J. Agr. Sci. Tech. (2015) Vol. 17: 1495-1505

Effect of Soapwort Root Extract and Glycyrrhizin on Consumer Acceptance, Texture, and Oil Separation of Pistachio Halva

A. Shakerardekani[1]*, and M. Shahedi[2]

ABSTRACT

Pistachio nut (*Pistacia vera* L.) is one of the most delicious and nutritious nuts in the world. In order to increase the added value of the pistachio nuts, it is necessary to develop new products to meet consumer needs. This is the first paper on pistachio halva. The product was developed using pistachio paste (as main ingredient), mixture of sugar-glucose, egg white and citric acid. The effect of soapwort root extract *(from saponaria officinalis)* and Glycyrrhizin (from *Glycyrrhiza glabra*) as whitening and emulsifying agent in three levels (0.00, 0.10, and 0.15%) on the oil separation, consumer acceptance, and texture of pistachio halva was investigated. Sensory evaluation was carried out after 4 months storage at 20±2°C. There was a significant difference (P< 0.05) between samples with and without soapwort and glycyrrhizin. The oil separation (R= 0.595, P=0.001), from halva were moderately correlated to the hardness. The sensory texture of halva was negatively correlated to the hardness (R= -0.694, P= 0.000) and oil separation (R= -0.730, P= 0.000). The sensory color (R= 0.652, P= 0.000) of halva was moderately correlated to the a-value. It is recommended that mixture of 0.10% soapwort root extract and 0.10% commercial Glycyrrhizin be used for the pistachio halva production. Using combination of soapwort root extract and Glycyrrhizin in the formulation of pistachio halva prevents oil separation from the product and increases its consumer acceptance. Development of pistachio halva would potentially increase the food uses of nuts and introduce consumers with a healthier non-animal snack food.

Keywords: Liquorice extract, Pistachio paste, Sensory evaluation, Soap root.

INTRODUCTION

Tree nuts are rich in macro and micronutrients, tocopherols, phytochemicals, and phenolic compounds (Shakerardekani *et al.*, 2013a). The development of nut products would potentially increase the food uses of nuts and introduce consumers with a healthier non-animal breakfast snack food. The pistachio nut (*Pistacia vera* L.) is a nutritious and popular tree nut. The split pistachios are consumed as roasted and/or salted nut snacks. The unsplit form can be used for the production of pistachio products, such as pistachio spread (Shakerardekani *et al.*, 2013b; Maghsoudi *et al.*, 2012; Rafiee *et al.*, 2009). There is some literature on pistachio paste and pistachio butter as the main ingredient of pistachio halva (Emadzadeh *et al.*, 2011a; Emadzadeh *et al.*, 2011b; Taghizadeh and Razavi, 2009; Ardekani *et al.*, 2009). Pistachio Halva is a new confection which is similar to sesame halva. The main ingredients of pistachio halva are pistachio paste and sugar syrup. During the production of pistachio paste,

[1] Department of Food Technology, Iran Pistachio Research Institute, P. O. Box: 77175-435, Rafsanjan, Islamic Republic of Iran.
[2] Department of Food Science and Technology, College of Agriculture, Isfahan University of Technology, Isfahan, Islamic Republic of Iran.
* Corresponding author; e-mail: shaker@pri.ir

[DOR: 20.1001.1.16807073.2015.17.6.23.4]

pistachio kernels are dehulled, roasted and ground into a paste (Shakerardekani *et al.*, 2013b). Sesame halva mainly consists of 50% wt of sesame paste, 25–35% wt sucrose and 12–25% wt glucose and small amounts of citric acid and soapwort extract (Abu-Jdayil, 2004; Zahedi and Mazaheri-Tehrani, 2012; Kahraman *et al.*, 2010; Guneser and Zorba, 2011). Sesame paste (tahini) is a colloidal solution mainly composed of protein in sesame oil (Abu-Jdayil, 2004; Aktaş and Cebirbay, 2010; Racolta *et al.*, 2010; Eissa and Zohair, 2006; Ceyhun Sezgin and Artik, 2010).

Soapwort extract is obtained by boiling the roots of the soapwort. Saponins (active substance of soapwort extract) are found in many plants, including several that are often used for food, such as soybeans, chick peas, peanuts, lentils, spinach, oats, garlic, sugar beet, potatoes, green peppers, tomatoes, and tea (Guclu-Ustundag and Mazza, 2007). In the diet, phytochemical saponins have a wide spectrum of activity as antifungal and antibacterial agents, lowering of blood cholesterol and inhibition of cancer cell growth. However, many saponins show haemolytic activity, and have a bitter taste (Ceyhun Sezgin and Artik, 2010). Soapwort extract affects positively the color (whitening agent) and consistency of the sesame halva and prevents especially the oil separation from the halva in time by acting like an emulsifier (Abu-Jdayil, 2004).

