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Effects of Damask Rose (*Rosa damascena* Mill.) Extract on Chemical, Microbial, and Sensory Properties of Sohan (an Iranian Confection) During Storage

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HIGHLIGHTS

- Sohan (Iranian traditional confection) formulations were prepared, including rose extracts and butylated hydroxyanisole.
- The color indices (L*, a*, and b*) were significantly decreased during storage time.
- At 25 °C storage, 0.5% rose extract extended effectively Sohan shelf life until 90 days.

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Acronyms and abbreviations
BHA=Butylated Hydroxyanisole
FFA=Free Fatty Acid
AnV=*p*-Anisidine Value
TPC=Total Phenolic Content
DPPH=2,2-diphenyl-1-picrylhydrazyl
AA=Antioxidant Activity
GAE=Gallic Acid Equivalent

ABSTRACT

Background: Sohan is an Iranian traditional brittle confection which its ingredients are susceptible to oxidation and microbial contamination during storage. This experimental study was designed to determine the effect of damask rose (*Rosa damascena* Mill.) extract on some chemical, microbial, and sensory properties of Sohan during storage at 25 °C.

Methods: The Sohan ingredients were mixed, baked, and shaped in flatted types. Different Sohan formulation groups were separately prepared, including 0.1, 0.3, and 0.5% rose extracts groups; 0.02% Butylated Hydroxyanisole (BHA) group; and control group (with no foreign additive). The Sohan samples were packaged and stored at 25 °C for 1, 30, 60, 90, 120, 150, and 180 interval days. The samples were analyzed for Free Fatty Acids (FFAs), Peroxide Value (PV), *p*-Anisidine Value (AnV), Total Phenolic Content (TPC), 2,2-diphenyl-1-picrylhydrazyl (DPPH), surface color, microbial, and sensory properties. Data were compared using Duncan's multiple range tests by SPSS, Inc., Chicago (v. 16.0).

Results: Overall, Sohan groups contained 0.5% rose extract and also 0.02% BHA had significantly ($p<0.05$) better antioxidant and antimicrobial effects, and sensory properties in comparison with the other groups. The color indices (L*, a*, and b*) were significantly decreased during storage time. Based on panelist suggestion, the overall acceptance of samples were unacceptable at the end of storage period (day 180).

Conclusion: It is concluded that at 25 °C storage, 0.5% rose extract and 0.02% BHA were effective to retard Sohan rancidity until 90 and 120 days, respectively.

Introduction

Sohan is an Iranian traditional confection, produced mainly in Qom province as a popular edible souvenir, classified as calorie-rich snack food. Iranian national standards organization defines Sohan as a product that obtained by baking the mixture of wheat flour, wheat germ flour, sugar, vegetable or animal oil, egg yolk, and some optional ingredients such as pistachios, almonds, saffron, and cardamom (ISIRI, 2013a). Sohan is produ-

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ced in various flatted and morsel types with honey, sesame, almond, pistachio, and Gaz sweet (Mashak et al., 2014).

Confectionery products containing fats and oils are susceptible to lipid oxidation during storage (Reddy et al., 2005). Lipid oxidation is responsible for rancidity, development of off-flavors, nutrient, and color losses; and more importantly, development of numerous diseases such as cancer, atherosclerosis, as well as heart disease (Mildner-Szkudlarz et al., 2009; Reddy et al., 2005). The rate of lipid autoxidation may be influenced by many factors such as manufacturing, storage condition, exposure to air, light, and temperature, saturation degree, and content of unsaturated fatty acids as well as double bound position in the molecules (Kozłowska et al., 2014; Mildner-Szkudlarz et al., 2009). Autoxidation of fats and oils in processed foods may be prevented by the use of antioxidants (Reddy et al., 2005). Synthetic antioxidants such as Butylated Hydroxyanisole (BHA), butylated hydroxytoluene, and tert-butylhydroquinone have been usually used as food antioxidants (Jay et al., 2005). But, consumer concerns over the health risks of synthetic antioxidants motivated researchers to find natural alternatives (Mildner-Szkudlarz et al., 2009).

Maintaining quality of baked foods is important from economic aspects during storage at room temperature (Kozłowska et al., 2014). Fortification of Sohan with natural antioxidant can be affected oxidative stability of their lipid fraction and improved their sensory properties. Therefore, there is a special trend towards the use of antioxidants from natural sources. Natural aromatic plants have been studied previously in some bakery products such as cookie (Kozłowska et al., 2014), biscuits (Aksoylu et al., 2015; Mildner-Szkudlarz et al., 2009; Reddy et al., 2005), cake (Khaki et al., 2012), and Kolompe (Noorolahi et al., 2013). Sohan contamination with pathogenic microorganisms, especially in warm seasons has been reported (Mashak et al., 2014). So, microbial quality of this product needs to be highlighted, too.

Some plants are used as natural food preservatives due to their aromatic, antimicrobial and antioxidant compounds (Azhdarzadeh and Hojjati, 2016; Azizkhani et al., 2013; Khorasany et al., 2016; Kozłowska et al., 2014). Damask rose (*Rosa damascena* Mill.) named Gole Mohammadi in Iran with pink flowers which its major components of rose extract (citrenellol, geraniol, and nerol) has antibacterial effects against both Gram-negative and Gram-positive bacteria (Boskabady et al., 2011; Meimandi and Yaghoobi, 2015). Also, antioxidant activities of damask rose have been attributed to their phenolic compounds (Boskabady et al., 2011; Ozkan et al., 2004). However, antimicrobial and antioxidant activities of this plant in Sohan have not been studied. Considering the potential health risks of synthetic antioxidants, damask rose extract can be evaluetaed as an alternative to the synthetic commercial antioxidant. Therefore, the aim of this study was to determine the effect of damask rose extract, on some chemical, microbial, and sensory properties of Sohan during storage.

