The samples were prepared according to the traditional Turkish coffee standard published by The Turkish Coffee Culture and Research Association (ÖZGÜR, 2012).
Coffee beans and rose petals were fine ground with a grinding machine (Krupps F203 Electric Grinder®) on the analysis day. Fine ground 7 g coffee was prepared with 70 mL water (traditional coffee cup measure). To ensure the volume of coffee cup, the samples of Turkish coffee cups were also collected from coffee manufacturers and coffee shops, and their average service volumes were calculated.
Instead of steel/copper coffee pot, which is used for the preparation of traditional Turkish coffee, an electricity coffee pot (Arçelik K® 3300) was used to prepare multiple samples and ensure standardization. Coffee samples were prepared in avarege 1.15 minutes.
Fine ground coffee and rose petals were taken in certain amounts [7/0, 7/0.5, 7/1.5, 7/2 g (w/w)] to prepare four different samples as described above. Samples were taken from only the drinkable part of the coffee to eppendorf tubes one minute after the rose petal coffee was ready. Three samples of each experimental coffee were prepared and all samples were analyzed for three times.

2.2. Measurement of Total Phenolic Content (TPC)

The amount of phenolic compounds in the spent rose (*Rosa damascene Mill.*), Turkish coffee beans and all coffee samples with spent roses were determined by Folin-Ciocalteu colorimetric method (SİNGLETON *et al*., 1999). For sample extraction, spent rose and coffee beans were dissolved and homogenized in 80% ethanol and heated for 5 minutes. Extracts filtered with Whatman filter paper (number 4). Then, 80% ethanol was added to residue after filtration and heated for 10 minutes and filtered again up to ensure extraction. Extracts of dry coffee-rose samples and drinkable part of the coffee samples with rose in eppendorf tubes dilueted and analysed using a Folin-Ciocalteu reagent. TPCs were expressed as mg/L gallic acid equivalents (GAE) extract.

2.3. Measurement of Total Antioxidant Status (TAS)

TAS levels were measured using commercially available kits (Relassay, Turkey). The novel automated method is based on the bleaching of characteristic color of a more stable ABTS (2,2′ - Azino-bis (3-ethylbenzothiazoline-6-sulfonic acid)) radical cation by antioxidants. The assay has excellent precision values, which are lower than 3%. The results were expressed as mmol Trolox equivalent/L (EREL, 2004).

2.4. Measurement of Total Oxidant Status (TOS)

TOS levels were measured using commercially available kits (Relassay, Turkey). In the new method, oxidants present in the sample oxidized the ferrous ion-o-dianisidine complex to ferric ion. The oxidation reaction was enhanced by glycerol molecules abundantly present in the reaction medium. The ferric ion produced a colored complex with xylenol orange in an acidic medium. The color intensity, which could be measured spectrophotometrically, was related to the total amount of oxidant molecules present in the sample. The assay was calibrated with hydrogen peroxide and the results were expressed in terms of micromolar hydrogen peroxide equivalent per liter (μmol H_2O_2 equivalent/L) (YUMRU *et al*., 2009).

2.5. Calculation of the Oxidative Stress Index (OSI)

The ratio of TOS to TAS was accepted as the oxidative stress index (OSI). For calculation, the resulting unit of TAS was converted to μmol/L, and the OSI value was calculated according to the following Formula (YUMRU *et al*., 2009):

$$\text{OSI (arbitrary unit)} = \text{TOS (}\mu\text{mol } H_2O_2 \text{ equivalent/L)} / \text{TAC (}\mu\text{mol Trolox equivalent/L)}$$