Halva has non-crystalline sugar melt particles surrounded by a protein layer originating from sesame paste. The sesame oil was found as a free fluid, filling in the spaces between sugar and protein particles. Therefore, halva has got oil separation problem (Guneser and Zorba, 2011). Oil separation in halva during storage leads to a tough texture. The separated oil contaminates the packaging and reduces marketability (Ereifej *et al.*, 2005). Ceyhun Sezgin and Artik (2010) reported that concentration of saponin ranged between 32-172 mg kg^{-1} in sesame halva, but higher amount of root extract (and as a result higher saponin concentration) is used for whitening of the product by some producers. Therefore, there is a limitation for using root extract due to haemolytic activity of saponins. Total saponin content of halva was reported 32-172 mg kg^{-1} in sesame halva (Ceyhun Sezgin and Artik, 2010).

Ilany-Feigenbaum (1965) in his study has shown that it is possible to replace Licorice (or 'liquorice') extract with soapwort extract. Licorice extracts have extensive use in foods and in both traditional and herbal medicine (Isbrucker and Burdock, 2006; Nassiri Asl and Hosseinzadeh, 2008; Bi *et al.*, 2010). Extracts from liquorice roots have been used in the treatment of abdominal complaints including gastric ulcers and dermatitis (Elgamal *et al.*, 1990; Schambelan, 1994). They are involved in the recipes of cough syrups and also are used to mask the bitter taste of medicines.

The active ingredient in liquorice is mainly glycyrrhizin, a triterpenoid glycoside, which constitutes up to 14% of total soluble solids content (Isbrucker and Burdock, 2006; Nassiri Asl and Hosseinzadeh, 2008) giving the characteristic sweet taste of the liquorice root. Glycyrrhizin is low in calories and can be used in the foods and beverages. It is about 50 times as sweet as cane sugar, imparts a yellowish-brown color and slight liquorice flavor (Nassiri Asl and Hosseinzadeh, 2008; Bi *et al.*, 2010; Ibanoglu and Ibanoglu, 2000). The liquorice root extract has been widely used in the food industry as a sweetening and flavoring agent (Chin *et al.*, 2007). It has also found widespread usage as a foaming agent in alcoholic and non-alcoholic beverages, in confectionery products, in halva and sweets (Damir, 1984). Foaming properties of liquorice extract also influence the sensory quality and shelf-life of the final product (Ibanoglu and Ibanoglu, 2000).

In this study, the effect of soapwort root extract (from *saponaria officinalis*), Glycyrrhizin (from *Glycyrrhiza glabra*) and their combination on the consumer acceptance and oil separation of pistachio halva was studied.

[DOR: 20.1001.1.16807073.2015.17.6.23.4]

MATERIALS AND METHODS

Materials

Commercial *Saponaria officinalis* (halva roots) and citric acid were purchased from local markets in Rafsanjan (Kerman, Iran). Glycyrrhizin was obtained commercially from the market (Reglis moattar, Irandarouk Co., Tehran, Iran). Pistachio paste was produced in Iran Pistachio Research Institute (Rafsanjan, Iran).

Methods

Pistachio Halva Preparation

The formula used for production of pistachio halva contained 43.1% beet sugar-starch-based glucose, 45.3% pistachio paste, 2% egg white, 9.2-9.3% water, 0.1% citric acid and 0.2-0.3% soapwort extract and glycyrrhizin. Pistachio halva was produced according to the method described for sesame halva by Ereifej *et al.* (2005) with some modifications. Sugar and glucose solution containing citric acid was heated and stirred to reach 105°C. Then, soapwort extract and glycyrrhizin was added and heating was continued for 60–70 minutes. The mixture was allowed to cool to room temperature for 15 minutes pistachio paste was added (1:1) and mixed for 10 minutes. Samples were stored at 20±2°C for four months and oil separation measurement and sensory evaluation was carried out (Meilgaard *et al.*, 1999).

Chemical Measurement

Moisture content was measured by drying the samples at 105±2°C until a constant weight was achieved. The ash content was determined by igniting the sample at 550°C until a constant weight was obtained. The oil content of halva mixtures was determined using Soxhlet apparatus with petroleum ether as the carrier. Protein was determined by Kjeldahl's method. In the protein determination, a nitrogen-to-protein conversion factor of 6.25 was used. Total carbohydrate content was determined by difference.