Materials and methods

Material

Fresh flowers of damask rose (*Rosa damascena* Mill.) were harvested from Kashan, Iran. Folin-Ciocalteu's phenol reagent, BHA, NaOH, sodium carbonate, and sodium thiosulphate were purchased from Merck Darmstadt, Germany. The gallic acid and *p*-anisidine were purchased from Sigma–Aldrich Chemical Company, USA. The microbial culture media were purchased from Merck, Germany and Difco, Germany. The other common chemicals were analytical reagent grade.

Preparation of damask rose extract

The damask rose flowers were transported to the Food Science Laboratory of Islamic Azad University using dry ice and were stored at -80 °C until extraction. The rose extracts were prepared using the method described by Meimandi and Yaghoobi (2015). Briefly, each sample (200 g) was ground in a small mortar with a pestle under liquid nitrogen. Then, each sample was mixed with 400 ml ethanol/water (8:2 v/v) and shaked at 4 °C for 48 h in dark, filtered through Whatman No. 1 filter paper, using a vacuum pump. Solvent was evaporated to dryness in a rotary evaporator at 40 °C. Dry extracts were stored at -18 °C before use.

Sohan preparation

The ingredients for making the different Sohan formulations in this study are shown in Table 1. For Sohan preparation, sugar dissolved in boiling water and after that saffron added to the mixture. Then, wheat flour, wheat germ flour, oil, egg yolks, and other additives were added and incubated at low temperature. The resulting dough was spread over a stainless steel greasy tray and pressed with a metallic hammer to be flattened. Then, nuts of almonds and pistachios were scattered on the Sohan surface. After cooling, Sohan was put in the sealed metal containers (ISIRI, 2013a; Mashak et al., 2014). Finally, the samples were stored at 25 °C and analyzed on days 1, 30, 60, 90, 120, 150, and 180. The Sohan samples containing BHA and rose extracts (0.1, 0.3, as well as 0.5% levels) were abbreviated as S-BHA S-Rose 0.1%, S-Rose 0.3%, as well as S-Rose 0.5%, respectively.

Sohan lipid fraction oxidation measurements

The lipids of ground Sohan were extracted using n-hexane. Stability of Sohan lipids were followed periodically at interval of 30 days during storage for 6 months at ambient temperature, by determining Free Fatty Acid (FFA), Peroxide Value (PV), *p*-Anisidine Value (AnV) according to the standard methods (AOCS, 1998; Mildner-Szkudlarz et al., 2009).

Measurement of Total Phenolic Content (TPC) and Antioxidant Activity (AA)

TPC of damask rose extract was determined using Folin–Ciocalteu's reagent and the results were expressed as Gallic Acid Equivalent (GAE) in mg GAE/g fresh starting material. The antiradical efficiency of extract was measured using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical method (Mildner-Szkudlarz et al., 2009).

To measure the antioxidant activity of Sohan, a hydroalcoholic extraction was conducted. One g of Sohan powder was extracted with 20 ml of 80% acetone and centrifuged at 8000 g at 4 $^{\circ}$C. The supernatant was used for the analysis of total phenolics and the determination of antioxidant activity. The total phenolics were estimated by Folin-Ciocalteau method (Mildner-Szkudlarz et al., 2009) using gallic acid as standard, and results were expressed as mg GAE/g Sohan. The effect of acetone extracts of Sohan samples on scavenging of DPPH radicals was determined according to the method described by Ajila et al. (2008).

Color measurement of Sohan

The surface color, L* (brightness), a* (redness), and b* (yellowness) were measured using a Color Meter (TES-135A, Twain). Average of six values was taken for each set of samples (Ajila et al., 2008).

Microbial analysis of Sohan

In different analysis interval times, total yeasts and molds, Enterobacteriaceae, *Salmonella* spp., *Escherichia coli*, and *Staphylococcus aureus* were assayed according to ISIRI (2011).

Sensory evaluation of Sohan

The sensory characteristics of Sohan incorporated with BHA and rose extracts were conducted to determine the acceptability of the product. The sensory analysis performed with 20 untrained panelists, over than 20 years old, 10 male and 10 female, who were living in Qom, Iran. They were regular consumers of Sohan and were familiar with its quality attributes. Sensory acceptance test, including surface color, taste, flavour, texture, and overall acceptance was conducted using a 9-point hedonic scale (1="disliked extremely", 9="liked extremely"). Scores from 5 to 9 were considered acceptable.

Statistical analysis

All experiments were carried out in triplicate and obtained data were reported as mean±standard deviation. Using SPSS, Inc, Chicago, IL software (v. 16.0), Duncan's multiple range test was applied to determine the difference of means.