2.6. Sensory evaluation

The samples prepared in the same order as the coffees prepared for chemical measurements. Sugar was not added to coffee samples. Fine ground coffee and rose petals were taken in certain amounts [7/0, 7/0.5, 7/1.5, 7/2 g (w/w)] to prepare traditional Turkish coffee samples as described above.
Panelists were chosen among the people (20-64 years) who consume Turkish coffee regularly, accepted participating in the study voluntarily, do not smoke and do not have any mouth and dental (tooth decay etc.) and chronic disease that may affect their palate. Each group is expected to consist of 10-15 individuals in such studies considering the fact that there is not any data in the literature with regard to the appropriate number of panelists and qualitative research aspect of the study (ÇOKLUK *et al*., 2011). Therefore, 15 panelists participated in the study.
Panelists were chosen in "Food Preparation Laboratory" and they were seated in a way that they could not communicate with each other during the tasting stage. Each panelist was also given a number randomly. The panelists were informed for approximately fifteen minutes about the procedures of evaluation and the points to be taken into account before coffee presentation. The coffees prepared by the researchers with rose petals in four different amounts were presented in Turkish coffee cups, which had the same volume and design (70 mL). In order that panelists could differentiate the tastes of coffee samples, they were presented every ten minutes and participants were asked to eat a fat-free salt cracker and gargle with water at the intervals. After each coffee taste, the panelists wrote down their rating points form for each coffee sample. The evaluation was made from the lowest point (0 points) towards the highest point (10 points).
Panelist evaluation scores were assessed separately for each sample under the following criteria:

- Smell (the harmony of coffee and rose smell, dominant one etc.)
- Aroma (harmony and range of aroma component)
- Taste (the taste and aroma combination experienced when the coffee sample was tasted)

- Aftertaste (the duration of feeling the taste at the back of palate after swallowing the sample)
- Acceptability
- Preference (consumption preference)
- General impression (panelist's own remarks)

This study was approved by Baskent University Institutional Review Board (Project no: KA17/83) and supported by Baskent University Research Fund. Clear explanations were provided for the individuals with regard to the purpose of the study, after which written informed consent was obtained from all participants in accordance with the Declaration of Helsinki (World Medical Association).

2.7. Statistical analysis

All statistical analyses were performed using SPSS (The Statistical Package for Social Sciences) Version 20.0 (SPSS Inc., Chicago, IL, USA). Percentage, mean ± standard deviation (SD) values were taken for the evaluation of the data. In addition, a Kolmogorov-Smirnov test was used to determine whether the panelist evaluation ratings had a normal distribution. Panelists' evaluation ratings for the coffee samples were shown as mean ± SD and median (minimum-maximum). Kruskal Wallis and Mann-Whitney-U tests were used to compare the means of TPC, TAS, TOS and OSIs of coffee samples prepared with rose in four different amounts. Differences among means with $p < 0.05$ were accepted as representing statistically significant differences.

3. RESULTS AND DISCUSSION

3.1. Evaluation of the Total Phenolic Content and Antioxidant/Oxidant Status

Table 1 shows the TPC (mg/L GAE), TAS (mmol/L), TOS (μmol/L) and OSIs of coffee samples prepared with raw and spent rose and coffee samples in different amounts. Accordingly, the TPC of raw dry coffee and rose was 611.3±1.19 mg/L GAE and 605.2±0.64 mg/L GAE respectively. There was no statistically difference between the TPC of plain coffee sample (445.7±6.66 mg/L GAE) and that of the samples prepared with 0.5g rose (458.4±11.75) ($p>0.05$). However, TPC of the coffee samples prepared with 1.5 and 2g rose (463.1±6.42 and 479.3±12.56 mg/L GAE) was statistically different compared to that of plain coffee sample. In addition, TPC of the coffee samples with 1.5 and 2g rose was not different from that of the sample with 0.5g rose ($p>0.05$). TPC of the coffee samples with 1.5 and 2 g rose was similar to each other ($p>0.05$).
The evaluation of TAS of the samples showed that the TAS of raw/dry coffee and rose samples was 3.1±0.00 mmol/L and 2.3±0.02 μmol/L respectively. The evaluation of TAS of the coffees prepared with rose in different amounts and without any rose showed that the TAS value of plain coffee was 2.2±0.011 mmol/L, while the values of the coffees including 0.5g, 1.5g and 2g rose were 2.4±0.09, 2.4±0.05 and 2.7±0.02 mmol/L respectively, and thus all TAS values of coffee samples with rose were different from each other ($p<0.05$).
The evaluation of TOS of the samples showed that the TOS values of raw/dry coffee and the spent rose were 9.5±0.02 μmol/L and 16.8±0.06 μmol/L respectively (Table 1). In addition, the evaluation of TOS of coffee samples showed that the TOS value of plain coffee was 17.6±0.24, while the values of the coffees including 0.5 g, 1.5g and 2g rose were 13.0±1.00 μmol/L, 9.4±1.30 μmol/L and 7.5±0.31 μmol/L respectively. The difference between the TOS values of all coffee samples with rose was important ($p<0.05$).