Oil Separation Test

Oil separation was measured according to Ereifej *et al.* (2005) with some modifications. First 100 grams of fresh pistachio halva were taken in a cup (150 g capacity). The cup was then covered with perforated aluminum foil. This cup was inverted and placed on a Petri dish (weight A) containing three filter papers (Whatman #4) to absorb the oil passing through the perforations in the aluminum foil. The weight of the Petri dish with absorbed oil by filter paper was taken to determine the amount of oil separation after 4 months storage (weight B). Oil separation from product was evaluated using following equation:

Oil separation (%)= [(B-A)/(Sample weight)]×100

Sensory Evaluation

The sensory evaluation was performed by 35 panelists (consisting of 24 males and 11 females, aged between 22 and 39 years) familiar with sensory evaluation of food materials, selected from staffs of Iran Pistachio Research Institute. Sensory evaluation was carried out at room temperature under normal lighting conditions. The characteristics of interest for the taste panel were flavor, texture, color, and overall acceptability. A 9-point hedonic scale was used (9= Like extremely, 8= Like very much, 7= Like moderately, 6= Like slightly, 5= Neither like nor dislike, 4= Dislike slightly, 3= Dislike moderately, 2= Dislike very much, 1= Dislike extremely) (Lawless and Heymann, 1999). Panelists were asked to rinse their mouths with water between samples. The average values of the

[DOR: 20.1001.1.16807073.2015.17.6.23.4]

sensory scores were used for the analysis (Zahedi and Mazaheri-Tehrani, 2012).

Instrumental Measurement

"*a*" Value Measurement

The best color for pistachio halva is green color. The "*a*" value (indicator of green color) was measured according to Shakerardekani (2013b) method.

Hardness Measurement

The texture of pistachio halva sample was evaluated by determining penetration force. Texture analyzer, TA.XT Plus (Stable Micro Systems Ltd., U.K.) with P3 probe was used. The penetration measurement was carried out on 15×15×15 mm of pistachio halva sample at 20°C (penetration distance of 5 mm and test speed of 2 mm s^{-1}). The penetration force was recorded and calculated by the TA 32 software program from the penetration force vs. time diagram in the unit of gram force. Five measurements were made for each pistachio halva sample.

Statistical Analysis

Soapwort extract and glycyrrhizin was added in the formula in 3 levels (0.00, 0.10 and 0.15%) using full factorial design. Data were analyzed by analysis of variance (ANOVA) using Minitab version 16.1.0.0 (Minitab Inc., State College, PA). Tukey's test was applied to detect the differences among the pistachio paste samples.

RESULTS AND DISCUSSION

Figure 1 shows pistachio halva produced in this research. This product is made from pistachio paste, sugar-glucose mixture, egg white, and citric acid. The green color of the product is related to the pistachio paste.

Chemical Measurement

Table 1 shows the chemical measurement of pistachio halva. There is no significant difference ($P< 0.05$) among all pistachio halva produced using different soapwort and glycyrrhizin concentrations after 4 months storage. These results are similar to sesame halva (ISIRI, 2007).

Figure 1. Pistachio halva made from pistachio paste, sugar-glucose mixture, egg white, and citric acid.

[DOR: 20.1001.1.16807073.2015.17.6.23.4]

Table 1. Chemical composition of pistachio halva using soapwort and glycyrrhizin.[a]

Sample[b]	Moisture	Carbohydrate	Fat	Protein	Ash	Fiber
S0G0	1.0±0.1a	43.3±2.1a	26.0±1.0a	10.5±0.5a	1.5±0.2a	1.1±0.1a
S1G0	1.1±0.1a	43.2±2.0a	25.7±1.1a	10.3±0.4a	1.4±0.2a	1.0±0.1a
S2G0	1.1±0.1a	43.1±1.9a	25.9±1.3a	10.3±0.3a	1.4±0.1a	0.9±0.1a
S0G1	1.1±0.1a	43.2±1.7a	25.9±1.4a	10.4±0.5a	1.3±0.2a	1.0±0.1a
S0G2	1.1±0.1a	43.2±1.7a	25.8±1.5a	10.3±0.6a	1.3±0.1a	0.9±0.1a
S1G2	1.2±0.2a	43.0±1.6a	25.8±1.3a	10.2±0.4a	1.4±0.1a	0.9±0.1a
S2G1	1.2±0.2a	43.0±1.5a	25.7±1.0a	10.2±0.3a	1.3±0.1a	1.0±0.1a
S1G1	1.2±0.2a	43.0±1.4a	25.9±1.1a	10.3±0.5a	1.2±0.1a	0.9±0.1a
S2G2	1.3±0.2a	43.2±1.5a	25.5±1.3a	10.1±0.6a	1.1±0.1a	0.8±0.1a