Results

FFAs content of Sohan samples went on increasing with the increase in storage period, but no regular pattern of increase could be observed (Fig. 1-A). Control and S-Rose 0.1% exhibited the highest FFAs (increased from 0.1% to >1.10%), while S-BHA exhibited the least FFAs (increased from 0.1% to ~0.60%) at the end of storage periods. A significant difference (p<0.05) in FFAs content was observed between the control and S-Rose 0.1% with S-BHA, S-Rose 0.3%, and S-Rose 0.5%. Although, no significant difference (p>0.05) was observed between S-Rose 0.5% and S-BHA until 90th day, but after this period, the difference was significant. FFAs content of S-BHA and S-Rose 0.5% was 0.24 and 0.22% until 120th and 90th day, respectively; which was below the acceptable limit (0.25 %).

Effect of BHA and rose extracts on the lipid oxidation progresses in stored Sohan has been shown in Fig. 1-B. The peroxide values significantly were increased at different rates with time and the highest level of PV was observed in control sample (6 meq/kg). The least levels of PV were observed respectively in S-BHA (2.17 meq/kg) and S-Rose 0.5% (3.20 meq/kg). PV of the control and samples containing rose extracts and BHA showed significant difference (p<0.05). The potential of S-Rose 0.1% and S-Rose 0.3% to prevent lipid oxidation were significantly lower than S-Rose 0.5% (p<0.05). Maximum permissible limit of PV is given by Iranian national standard as 2 meq/kg oil in Sohan. In this regard, S-Rose 0.5% and BHA prevented the oxidation process of Sohan until the 90th as well as 150th days of storage, respectively.

As seen in Fig. 1-C, AnV was increased significantly during storage periods, which this trend was accelerated after the 30th day. Addition of BHA as well as S-Rose 0.5% caused significant reduction in AnV of Sohan during storage (p<0.05). Therefore, the rose extracts could be significantly delayed the accumulation of secondary oxidation products. Rose extracts at the level of 0.1 and 0.3% did not significantly improve lipid stability, measured by AnV.

Total phenolic content of tested rose extract was 318 mg gallic acid per g of fresh flower. The BHA and rose extract addition and storage time significantly affected the TPC of Sohan samples (Fig. 2-A). The higher concentration of rose extract resulted in a significant (p<0.05) increase in TPC of Sohan. At the end of storage, control had the lowest (35.0 mg GAE/g) and S-Rose 0.5% had the highest (74.3 mg GAE/g) TPC. TPC was decreased significantly for all samples during storage for 180 days. In contrast, S-BHA showed the lowest decrease (28%) after 180 days of storage.

The DPPH radical scavenging activities of the rose extracts and BHA in Sohan formulations can be observed in Fig. 2-B. Control samples showed significantly lower DPPH radical scavenging activity than the other samples with rose extracts and BHA (p<0.05). The DPPH free radical scavenging activity of S-BHA (52.3%) was significantly higher than the others, followed by S-Rose 0.5% (24.6%). The antioxidant activities of all samples were significantly decreased (>60%) during storage period (p<0.05).

Comparisons of Sohan surface color between the control and samples with rose extracts and BHA are shown in Fig. 3A-C. The Sohan containing rose extracts displayed slightly lower lightness (L*) and yellowness (b*) values but higher redness (a*) values than the control and S-BHA. In general, as rose extract level increased, the surface color of Sohan became significantly darker (p<0.05) and relatively redder. Also, the surface color of samples was affected by the storage time. The color indices (L*, a*, and b*) were significantly decreased during storage time (p<0.05). At the end of storage period, the L* level of control was higher than the others; however, no significant differences were found between Sohan samples in term of a* and b* (p>0.05).

In S-Rose 0.3% and S-Rose 0.5%, microbial tests confirmed the absence of *E. coli*, *S. aureus*, and *Salmonella* spp.; also Enterobacteriaceae count was below the detection limit (10 CFU/g) during storage. In other Sohan groups, the counts of studied microorganisms were increased during storage (p<0.05). Also, no significant difference were observed in counts of *E. coli* (<10-0.5×10^2 CFU/g), *S. aureus* (<10-1.0×10^2 CFU/g), *Salmonella* spp. (<10-0.5×10^2 CFU/g), and Enterobacteriaceae (<10-1.2×10^2 CFU/g) between control, S-BHA and S-Rose 0.1% during storage.

As indicated in Table 2, fungal enumeration of control sample was higher than other treatments (473 CFU/g), while fungal counts in samples with 0.5% rose extract were below the detection limit (10^1 CFU/g) at the end of storage period. The fungal counts in all samples which did not exceed 200 CFU/g until 90th days of storage, was below the permissible limit. But, addition of rose extracts in Sohan reduced the microbial population significantly (p<0.05) at the end of storage period, and also this effect was enhanced at higher concentrations of the rose extracts.

Fig. 4 shows the quality attribute scores (surface color, taste, flavour, texture, and overall acceptance) for the examined samples. Irrespective of additive agents, scores of sensorial properties was decreased at the end of storage compared with initial of storage. S-BHA and S-Rose 0.5% obtained higher sensory scores from the view-point of color, taste, flavor, and overall acceptance than other samples. The color scores of Sohan samples showed a significant reduction over time, which was in consistent with the results of L* variations. The rose extract and BHA additions showed no significant effect on Sohan texture. But, the Sohan firmness slightly was increased during storage in all studied samples. The type of additive agents (p<0.05) and storage time (p<0.05) affected the overall acceptability scores of Sohan samples. The highest overall acceptance was observed in S-BHA followed by S-Rose 0.5%. In general, S-BHA as well as S-Rose 0.5% were still between the acceptance limit (5-9) of hedonic scale until day 120. Based on the panelist suggestion, the overall acceptance score of Sohan samples was reduced to a minimum level (<5) and all samples were unacceptable at the end of storage period at 25 °C.