The evaluation of OSIs of all samples showed that the OSIs of raw/dry coffee and rose samples were 3.0 and 7.2 respectively. OSIs of coffee samples including 0, 0.5, 1.5, 2 g rose were found to be 7.7, 5.2, 3.6 and 2.7 respectively ($p<0.05$) (Table 1).

Table 1. The total phenolic content (GAE/g), total antioxidant status (mmol/L), total oxidant status (μmol/L) and oxidative stress indexes of coffee samples including rose in different amounts*.

Sample	TPC (mg/L GAE)	TAS (mmol/L)	TOS (μmol/L)	OSI
Powder and raw				
Dry coffee	611.3±1.19	3.1±0.00	9.5±0.02	3.0
Spent rose	605.2±0.64	2.3±0.02	16.8±0.06	7.2
Boiled (per Turkish coffee cup) (w/w)				
7 g coffee	445.7±6.66 [a]	2.2±0.11[a]	17.6±0.24[a]	7.7[a]
7 g coffee + 0.5 g rose	458.4±11.75[a]	2.4±0.09[a]	13.0±1.00[b]	5.2[b]
7 g coffee + 1.5 g rose	463.1±6.42 [b]	2.6±0.05[b]	9.4±1.30[c]	3.6 [c]
7 g coffee + 2 g rose	479.3±12.56 [b]	2.7±0.02[c]	7.5±0.31[d]	2.7[d]

*TPC: Total Phenolic Content, TAS: Total Antioxidant Status, TOS: Total Oxidant Status, OSI: Oxidative Stress Index.

[a-d]Values are the mean ± SD of three replicates. Values with different letters in the same column are statistically different ($p<0.05$).

3.2. Sensory evaluation

In this experiment, plain and coffee with rose (with different concentrations) were tasted in the panel and 66.7% of the panelists were female, while 33.3% of them were male. The mean age of the panelists was 43.8 ±7.5 years. 46.7% of the panelists were drinking Turkish coffee every day, 46.7% several times a week and 6.6% once a week. 66.7% of the participants were drinking sugar-free Turkish coffee, 26.7% of them preferred coffee with little sugar and 6.6% consumed coffee with sugar.

Table 2 shows the evaluation scores (smell, aroma, taste, aftertaste, acceptability, preference and general impression) of the panelists about the coffee samples with rose in different amounts. The sensory evaluation scores given to coffee samples with rose in different amounts show that panelists gave more points to the coffee samples containing 1.5 g and 2 g rose than plain coffee sample (6.2±2.2 vs. 6.1±2.3, respectively) (Table 2). In addition to this, the sensory evaluation scores of the coffee samples containing 0.5g rose are similar to or less than that of plain coffee (Table 2).

When general impression scores of the coffee samples as a result of the panel test and total antioxidant and total oxidant status of coffee samples are evaluated, the interpretation of consumer preference and both TAS and TOS of coffee samples showed that the coffee sample containing 2 g rose both had relatively the highest TAS and low TOS and got the highest score from the panelists. Additionally, the coffee sample containing 1.5 g rose content had relatively higher TAS and lower TOS than plain coffee and received higher general impression score from the panelists.

Table 2. Panelist evaluation scores of coffee samples with rose in different concentrations*.