[a] In each column means that do not share a letter are significantly different (P< 0.05).
[b] S0G0= Without Saponaria officinalis root extract and glycyrrhiza glabra (control); S1G0= 0.10% *Saponaria officinalis* root extract; S2G0= 0.15% *Saponaria officinalis* root extract; S0G1= 0.10% *Glycyrrhiza glabra* extract; S0G2= 0.15% *Glycyrrhiza glabra* extract; S1G2= 0.10% *Saponaria officinalis* root extract and 0.15% *Glycyrrhiza glabra*; S2G1= 0.15% *Saponaria officinalis* root extract and 0.10% *Glycyrrhiza glabra*; S1G1= 0.10% *Saponaria officinalis* root extract and 0.10% *Glycyrrhiza glabra*; S2G2= 0.15% *Saponaria officinalis* root extract, and 0.15% *Glycyrrhiza glabra.*

Oil Separation

As expected, the highest oil separation was observed in the sample without soapwort and glycyrrhizin (Table 2). Combination of 0.15% soapwort and 0.15% glycyrrhizin showed the lowest oil separation from pistachio halva. There is no significant difference (P< 0.05) among sample with 0.15% soapwort and all the other samples containing combination of soapwort and glycyrrhizin. It is reported that soapwort (Ceyhun Sezgin and Artik, 2010) and glycyrrhizin (Ilany-Feigenbaum, 1965; Damir, 1984) are emulsifying agent and prevent oil separation in the halva. There is no significant difference (P< 0.05) between individual concentration of 0.1% (S1G0 and S0G1) or 0.15% (S2G0 and S0G2). Therefore, none of these parameters are dominant.

Sensory Evaluation

Flavor

The results (Table 3) show that the flavor score obtained was in the range of 5.10-7.89 which is 'neither like or dislike' to 'like very much'. Samples without soapwort (S0G0, S0G1 and S0G2) obtained the lower scores. It means that we cannot replace glycyrrhizin with soapwort in the pistachio halva formulation. The highest score was obtained when a combination of soapwort (0.10%) and glycyrrhizin (0.10%) was used for the preparation of pistachio halva (sample S1G1), but no significant difference (P< 0.05) was observed when 0.15% glycyrrhizin was used instead of 0.10% (sample S1G2). According to the results, concentration of 0.15% soapwort (S2G0) changed the taste of the product to a bitter

Table 2. Oil separation from pistachio halva after 4 months storage at 20±2°C.[a]

Sample	Oil separation (%)
S0G0	4.3 a
S1G0	3.8 bc
S2G0	3.6 cde
S0G1	4.0 ab
S0G2	3.7 bcd
S1G2	3.5 cde
S2G1	3.4 de
S1G1	3.6 cde
S2G2	3.3 e

[a] Means that do not share a letter are significantly different (P< 0.05), ±*SD*< 0.2. Samples symbols are defined under Table 1.

[DOR: 20.1001.1.16807073.2015.17.6.23.4]

Table 3. Sensory evaluation of pistachio halva using soapwort and glycyrrhizin.[a]

Sample	Flavor	Texture	Color	Overall acceptability
S0G0	5.10 d	4.18 c	5.21 c	5.00 e
S1G0	5.96 bcd	6.30 b	7.5 a	6.34 cd
S2G0	5.74 c	8.41 a	7.53 a	7.00 bc
S0G1	6.60 b	5.68 b	5.72 bc	5.67 de
S0G2	5.51 cd	5.72 b	5.93 b	5.72 de
S1G2	6.90 ab	8.20 a	7.50 a	7.3 b
S2G1	6.60 b	8.50 a	7.53 a	6.68 bc
S1G1	7.89 a	8.60 a	7.72 a	8.20 a
S2G2	6.50 bc	8.40 a	7.50 a	6.64 bc

[a] Means that do not share a letter are significantly different ($P< 0.05$), $\pm SD< 0.5$. Samples symbols are defined under Table 1.

taste. This bitter taste is related to saponin content of soapwort extract (Ceyhun Sezgin and Artik, 2010). Increase in soapwort portion leads to higher bitter taste and increase in glycyrrhizin portion leads to stronger sweet taste. For this reason, we used glycyrrhizin in the pistachio halva formulation. The sweetness of Glycyrrhizin is more than sugar (Nassiri Asl and Hosseinzadeh, 2008; Bi *et al.*, 2010; Ibanoglu and Ibanoglu, 2000). Therefore, concentration of 0.15% glycyrrhizin changed the taste of the product to a sweeter taste.