Table 1: Initial ingredients for different Sohan formulations prepared in this study

Ingredient (g/100 g)	Control group	Sohan containing rose extract	Sohan containing BHA
Sugar	21	21	21
Wheat flour	16	16	16
Edible oil	36.2	36.2	36.2
Wheat germ flour	0.8	0.8	0.8
Egg yolk	1.85	1.85	1.85
Saffron	0.05	0.05	0.05
Rosewater	1.2	-	-
Rose extract	-	0.1, 0.3,0.5	-
BHA	-	-	0.02
Cardamom	0.4	0.4	0.4
Water	~22.5	~23.2-23.6	~23.68

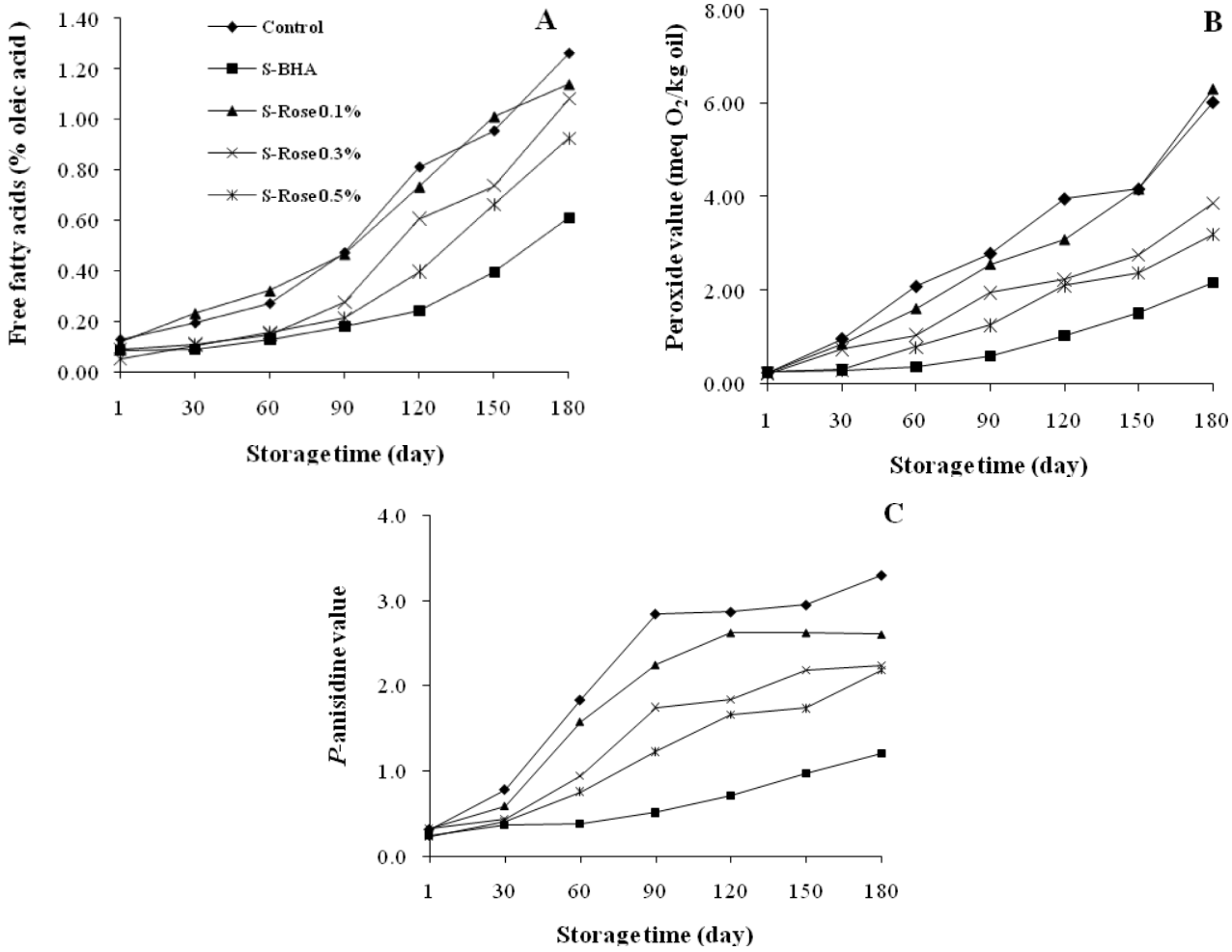

Fig. 1: FFAs (A), PV (B), and AnV (C) values of different groups, including control, rose containing (0.1, 0.3, and 0.5%), and BHA containing (0.02%) Sohan stored at 25 ˚C for 180 days