Sample	Smell	Aroma	Taste	Aftertaste	Acceptability	Preference	General Impression
7 g coffee	5.7±2.8 5 (1-9)	5.8±1.7 6 (3-8)	6.3±2.4 7 (3-9)	6.8±1.6 7 (4-9)	6.1±2.3 6 (3-9)	5.8±2.3 6 (3-9)	5.8±1.77 6(4-9)
7 g coffee+0.5 g rose	6.6±1.5 6 (4-8)	5.7±1.8 6 (3-8)	6.4±1.7 7 (4-8)	6.8±0.7 7 (6-8)	5.3±1.34 6 (3-7)	5.6±1.9 6 (3-9)	5.4±2.09 6(3-9)
7 g coffee+1.5 g rose	7.3±1.4 8 (5-9)	7.0±1.7 8 (4-9)	6.5±1.8 6(4-9)	7.9±0.7 8(7-9)	6.4±1.7 6 (4-9)	6.1±1.7 6 (4-9)	6.2±2.2 6(4-9)
7 g coffee+2 g rose	7.0±1.6 8 (5-9)	6.3±1.9 6 (3-9)	6.4±1.9 6 (4-9)	7.4±1.8 8 (5-10)	6.0±2.3 5 (3-9)	5.7±2.2 5 (3-8)	6.1±2.3 5(3-9)

*Scores were shown as mean ± SD and median (minimum-maximum points).

4. DISCUSSION

Coffee is consumed worldwide and one of the most popular beverages. A number of epidemiologic and clinic studies proved that coffee consumption may prevent several chronic and degenerative diseases, such as cancer, cardiovascular disorders, diabetes, and Parkinson's disease (LUDWIG *et al*., 2014). Within this scope, this study was conducted to strenghten potential health effects and antioxidant feature of Turkish coffee and improve health condition by adding rose petals to the traditional beverage Turkish coffee which is widely consumed in Turkey.

It was found out in the study that TPC of the raw and dry coffee beans of *Coffee Arabica L* roasted for 4 minutes at 220° C was 611.3±1.19 mg/L GAE, while the value decreased to 451.4±1.20 mg/L GAE after the coffee was boiled. Moreover, TAS value decreased while TOS values and OSIs increased. An important family of phenolic compounds, chlorogenic acids are green coffee compounds which are formed by the esterification of caffeic, ferulic, and p-coumaric trans-cinnamic acids with (−)-quinic acid and associated with hepatoprotective, hypoglycemic and antiviral activities because of their antioxidant effects (FARAH AND DONANGELO, 2006). Chlorogenic acids (CGA) and related compounds (caffeoylquinic acids, dicaffeoylquinic acids, feruloylquinic acids, *p*-coumaroylquinic acids and mixed diesters of caffeic and ferulic acids with quinic acid and their isomers) constitutes the most important phenolic fraction of green coffee bean (CLIFFORD, 2000) and its content reaches up to 14% in dry substance (FARAH AND DONANGELO, 2006). The chlorogenic acid content of a 200 mL (7-oz) cup of coffee has been reported to range from 70-350 mg (CLİFFORD, 1999).

During the roasting, CGA can turn into isomerized, hydrolyzed or degraded lower molecular weighted materials. Roasted beans of *Coffee Arabica L.* contain 1.9-2.5 g/100g CGA in average, while the roasted beans of *Coffee Canephora* contain 3.3-3.8 g/100 g in average and these average values change depending on the type of coffee beans (FARAH, 2012). Especially roasting coffee beans at high temperatures (230°C) turns a part of CGA into quinolactons and melanoidins, and thus CGA content decreases after roasting (Farah 2006; FARAH, 2012). A study showed that roasting coffee beans causes 23% CGA loss because of degredation and constitutes condensed form (42-62 mmol/100 g) and ester-linked melanoiding forms (1.1-1.6 mmol/100 g) (COELHO *et al*., 2014). It was considered after this study that the decrease in the TPC after the roasted dry coffee was boiled in water at high temperature was the result of the transformation and condensation of the free forms of CGA into quinolactons and melanoidins through various mechanisms due to degredation. Moreover, the decrease in TPC also caused decrease in total antioxidant capacity and increase in oxidant capacity and OSI value.