Texture

The texture score was in the range of 4.16-8.60 (Table 2) which is 'dislike slightly' to 'like extremely'. The sample without soapwort and glycyrrhizin obtained the lowest score (4.16). Higher scores were obtained in the pistachio halva containing 0.15% soapwort and other formulations with combination of soapwort and glycyrrhizin (samples S1G1, S1G2, S2G2, S2G1). There is no significant difference at concentration of 0.1% between S1G0 and S0G1, while significant difference was observed at concentration of 0.15% between S2G0 and S0G2. It means that soapwort, which obtained higher score, is a dominant parameter. Soapwort and glycyrrhizin play as an emulsifying agent and improve the texture of the product. Ereifej *et al.* (2005) reported that the saponin from soapwort possibly precipitated the colloidal proteins of sesame paste, and contributed to a fragile structure. On the other hand, the highest oil separation was observed in S0G0. This product showed the lowest score of texture sensory evaluation, which was indicator of a tough structure.

Color

The color score of pistachio halva formulations was in the range of 5.21-7.72 (Table 2), corresponding to 'neither like or dislike' to 'like very much'. The lower score was obtained in the samples without soapwort extract, indicating the necessity of using soapwort extract in the formulation of pistachio halva. The higher score was obtained in the S2G0 and other formulations with combination of soapwort and glycyrrhizin (S1G1, S1G2, S2G2, S2G1). The dark color was observed for the other analyzed samples, regardless of the soapwort portion. High concentration of Glycyrrhizin in the pistachio halva formulations (such as sample S0G2), can impart a yellowish brown color (Ibanoglu and Ibanoglu, 2000) which is not acceptable. The best color for pistachio halva is green color.

Overall Acceptability

The overall acceptability was in the range of 5.00-8.20 (Table 2), corresponding to 'neither

[DOR: 20.1001.1.16807073.2015.17.6.23.4]

like or dislike ' to 'like very much'. The highest score was obtained in the S1G1 with the combination of 0.10% soapwort and 0.10% glycyrrhizin. According to the results, application of soapwort and glycyrrhizin either alone or in combination, improved the overall acceptability of the product. In general, there was a significant difference (P< 0.05) between the samples with and those without soapwort and glycyrrhizin.

Instrumental Measurement

Hardness

The changes on textural characteristics of pistachio halva were determined by measuring the penetration force to describe the hardness of halva (Table 4). The highest value of penetration force was observed in the control sample (S0G0). The reason for this significant difference was the higher oil separation from pistachio halva samples during 4 months of storage. The smoothest pistachio halva sample was S2G2, with the lowest penetration force. It means that application of soapwort and glycyrrhizin in the pistachio halva prevent oil separation from the products and, as a result, lower penetration force.

"*a*" Value

The most important color attribute of pistachio products is the "a" value, which was related to green color (Gamli and Hayoglu, 2007). The "*a*" values of the halva which indicates greenness/redness were mainly contributed by the presence of pistachio paste. The "*a*" values ranged from 2.2 to 2.8 for different formulations. It was found that the changes on the green color for pistachio halva were not significant (P> 0.05). This shows that usage of soapwort and glycyrrhizin did not have any significant effect on green color value of pistachio halva.

Relationship between Instrumental Parameters and Sensory Acceptability Attributes

The relationship between the dependent variables such as moisture content, hardness, *a*-value, degree of oil separation and sensory acceptability of pistachio halva is shown in Table 5. The oil separation (R= 0.595, P= 0.001), from pistachio halva were moderately correlated to the hardness. Thus, if oil separation increased, the texture of the halva became tougher. The sensory texture (R= -0.694, P= 0.000) of pistachio halva were negatively correlated to the hardness and oil separation (R= -0.730, P= 0.000). This result showed that the consumer acceptability was more when the hardness and oil separation of the product were less. The sensory color (R= 0.652, P= 0.000) of pistachio halva were moderately correlated to the *a*-value. In other words, more green

Table 4. Instrumental measurement (hardness and a-value) of pistachio halva.[a]

Sample	Hardness (gf cm^{-2})	*a*-value
S0G0	450±21 a	2.4±0.1 a
S1G0	398±18 bc	2.4±0.2 a
S2G0	377±17 bc	2.6±0.2 a
S0G1	418±17 ab	2.2±0.2 a
S0G2	387±16 bc	2.3±0.2 a
S1G2	366±15 c	2.5±0.3 a
S2G1	356±20 c	2.7±0.3 a
S1G1	378±18b c	2.8±0.3 a
S2G2	250±14 d	2.8±0.2 a

[a] Means that do not share a letter are significantly different (P< 0.05). Samples symbols are defined under Table 1.