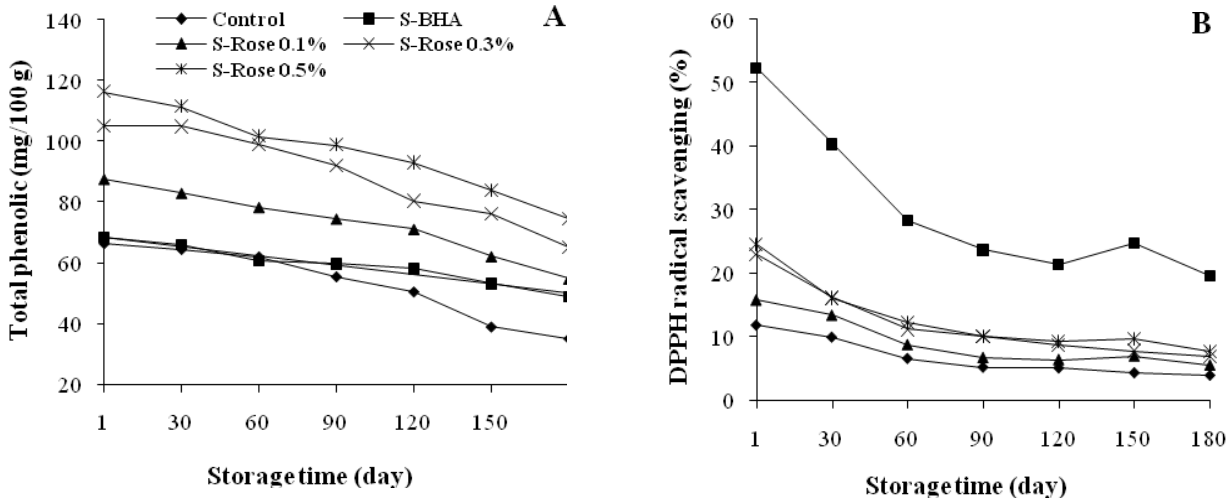

Fig. 2: TP content (A) and DPPH radical scavenging (B) values of different groups, including control, rose containing (0.1, 0.3, and 0.5%), and BHA (0.02%) containing Sohan stored at 25 ˚C for 180 days

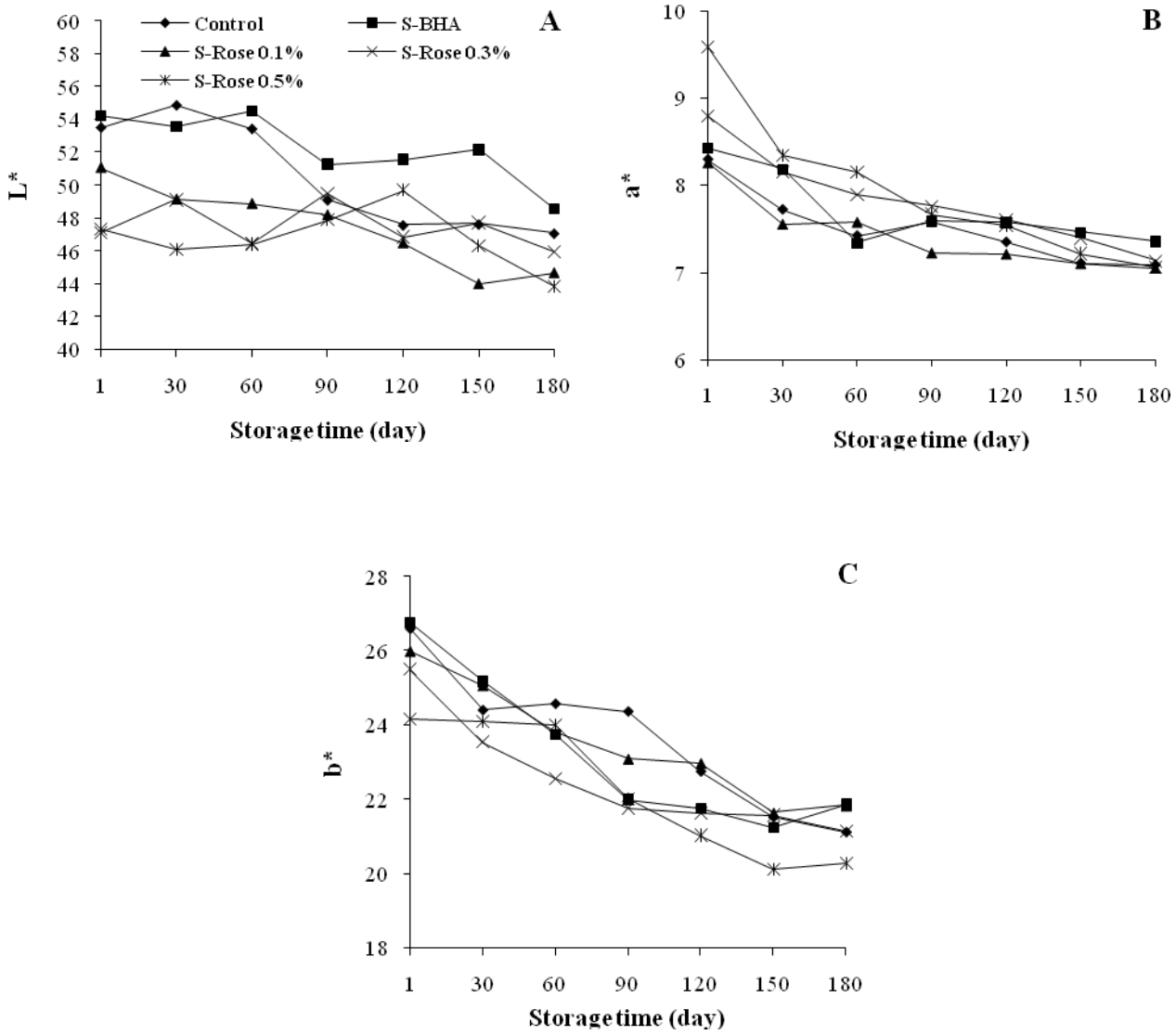

Fig. 3: Color indices of L* (A), a* (B), and b* (C) pertaining to different groups, including control, rose containing (0.1, 0.3, and 0.5%), and BHA (0.02%) containing Sohan stored at 25 °C for 180 days