The determination of TPC, TAS, TOS and OSI values of a coffee prepared in Turkish coffee preparation method (7 g/70 mL) for the first time was one of the important findings of this study. Coffees are prepared in different methods such as drip or filter, plunger or cafetière, espresso, cappuccino, moka-napoletana, percolator, soluble or instant and flavored (KARABUDAK *et al*., 2015). Preparation method of Turkish coffee is different from other coffee types (ÖZGÜR, 2012). For the traditional preparation of Turkish coffee, fine ground powder coffee is added to cold water and the coffee is boiled. This produces a strong coffee with a layer of foam on the surface and sediment (not meant for drinking) that settles on the bottom of the cup. LUDWİG *et al*. (2012) indicated that brewing time and preparation method affected the antioxidant amount of coffee (LUDWİG *et al*., 2012). It is generally reported that the total antioxidant capacity of 7-10 g of coffee is 150-300 mg/g (YASHİN *et al*., 2013). In a comprehensive evaluation made by using different methods, ferric reducing antioxidant power (FRAP) values of espresso, instant coffee, decaffeinated espresso coffee were 129.4, 108.6, 93.0 mol Fe^{+2}/L respectively (PELLEGRINI *et al*., 2003). Additionally, it was found out that total radical trapping antioxidant power (TRAP) of espresso was 66 mol Trolox/L, that of instant coffee 52.4 Trolox/L and that of decaffeinated espresso 45.8 mol Trolox/L. Trolox equivalent antioxidant capacity (TEAC) values for espresso, instant coffee and decaffeinated espresso were found to be 36.5, 32.5 and 27.0 mol Trolox/L respectively (PELLEGRİNİ *et al*., 2003). Therefore, the presence and amount of bioactive compounds have important roles in health effects depending on the preparation method of coffee (PETERS, 1991). However, the unstandardized methods and amounts (water and coffee amounts) and different unit of measurement (w/w, w/v, w/dose, and w/cup) make it difficult to compare the results of studies with other studies and the coffees prepared with different methods (CAPRİOLİ *et al*., 2015). This is one of the most important limitations in the literature.

Rosa damascena Mill's antimicrobial, anti-inflammatory, anticancer effects and protective effects against neurological, cardiovascular and liver diseases were proved in a number of *in vitro* and animal studies (NAYEBİ *et al*., 2017). The flowers, petals and hips of *Rosa Damascena* contain terpenes, glycosides, flavonoids and anthocyanins. In addition, this plant contains carboxylic acids, myrcene, vitamin C, kaempferol, quarcetin, tannin and essential oils and organic acids (BOSKABADY *et al*., 2011). A study showed that three flavonol glycosides, specifically quercetin-3-O-glucoside, kaempferol-3-O rhamnoside and kaempferol-3-O-arabinoside, contained in *Rosa Damascena*, are responsible for antioxidant activity. In our study, the TPC and TAS of spent rose leaf powder were found to be quite high (605.2±0.64 mg/L GAE and 2.3±0.02 mmol/L, respectively). In another study conducted by using *Rosa Damascena* extracts grown in the same region of Turkey, TPC of fresh leaf extract of *Rosa Damascena* was 276.0±2.93 mg/L GAE, while that of spent flower was found to be 248.9±2.96 mg/L GAE. Antiradical activities of fresh and spent leaf were determined, through α-diphenyl- α-picrylhydrazyl (DPPH), to be %74.51±1.65 and %75.94±1.72 at 100 ppm respectively. Additionally, determined by the method depending on phosphomolybdenum complex formation, the antioxidant activity of fresh leaf extract (372.2±0.96 mg/g) was higher than that of spent leaf extract 351.3±0.84 mg/g (ÖZKAN *et al*., 2004). The reason of the difference between the results of our study and above mentioned study may be a number of factors such as seasons and the difference in analysis techniques, land and improvement methods although *Rosa Damascenas* of the same region were used.

The aim of this study was to increase existing TPC and TAS value of Turkish coffee by adding spent rose flower grown in Isparta region of Turkey. As a result, TPC and TAS values increased and TOS and total OSI values decreased after 0.5 g, 1.5 g and 2.0 g rose aroma were added to plain coffee. The coffee sample containing 2g rose (the highest amount) had the highest TPC and TAS values and lowest oxidant content and OSI values.

Some studies suggest that *Rosa damascena* plant may be used as a medical source in the prevention and treatment of many diseases caused by free radicals (BOSKABADY *et al*., 2011). It is considered that it would be beneficial to carry out preclinical and clinical evaluations of above mentioned rose coffee samples in future studies.