[DOR: 20.1001.1.16807073.2015.17.6.23.4]

Table5. Pearson's correlation coefficients and *P* values for the physical and instrumental measurements and sensory acceptability of pistachio halva. [a]

Sensory attributes (Hedonic test)	Physical measurement	Instrumental measurement		
	Oil separation	Moisture content	Hardness	*a* value
Flavor	-0.332	0.659	-0.376	0.507
	(0.090)	(0.000)	(0.053)	(0.007)
Color	-0.620	0.618	-0.627	0.652
	(0.001)	(0.001)	(0.000)	(0.000)
Texture	-0.730	0.631	-0.694	0.661
	(0.000)	(0.000)	(0.000)	(0.000)
Overall acceptability	-0.504	0.629	-0.447	0.636
	(0.007)	(0.000)	(0.019)	(0.000)
Oil separation (Physical measurement)		-0.115	0.595	-0.133
		(0.566)	(0.001)	(0.510)

[a] Average was taken for sensory attribute score (n= 35), and values in parentheses are *P* values.

color showed more consumer acceptability. Also, overall acceptability (R= 0.636, P= 0.000) was positively correlated to *a*-value. Even though color parameters is one of the important factors that determine consumer acceptability, the overall acceptability of pistachio spread is also influenced by other factors such as the physical (degree of oil separation), textural, and moisture content.

Muego *et al.* (1990), in their attempt to correlate instrumental and sensory analysis of peanut butter texture using different instrumental methods, found that correlations varied depending on the method. Johnson (1989) discovered high correlation coefficient (R> 0.88) between sensory firmness and oiliness of peanut butter using a cone penetrometer, however, weaker correlations between back extrusion force and sensory textural attributes were obtained. Gills and Resurreccion (2000) were not successful in obtaining high correlations between sensory peanut butter texture and instrumental TPA. In general, the findings showed that most of the sensory parameters and physical and instrumental measurements studied correlated to each other to a certain degree.

CONCLUSIONS

The lowest oil separation was observed in the sample S2G2. This is because saponin content of the halva acted as emulsifying agent and prevented oil separation from the product. Samples with 0.15% soapwort showed a bitter taste in the sensory evaluation. Samples with 0.15% glycyrrhizin showed sweeter taste in the product, which is not acceptable. Combination of soapwort and glycyrrhizin improved the texture, color, and overall acceptability of the product. Considering oil separation, instrumental measurements, and sensory evaluation of the product, it is recommended to use 0.10% soapwort and 0.10% glycyrrhizin for production of pistachio halva. In this way, we also minimize using additives in the product. Using the combination of soapwort root extract and Glycyrrhizin in the formulation of pistachio halva prevents oil separation from the product and increase its consumer acceptance.

[DOR: 20.1001.1.16807073.2015.17.6.23.4]

ACKNOWLEDGEMENTS

The authors thanks Iran Pistachio Research Institute for supporting this project (Project No. 6-014-150000-06-8301-86004).