Table 2: Effect of rose extracts and BHA on total fungi count (CFU/g) of Sohan samples stored at 25 °C for 180 days

Treatment	Storage time (days)						
	1	30	60	90	120	150	180
Control	ND ^{a,6}	ND ^{a,6}	75±10 ^{b,5}	137±20 ^{a,4}	221±23 ^{a,3}	320±31 ^{a,2}	473±46 ^{a,1}
S-BHA (0.02%)	ND ^{a,6}	ND ^{a,6}	85±13 ^{a,5}	103±16 ^{c,4}	167±16 ^{c,3}	284±29 ^{b,2}	427±25 ^{b,1}
S-Rose 0.1%	ND ^{a,6}	ND ^{a,6}	72±15 ^{b,5}	122±10 ^{b,4}	180±28 ^{b,3}	286±30 ^{b,2}	418±27 ^{b,1}
S-Rose 0.3%	ND ^{a,4}	ND ^{a,4}	ND ^{c,4}	14±4 ^{d,3}	46±10 ^{d,3}	102±14 ^{c,2}	206±26 ^{c,1}
S-Rose 0.5%	ND ^{a,1}	ND ^{a,1}	ND ^{c,1}	ND ^{e,1}	ND ^{e,1}	ND ^{d,1}	ND ^{d,1}

-Values within the same column with different superscript lowercase letter (a–e) differ significantly (p<0.05)
-Values within the same row with different superscript numerical (1–6) differ significantly (p<0.05)
-ND: not detected (below detection limits of <10 CFU/g)

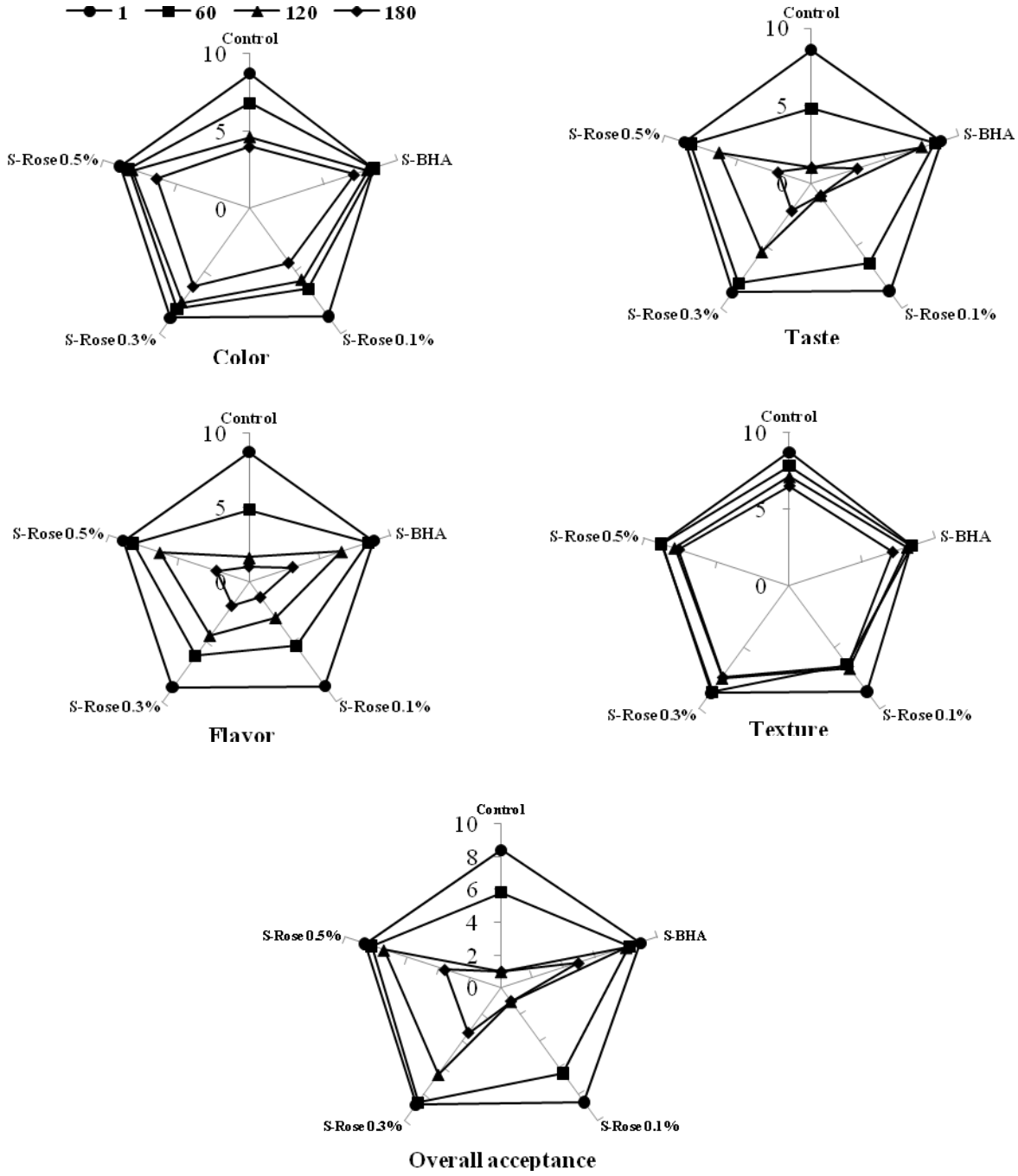

Fig. 4: Sensory attributes of different groups, including control, rose containing (0.1, 0.3, and 0.5%), and BHA (0.02%) containing Sohan during storage at 25 °C. Scoring system of color, taste, flavour, texture, and overall acceptance from dislike extremely (1) to like extremely (9)