Oxidative stress is associated with the excessive increase in oxidant levels and/or antioxidant capacity. The atoms or molecules, which contain one or more unpaired electron(s), are called oxidants or free radicals in biological system. Oxidants deteriorate cell structure and extracellular matrix and cause damages in genetic structure by distorting DNAs. Therefore, free radicals have a role in the pathogenesis of various diseases such as atherosclerosis, neurodegenerative diseases, cancer, allergies, diabetes and cataract (YUMRU *et al*., 2009). This study evaluated the OSIs of the coffee samples containing rose in different amounts and revealed that OSI values of coffee samples decreased as the amount of rose increased. In another study, rats were given 50, 75, 100 and 200 mg/kg/day of ethanol extract produced from *Rosa Damascena* petals for 10 days orally and it was found out that all doses of *Rosa Damascena* prevented lipid peroxidation and the highest antioxidant activity was observed after the consumption of 200 mg/kg (SHAHRİARİ *et al*., 2007). Therefore, coffee with rose consumption may be considered to support the antioxidant defense system in order to prevent free radical formation and prevent biological damage.

Coffee is one of the most widely consumed beverages throughout the world because of its unique sensory properties (KREUML *ET AL*., 2013). So, aromatic components are very important in coffee beverages, because they are the principal constituents of sensory experience for coffee consumers (JAIMES *et al*., 2015). The aroma of the coffee comes from caffeine and trigonelline alkoloid, chlorogenic acid, kahweol and cafestol and melanoidin, which is a Maillard reaction products (LUDWIG *et al*., 2014). One of the way for strenghten aroma profile of coffee is inserting a herb with rich source of aroma such as rose. Aroma compounds of rose vary according to parts of herb and its recovering periods (FENG *et al*., 2008; ZHAO *et al*., 2016). At the full opening stage of rose, β-citronellol citronellol acetate, phenethyl alcohol, geranyl acetate, geraniol, phenethyl acetate, nerol, *n*-hexyl acetate and *α*-myrcene, and alcohols are the major constituents of aroma (ZHAO *et al*., 2016).

Consumer appreciation/evaluation plays an important role in the innovation studies of food and various drinks. Therefore, this study includes panelist evaluation tests conducted on the coffee samples containing different amounts of rose aroma. In these evaluations, panelists ranked coffees in terms of their smell, aroma, taste, acceptability, preference and general impression and the coffee samples containing 1.5 g and 2 g rose aroma received relatively highest scores generally. These coffee samples had the highest phenolic content and antioxidant status, but lowest oxidant status and OSI values. Coffee consumers prefer products, not only good flavour and taste, but also good for health (JAIMES *et al*., 2015). So, through this study, it was to develop a new and relatively healthy version Turkish coffee with rose through preserving its traditional and nutritional value while investigating consumers' liking and preferences.

5. CONCLUSIONS

It is considered to strenghten existing phenolic content and antioxidant features of Turkish coffee especially with Turkish coffees containing 1.5 and 2 g rose as an innovative design. Moreover, these coffee samples are considered as the antioxidant & healthy products enriched with a different aroma and appreciated by consumers. Nonetheless, it is necessary to conduct a further study for more detailed investigation of the consumption

doses, possible potential short and long term health effects and risks of these promising combinations.

As far as is known, this is the first study that a promising combination of coffee and *Rosa Damascena* is shown as an innovative design. This study has a number of limitations. First of all, total antioxidant and oxidant profile were focused in this study. So, each phenolic composition of rose and coffee samples related to the antioxidant and oxidant activity were not determined. Nevertheless, it is considered that this study will light the way for other studies. Furthermore, this study focused on Turkish coffee, which was a particular kind of brewed coffee. So, the results could not be generalized to the effects of all coffee types. Finally, when comparing to other studies, our number of panelists might be relatively less or not because of rigid inclusion criteria. Further sensory evaluation may conduct with a larger sample size, including different age groups and populations. It is believed that taking into consideration these situations would be useful in future studies.

The author(s) received no financial support for the research, authorship, and/or publication of this article.

REFERENCES

Aguiar J., Estevinho B.N. and Santos L. 2016. Microencapsulation of natural antioxidants for food application-The specific case of coffee antioxidants-A review. Trends Food Sci. Technol. 58:21-39.