REFERENCES

1. Abu-Jdayil, B. 2004. Flow Properties of Sweetened Sesame Paste (Halawa Tehineh). *Eur. Food Res. Technol.,* **219:** 265-272.
2. Aktaş, N. and Cebirbay, M. A. 2010. A Traditional Helva in Turkey: Koz Helva. *J. Food Agric. Environ.,* **8:** 213-215.
3. Ardekani, A. S. H., Shahedi, M. and Kabir, G. 2009. Optimizing Formulation of Pistachio Butter Production. *J. Sci. Technol. Agric. Natural Res.,* **13:** 49-59.
4. Bi, W., Tian, M. and Row, K. H. 2010. Solid-phase Extraction of Liquiritin and Glycyrrhizin from Licorice Using Porous Alkyl-pyridinium Polymer Sorbent. *Phytochem. Analysis,* **21:** 496-501.
5. Ceyhun Sezgin, A. E. and Artik, N. 2010. Determination of Saponin Content in Turkish Tahini Halvah by Using HPLC. *Adv. J. Food Sci. Technol.,* **2:** 109-115.
6. Chin, Y. W., Jung, H. A., Liu, Y., Su, B. N., Castoro, J. A., Keller, W. J., Pereira, M. A. and Kinghorn, A. D. 2007. Anti-oxidant Constituents of the Roots and Stolons of Licorice (*Glycyrrhiza glabra*). *J. Agr. Food Chem.,* **55:** 4691-4697.
7. Damir, A.A. 1984. Utilization of Sunflower Seeds in Tahina and Halawa Processing. *Food Chem.,* **14:** 83-92.
8. Eissa, H. A. and Zohair, A. 2006. Quality and Safety of Halawa Modified with Mushroom. *J. Sci. Food Agr.,* **86:** 2551-2559.
9. Elgamal, M. H., Hady, F. K., Hanna, A. G., Mahran, G. H. and Duddeck, H. 1990. A Further Contribution to the Triterpenoid Constituents of *Glycyrrhiza glabra* L. *J. Biosci.,* **45:** 937-941.
10. Emadzadeh, B., Razavi, S. M. A. and Hashemi, M. 2011b. Viscous Flow Behavior of Low-calorie Pistachio Butter: A Response Surface Methodology. *IJNRS,* **1:** 37-47.
11. Emadzadeh, B., Razavi, S. and Mahallati, M. 2011a. Effects of Fat Replacers and Sweeteners on the Time-Dependent Rheological Characteristics and Emulsion Stability of Low-calorie Pistachio Butter: A Response Surface Methodology. *Food Bioprocess Tech.,* **55:** 1-11.
12. Ereifej, K. I., Rababah, T. M. and Al-Rababah, M. A. 2005. Quality Attributes of Halva by Utilization of Proteins, Non-hydrogenated Palm Oil, Emulsifiers, Gum Arabic, Sucrose, and Calcium Chloride. *Int. J. Food Prop.,* **8:** 415-422.
13. Gamli, O. F. and Hayoglu, I. 2007. The Effect of the Different Packaging and Storage Conditions on the Quality of Pistachio Nut Paste. *J. Food Eng.,* **78:** 443-448.
14. Gills, L. A. and Resurreccion, A. V. A. 2000. Overall Acceptability and Sensory Profiles of Unstabilized Peanut Butter and Peanut Butter Stabilized with Palm Oil. *J. Food Process. Preserv.,* **24:** 495-516.
15. Guclu-Ustundag, Ö. and Mazza, G. 2007. Saponins: Properties, Applications and Processing. *Crit. Rev. Food Sci.,* **47:** 231-258.
16. Guneser, O. and Zorba, M. 2011. Effect of Emulsifiers on Oil Separation Problem and Quality Characteristics of Tahin Helva during Storage. *J. Food Sci. Tech.* Mys.**:** DOI:10.1007/s13197-13011-10594-13197.
17. Ibanoglu, E. and Ibanoglu, S. 2000. Foaming Behaviour of Liquorice (*Glycyrrhiza glabra*) Extract. *Food Chem.,* **70:** 333-336.
18. Ilany-Feigenbaum, J. 1965. Improved Halva Made with Licorice Extract. *Food Technol.,* **19:** 114-115.
19. Isbrucker, R. A. and Burdock, G. A. 2006. Risk and Safety Assessment on

[DOR: 20.1001.1.16807073.2015.17.6.23.4]

the Consumption of Licorice Root *(Glycyrrhiza sp.)*, Its Extract and Powder as a Food Ingredient, with Emphasis on the Pharmacology and Toxicology of Glycyrrhizin. *Regul. Toxicol. Pharm.,* **46:** 167-192.