Discussion

FFAs are formed due to the hydrolysis of triglycerides, which is accelerated by reaction of oil with moisture (Zhang et al., 2010). In the present study, FFAs content of S-BHA, S-Rose 0.5%, and S-Rose 0.3% (until 120th, 90th, and 60th day of storage, respectively) was below the acceptable level (0.25%) which is stated by Iranian national standard (ISIRI, 2013b). The effect of 0.1 and 0.3% rose extracts to extend the shelf life of Sohan were significantly lower than 0.5% rose extract and BHA. These results indicated that BHA and S-Rose 0.5% cannot retard Sohan rancidity more than 120 and 90 days, respectively. Similar findings have been previously reported lower levels of FFAs in cake (Khaki et al., 2012; Sabouri et al., 2012) and biscuit (Reddy et al., 2005) with natural antioxidants. It should be noted that the high tem-

peratures used in Sohan processing probably destroyed lipase and microbial activities. But, reaction of oil with moisture, microbial post-contaminations, nuts addition, and elevated storage temperature could be the possible reasons for high FFAs of Sohan during storage. In this regards, inherent enzymes and microbial contamination of added pistachio nuts may affect lipolysis of triglycerides. In the other words, lipid hydrolysis is caused not only by inherent food enzymes but also by microorganism enzymes as a result of microbial contaminations (Noorolahi et al., 2013).

PV is one of the most widely-used tests for the measurement of oxidative rancidity in oils and fats, which represents the concentration of peroxides as well as hydroperoxides formed in the initial stages of lipid oxidation (Zhang et al., 2010). Maximum permissible limit of PV is given by Iranian national standard as 2 meq/kg oil in Sohan (ISIRI, 2013b). In this regard, S-Rose 0.5% and BHA prevented the oxidation process of Sohan until the 90^{th} and 150^{th} day of storage, respectively. Oxidative rancidity (autoxidation) of the unsaturated fatty acids, is promoted by heat, light, certain metals (iron and copper), and enzymes known as lipoxygenases (de Man, 1999). Sohan is a complex system with various compounds, including wheat flour, egg yolk, and saffron, that some its components act as a prooxidant (metals in flour and yolk); as well as some components (saffron phenolic compounds) act as natural antioxidants. Prooxidant compounds, accelerated lipid oxidation and antioxidants reduced oxidation with increasing the induction period (de Man, 1999). The secondary oxidation products such as aldehydes and also ketones originating from the decomposition of lipid hydroperoxides are measured by AnV (Zhang et al., 2010). It should be noted that AnV of S-BHA was significantly lower than other Sohan samples that is consistent with the research carried out Mildner-Szkudlarz et al. (2009). This difference in antioxidant activity of BHA and rose extract may be related to the differences in their chemical structures (Zhang et al., 2010). The antioxidant activity of rose extract can be due to their phenolic compounds, which have an important role in preventing lipid oxidation (Boskabady et al., 2011; Ozkan et al., 2004). The increasing trends of PV and AnV during storage were in line with cookies enriched with oat flakes (Zbikowska and Rutkowska, 2011), and also biscuits enriched with green tea extract (Mildner-Szkudlarz et al., 2009). Addition of green tea extract to biscuits at the level of 1% give an antioxidant effect on the biscuits lipid stability compared with BHA (Mildner-Szkudlarz et al., 2009). Therefore, phenolic substances have antioxidant characteristic that prevent or retard lipid oxidation (Aksoylu et al., 2015).

Our result showed considerable TPC and AA of Sohan samples. Animal oil, wheat flour, wheat germ flour, saffron, egg yolk, and cardamom are used in the Sohan formulation. These ingredients may contain phenolic compounds, ascorbic acid, tocopherol, and metal that are able to reduced Folin–Ciocalteu reagent, because this assay measures the reducing capacity of the sample, including phenolic compounds as well as non-phenolic compounds such as vitamin C or Cu (I) (Aksoylu et al., 2015). The low TPC of control sample may be explained by this phenomenon. TPC was decreased significantly for all samples during storage at 25 $^{\circ}$C for 180 days of storage. This decrease may be attributed to the free radical scavenging and decomposition of phenolic compounds over time (Aksoylu et al., 2015; Zamora and Hidalgo, 2016). Natural phenolic compounds have been shown effectively to delay the lipid oxidation process by scavenge free radicals or prevent decomposition of hydroperoxides into free radicals and chelate transition metals, thus inhibit the progress of autoxidative damage. In addition, phenolic compounds are also able to scavenge the carbonyl compounds (measured by AnV) produced in the lipid oxidation pathway, which can be considered as the additional protective effect of these compounds against secondary lipid oxidation products of food (Zamora and Hidalgo, 2016). In this regard, the oxidative reactions significantly affected the color, taste, flavour, and texture of foods.