Anonymous. 2003. The Annual Reports of the Union of Co-operative Societies for Agriculture and Sales of Rose Oil and Oily Seeds. Isparta, Turkey.

Bier D.M., Mann J., Alpers D.H., Vorster H.H.E. and Gibney M.J. (Ed.). 2015. The Food Industry and Consumer Nutrition and Health. In: Nutrition for the Primary Care Provider, p. 198-204. World Rev Nutr. Diet, Basel, Karger.

Boskabad M.H., Shafei M.N., Saberi Z. and Amini S. 2011. Pharmacological effects of *Rosa Damascena*. Iran J. Basic Med Sci. 14(4):295.

Capek P., Paulovičová E., Matulová M., Mislovičová D., Navarini L. and Sui-Liverani F. 2014. *Coffea arabica* instant coffee-Chemical view and immunomodulating properties. Carbohydr Polym 103:418-426.

Caprioli G., Cortese M., Sagratini G. and Vittori S. 2015. The influence of different types of preparation (espresso and brew) on coffee aroma and main bioactive constituents. Int. J. Food Sci. Nutr. 66(5):505-513.

Clifford M.N. 1999. Chlorogenic acids and other cinnamates-nature, occurrence and dietary burden. J. Sci. Food Agric. 79(3):362-372.

Clifford M.N. 2000. Chlorogenic acids and other cinnamates-nature, occurrence, dietary burden, absorption and metabolism. J. Sci. Food Agric. 80(7):1033-1043.

Coelho C., Ribeiro M., Cruz A.C., Domingues M.R., Coimbra M.A., Bunzel M. and Nunes F.M. 2014. Nature of phenolic compounds in coffee melanoidins. J. Agric. Food Chem. 62(31):7843-7853.

Çokluk Ö., Yılmaz K., Oguz E. 2011. Nitel bir görüşme yöntemi:Odak grup görüşmesi. Kuramsal Eğitimbilim 4(1):95-107.

El S.N. 2008. Türkiye'de Sıklıkla Tüketilen Bazı Gıdaların Toplam Fenolik Madde İçerikleri ve Antioksidan Aktiviteleri, presented at 10. Gıda Kongresi, Erzurum, May 21-23.

Erel O. 2004. A novel automated direct measurement method for total antioxidant capacity using a new generation, more stable ABTS radical cation. Clin BioChem. 37(4):277-285.

Farah A. and Donangelo, C.M. 2006. Phenolic compounds in coffee. Braz. J. Plant Physiol. 18(1):23-36.

Farah A. 2012. Coffee constituents. Coffee: emerging health effects and disease prevention 1:22-58.

Feng L.G., Sheng, L.X. and Zhao L.Y. 2008. Changes of the aroma constituents and contents in the course of *Rosa rugosa* thunb flower development. Sci. Agric. Sin 41:4341-4351.

Filho E.B.A., Ventura E., do Monte S.A., Oliveira B.G., Junior C.G.L., Rocha G.B. and Vasconcellos M.L.A.A. 2007. Synthesis and conformational study of a new class of highly bioactive compounds. Chemical Physics Letters 449(4):336-340.

Jaimes E.M.S., Torres I.B. and Pérez-Villarreal H.H. 2015. Sensory evaluation of commercial coffee brands in Colombia. Int. J. Business and Systems Research 9(3):195-213.

Karabudak E., Türközü D. and Köksal E. 2015. Association between coffee consumption and serum lipid profile. Exp Ther Med 9(5):1841-1846.

Kovatcheva-Apostolova E.G., Georgiev M.I., Ilieva M.P., Skibsted L.H., Rødtjer A., and Andersen M.L. 2008. Extracts of plant cell cultures of *Lavandula vera* and *Rosa damascena* as sources of phenolic antioxidants for use in foods. Eur. Food Res Technol. 227(4):1243-1249.

Kreuml M.T.L, Majchrzak D., Ploederl B. and Koenig J. 2013. Changes in sensory quality characteristics of coffee during storage. Food Sci. Nutr. 1(4):267-272.