20. ISIRI. 2007. *Halva Specifications and Test Methods*. Institute of Standards and Industrial Research of Iran, Karaj.
21. Johnson, B. C. 1989, Rheological and Sensory Characteristics of Peanut Butter, (MSc Thesis), Athens; University of Georgia, 97P.
22. Kahraman, T., Issa, G., Ozmen, G. and Buyukunal, S. 2010. Microbiological and Chemical Quality of Tahini Halva. *Brit. Food J.,* **112:** 608-616.
23. Lawless, H. T. and Heymann, H. 1999. *Sensory Evaluation of Food: Principles and Practices*. Kluwer Academic, New York.
24. Maghsoudi, H., Khoshtaghaza, M., Minaei, S. and Zaki Dizaji, H. 2012. Fracture Resistance of Unsplit Pistachio *(pistacia vera L.)* Nuts against Splitting Force, under Compressive Loading. *J. Agr. Sci. Tech.,* **14:** 299-310.
25. Meilgaard, M., Civille, G. V. and Carr, B. T. 1999. *Sensory Evaluation Techniques*. CRC Press, Boca Raton.
26. Muego, K. F., Resurreccion, A. V. A. and Hung, Y. C. 1990. Characterization of the Textural Properties of Spreadable Peanut Based Products. *J. Text. Stud.,* **21:** 61-74.
27. Nassiri Asl, M. and Hosseinzadeh, H. 2008. Review of Pharmacological Effects of *Glycyrrhiza* sp. and Its Bioactive Compounds. *Phytother. Res.,* **22:** 709-724.
28. Racolta, E., Muresan, V., Muste, S. and Semeniuc, C. A. 2010. Comparison of Sunflower Halva Products from Romanian Market. *Bull. UASVM Agric.,* **67:** 381-386.
29. Rafiee, S., Kashani Nejad, M., Keyhani, A. R. and Jafari, A. 2009. Pistachio Nut Mass Transfer Simulation during Process of Drying Using Finite Element Method. *J. Agric. Sci. Tech.,* **11:** 137-146.
30. Schambelan, M. 1994. Licorice Ingestion and Blood Pressure Regulating Hormones. *Steroid.,* **59:** 127-130.
31. Shakerardekani, A., Karim, R., Ghazali, H. M. and Chin, N. L. 2013a. Textural, Rheological and Sensory Properties and Oxidative Stability of Nut Spreads-A Review. *Int. J. Mol. Sci.,* **14:** 4223-4241.
32. Shakerardekani, A., Karim, R., Ghazali, H. M. and Chin, N. L. 2013b. Development of Pistachio *(Pistacia vera* L.) Spread. *J. Food Sci.,* **78:** S484-S489.
33. Taghizadeh, M. and Razavi, S. M. A. 2009. Modeling Time-independent Rheological Behavior of Pistachio Butter. *Int. J. Food Prop.,* **12:** 331-340.
34. Zahedi, Y. and Mazaheri-Tehrani, M. 2012. Development of Spreadable Halva Fortified with Soy Flour and Optimization of Formulation Using Mixture Design. *J. Food Quality,* **35:** 390-400.

[DOR: 20.1001.1.16807073.2015.17.6.23.4]

اثر عصاره ریشه چوبک و گلیسیریزین روی پذیرش مصرف کننده، بافت و جدا شدن روغن از بافت حلوای پسته

ا. شاکراردکانی و م. شاهدی

چکیده

پسته (*Pistacia vera* L.) یکی از خوشمزه ترین و مغذی ترین مغزهای درختی دنیاست. به منظور افزایش ارزش افزوده پسته، ضروری است تا محصولات جدیدی بر اساس نیازهای مشتری توسعه یابد. این نخستین گزارش در مورد حلوای پسته است. حلوای پسته با استفاده از خمیر پسته (به عنوان ماده اولیه اصلی)، مخلوط شکر- گلوکز سفیده تخم مرغ و اسید سیتریک تولید گردید. اثرعصاره ریشه چوبک (*saponaria officinalis*) و گلیسیریزین (*Glycyrrhiza glabra*) به عنوان سفید کننده و امولسیفایر در سه سطح (۰/۰، ۰/۱۰ و ۰/۱۵ درصد روی جدا شدن روغن ، پذیرش مشتری و بافت حلوای پسته بررسی گردید. ارزیابی حسی پس از ۴ ماه نگهداری در دمای ۲ ± ۲۰درجه سانتی گراد انجام شد. اختلاف معنی دار (در سطح ۵ درصد) بین نمونه های بدون چوبک و گلیسیریزین با نمونه های دارای چوبک و گلیسیریزین وجود داشت. در ارزیابی حسی ، بافت حلوا (R=-0.694; P=0.000) به طور متوسط با سختی همبستگی داشت. همچنین بافت با سختی (R=-0.694; P=0.000) و جدا شدن روغن(R=-0.730; P=0.000) همبستگی منفی داشت. رنگ حلوا (R=0.652; P=0.000) با عدد a همبستگی متوسط داشت. توصیه می گردد که مخلوط ۰/۱۰ درصد عصاره ریشه چوبک و ۰/۱۰ درصد گلیسیریزین تجاری در فرمول حلوای پسته به کار رود. کاربرد ترکیبی عصاره ریشه چوبک و گلیسیریزین در فرمولاسیون حلوای پسته از جدا شدن روغن از محصول جلوگیری می کند و پذیرش مشتری را افزایش می دهد. توسعه حلوای پسته، پتانسیل کاربردهای غذایی مغزهای درختی را بیشتر نموده و به مصرف کنندگان، یک فرآورده با منشاء غیر حیوانی را معرفی می نماید.

[DOR: 20.1001.1.16807073.2015.17.6.23.4]