A considerable free radicals scavenging activity of the rose extract was seen in the present work. The antioxidant properties of damask rose extracts have been reported previously (Ozkan et al., 2004). Sohan contains sugar and protein compounds; thus melanoidins are formed by interactions between reducing sugars and proteins in the last stage of the Maillard reaction. It should be noted that melanoidins have high antioxidant activity. In this regards, the antioxidant activity of Sohan can also be attributed to the formation of brown melanoidins as a result of Maillard reaction (Aksoylu et al., 2015). The addition of natural antioxidant (damask rose extract), containing phenolic compounds is probably responsible for considerable antioxidant activities of Sohan samples. The antioxidant activities of all samples were significantly decreased during storage period. Reduction trend of antioxidant activity in Sohan samples can be attributed to decomposition of phenolic compounds by environmental factors as well as free radical (arise from lipid oxidation) scavenging of phenolic compounds during storage (de Man, 1999; Mildner-Szkudlarz et al., 2009; Zamora and Hidalgo, 2016). The effects of variations in formulations, process variables, and the storage conditions on the quality of the baked products can be evaluated with color indices (L*, a*, and b*) measurement (de Conto et al., 2012). The color of Sohan is generated mainly during baking process from the Maillard reaction between reducing sugars and protein. Also, starch dextrinization and caramelization which are induced by heating (Chung et

al., 2014), also affected the Sohan color. Furthermore, the addition of plant extracts affected the color of Sohan. In general, as rose extract level was increased, the surface color of Sohan became significantly darker and relatively redder. The red and dark color of rose extract containing samples arising from natural phenolic pigments of damask rose flowers extract (Boskabady et al., 2011) may also be responsible for the decrease in L* values as well as increase in a* values. The color indices (L*, a*, and b*) of Sohan significantly was decreased during storage, which indicated that the samples color were darker. This statement was supported by Mildner-Szkudlarz et al. (2009) who stated that the decrease in lightness of biscuits was elevated as the substitution level of green tea extracts into formulation. The decrease in L* values during storage could be attributed to the promotion of non-enzymatic browning reactions. It should be noted that non-enzymatic browning was continued slowly during storage at room temperature (de Man, 1999). So, lightness and yellowness of Sohan might be decreased. Also, rose extract rich in polyphenols, following oxidation and non-enzymatic browning reactions (de Man, 1999) might decrease the lightness of Sohan.

The rose extract incorporated in Sohan formulation significantly reduced the bacterial and fungal populations, and this effect was enhanced at higher concentrations of rose extracts. It is somewhat obvious that cooking process and low moisture content of confectionary products could limit the presence of microorganisms and subsequent microbial growth. Thermal processing of food should inactivate pathogenic microorganisms, but their presence indicates process failure or post-process contamination of food (Erkmen and Bozoglu, 2016). Damask rose is a rich source of polyphenoles that its antimicrobial activities have been attributed to these compounds (Boskabady et al., 2011; Ozkan et al., 2004). Shohayeb et al. (2014) confirmed the antibacterial and antifungal activity of rose extracts. Microbial contamination of Sohan samples, especially pathogenic bacteria has been reported by Mashak et al. (2014), thus the addition of rose extracts as common rosewater substitute can increase microbial safety of Sohan. In general, rose extract was effective in reducing the level of fungi, Enterobacteriaceae, *E. coli*, *S. aureus*, and *Salmonella* spp., suggesting a bio-preservative function of the plant extract.

Sensory analysis revealed that S-BHA and S-Rose 0.5% were still between the acceptance limit (4.5-9) until day 120, and control Sohan samples were unacceptable at 60th day. Sohan with high lipid content is prone to oxidation and quality losses during storage periods. Lipid oxidation reduces the quality of Sohan, resulting in development of rancidity and unpleasant flavors, tastes, and color changes. The lipid oxidation and thereby undesirable changes in sensory properties (flavor and color) and nutritional value can be inhibited using natural antioxidants (de Man, 1999; Zamora and Hidalgo, 2016). According to the panelist scores and health risks about synthetic antioxidants, BHA could be replaced by 0.5% rose extract in the lipid fraction of Sohan formulations.

In general, the quality aspects were significantly better preserved in S-Rose 0.5% and S-BHA in comparison with control, S-Rose 0.1%, and S-Rose 0.3% groups. Also, in the most of the evaluated parameters, no significant differences were observed between S-Rose 0.5% and S-BHA during 120 days of storage. But, the quality aspects of S-BHA were higher than the other Sohan samples after 120th day. Furthermore, it should be noted that BHA had no antimicrobial activity; while 5% rose extract could significantly inhibit the growth of pathogenic bacterial and fungal during storage.

Conclusion

The addition of 0.5% rose extract significantly reduced FFA and hydroperoxide formation, and also inhibited pathogenic bacterial and fungal growth. Oxidation of the lipid fraction indicated that 0.5% rose and BHA extended the shelf life of Sohan during 90 and 120 days, respectively. But, due to the adverse effects of BHA on human health, rose extract can be a good alternative for synthetic antioxidants. Based on panelist suggestion, the Sohan sample with 0.5% rose extract was satisfied after 120 days of storage and was competitive with sample containing BHA. In general, according to the desirable effects of rose extract on chemical, microbial as well as sensorial characteristics of Sohan, the addition of 0.5% rose extract is recommended in Sohan formulations.

Conflicts of interest

There is not any conflict of interest.

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