Kris-Etherton P.M., Hecker K.D., Bonanome A., Coval S.M., Binkoski A.E., Hilpert K.F., Griel A.E. and Etherton T.D. 2002. Bioactive compounds in foods: their role in the prevention of cardiovascular disease and cancer. Am J. Med. 113(9):1-88.

Kris-Etherton P.M., Lefevre M., Beecher G.R., Gross M.D., Keen C.L. and Etherton T.D. 2004. Bioactive compounds in Nutrition and health-research methodologies for establishing biological function: the antioxidant and anti-inflammatory effects of flavonoids on atherosclerosis. Annu. Rev. Nutr. 24:511-538.

Liang N., Xue W., Kennepohl P. and Kitts D.D. 2016. Interactions between major chlorogenic acid isomers and Chemical changes in coffee brew that affect antioxidant activities. Food Chem. 213:251-259.

Ludwig I.A., Sanchez L., Caemmerer B., Kroh L.W., Paz De Peña M. and Cid C. 2012. Extraction of coffee antioxidants: impact of brewing time and method. Food Res Int. 48(1):57-64.

Ludwig I.A., Clifford M.N., Lean M.E., Ashihara H. and Crozier A. 2014. Coffee: bioChemistry and potential impact on health. Food Funct. 5(8):1695-1717.

Mahboubi M. 2016. *Rosa damascena* as holy ancient herb with novel applications. J. Tradit. Complement Med. 6(1):10-16.

Medical Research Council (MRC). Review of Nutrition and Human Health Research. 2017. MRC in partnership with NIHR and on behalf of OSCHR partners, UK.

Mlcek J. and Rop O. 2011. Fresh edible flowers of ornamental plants-a new source of Nutraceutical foods. Trends Food Sci. Technol. 22(10):561-569.

Nayebi N., Khalili N., Kamalinejad M. and Emtiazy M. 2017. A systematic review of the efficacy and safety of *Rosa damascena* Mill. with an overview on its phytopharmacological properties. Complement Ther. Med. 34:129-140.

Özgür N. 2012. Türk Kahvesi Standartları ve Pişirme Ekipmanları Teknik Analizi. Türk Kahvesi Kültürü ve Araştırmaları Derneği, Türkiye.

Özkan G., Sağdiç O., Baydar N.G. and Baydar H. 2004. Note: Antioxidant and antibacterial activities of *Rosa damascena* flower extracts. Revista de Agaroquimica y Tecnologia de Alimentos 10(4):277-281.

Pellegrini N., Serafini M., Colombi B., Del Rio D., Salvatore S., Bianchi M. and Brighenti F. 2003. Total antioxidant capacity of plant foods, beverages and oils consumed in Italy assessed by three different in vitro assays. J. Nutr. 133(9):2812-2819.

Peters A. 1991. Proceedings of the 14th ASIC Colloquium, Paris.

Poti J. M., Mendez M. A., Ng S.W. and Popkin B.M. 2015. Is the degree of food processing and convenience linked with the Nutritional quality of foods purchased by US households? AJCN 101(6):1251-1262.

Shahriari S., Yassa N., Mohammadirad A., Khorasani R. and Abdollahi M. 2007. In vitro antioxidant potential of *Rosa damascene* extract from Guilan, Iran comparable to α-tocopherol. Int. J. Pharmacol 3:187-190.

Singleton V.L., Orthofer R. and Lamuela-Raventós R.M. 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of folin-ciocalteu reagent. Methods Enzymol 299:152-178.

Yashin A., Yashin Y., Wang Y.G. and Nemzer B. 2013. Antioxidant and antiradical activity of coffee. Antioxidants (Basels) 2(4):230-245.

Yumru M., Savas H.A., Kalenderoglu A., Bulut M., Celik H. and Erel O. 2009. Oxidative imbalance in bipolar disorder subtypes:a comparative study. Prog. Neuropsychopharmacol. Biol. Psychiatry 330(6):1070-1074.

Zhao C.Y., Xue J., Cai X.D, Guo J., Li B. and Wu S. 2016. Assessment of the key aroma compounds in rose-based products. J. Food Drug Anal. 24(3):471-476.

Paper Received August 28, 2018 Accepted November 15, 2018