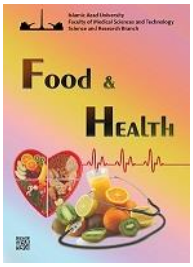

Food & Health Journal

Journal homepage: fh.srbiau.ac.ir

Effect of sugar replacement with date syrup on physicochemical and sensory properties of quince jam

Leila Nateghi [*1]

[1] Department of Food Science and Technology, Faculty of Agriculture, Varamin-Pishva Branch, Islamic Azad University, Varamin, Iran

ARTICLE INFO

Original Article

Article history:
Received 20 February 2022
Revised 12 April 2022
Accepted 01 June 2022
Available online 20 June 2022

Keywords:
Quince
Natural sugar
Calorie
Dietetic jam

ABSTRACT

Date syrup is healthy food for consumers especially people with diabetes because of its minerals, high amount of natural sugars such as fructose and glucose, and low percentage of sucrose. The objective of this study was to evaluate the effect of sugar replacement with date syrup on the physicochemical and sensory properties of quince jam. Date syrup at concentrations of 0 (control), 25, 50, 75, and 100% w/w was used in place of sucrose in the formulation of quince jam. As the concentration of date syrup increased, pH, Brix, viscosity, and calories decreased and acidity increased. With increasing concentration of date syrup, L* index decreased significantly ($p \leq 0.05$). The results of the sensory evaluation showed that the replacement of sugar with 50% of date syrup resulted in improved sensory properties as compared to control, however at higher concentrations it caused dark color and sour taste in the product. The sample containing 100% date syrup had the lowest calorie and the highest protein content as compared to other treatments, so it could be desirable in terms of nutritional and health properties. The addition of date syrup in place of sugar up to 50% improved the sensory properties of quince jam when compared to control, therefore it was selected as the superior treatment for sensory and health properties.

1. Introduction

The production of jams, marmalades, and jellies has long been a common method of preserving fruit products. Jam is a semi-solid food that is usually made by mixing 45% (w) fruit and 55% (w) sucrose (1). Sucrose, a natural sweetener with excellent functional properties usually extracted from sugar beet or sugarcane, has many uses in food products, however, due to its relationship with some health problems such as hypertension, heart disease, obesity, hyperglycemia, and hyperinsulinemia it is especially harmful to people with diabetes (2). Thus, research has been conducted to find cost-effective alternatives to sugar beet and sugarcane with no adverse effects on human health and product quality (3). People with diabetes are sensitive to the sugars used in regular jams because of the problems with the secretion or adequate activity of the hormone insulin so the consumption of the usual types of jam increases their blood sugar level. Therefore, diabetes has been the main reason for the development of healthy jams (4). Food production technology plays an important role in meeting the nutritional needs of consumers e.g., the production of low-calorie products such as dietetic jams (5). In general, low-calorie foods are modified products with 25% less energy or nutrients than the original food (6). In order to reduce the calories of jam, various sweeteners are used which are divided into nutritious and non-nutritious sweeteners by the American Nutrition Association. The nutritious sweeteners have a sweet taste and generate a certain amount of energy whereas the lower amount of non-nutritious ones develops a sweet taste with no energy therefore they are also called strong or synthetic sweeteners (7). The most important sugar replacers in dietetic jams in Iran have been sorbitol, fructose, aspartame, and some plant agents such as glycerin (8). Among the studies conducted in Iran are the production and qualitative evaluation of dietetic jelly jams prepared using fructose, sorbitol, and aspartame and the determination of their glycemic index in diabetic patients (4). Dates are one of the most important products in Iran mostly

[*]Corresponding author: Department of Food Science and Technology, Faculty of Agriculture, Varamin-Pishva Branch, Islamic Azad University, Varamin, Iran.

E-mail address: leylanateghi@iauvaramin.ac.ir (Leila Nateghi).

consumed fresh by the people. Iran is the second largest producer of dates in the world after Egypt with a production of about one million tons and a share of 15.57% in date production (9). Date is rich in sugar (~88-44%), carbohydrates, dietary fiber, essential vitamins and minerals, phenolic compounds, sterols, carotenoids procyanidins, flavonoids, and anthocyanins that can be used as a fresh source of sugar (10). These beneficial compounds are not found in sucrose, which is known as table sugar (3). About 30% of the dates produced in Iran are not used in the consumer market due to their poor quality and should be turned into valuable products such as date syrup in the processing industrial units (11). Date syrup is one of the most valuable date by-products. It is in a liquid form and relatively sweet, usually dark brown in addition to sugar compounds especially glucose, fructose, and a small amount of sucrose it contains useful compounds such as protein, fiber, pectin, and dye and is a good source of iron, potassium, and calcium, so it is a good sugar for people with diabetes and also has many uses in foods such as jams, marmalades, concentrated drinks, chocolate, ice cream and pastries (7). The incorporation of date syrup in food formulations, in addition to being a good replacement for harmful sugars or artificial sweeteners, can improve the nutritional properties of foods (12). Several studies have been conducted on the use of date syrup as a sweetener and flavoring in confectionery and bakery products; however, creating added value by using date by-products to increase the nutritional value and avoid the adverse effects of sucrose is desirable (13). Asgari *et al*. (14) reported that the use of fructose-rich corn syrup in carrot jam formulation changed the acidity. Also, the statistical results of sensory evaluation revealed that the jam produced via 25 and 50% replacement of fructose-rich corn syrup and 25% date juice showed no significant differences in aroma, taste, texture, and total acceptance from the control sample. Abdolfattah *et al*. (15) stated that the addition of date syrup to carrot jam increased ash, acidity, protein, fiber, and minerals contents and lowered the pH and salt levels. Also, 50% replacement of sucrose with date syrup improved the sensory properties of the produced jam. Homayouni Rad *et al*. (16) stated that there was no significant difference in the insoluble solids of the sour cherry dietetic jam containing date syrup and the control sample; however, the Brix value of the produced jam was 53 showing a significant decrease compared to control sample with Brix 70. The results also showed that there was a significant difference ($p \leq 0.05$) in the viscosity between the two products. Tayeri Shahandasht *et al*. (17) used different ratios of stevia, pectin, and sugar in the formulation of raspberry dietetic jam and reported that the sample contained 45% sugar, 0.75% stevia, and 0.15% pectin was the superior sample in terms of sensory properties. Benali *et al*. (18) demonstrated that replacing 25% of sucrose with date syrup in an orange jelly formulation did not affect the sensory properties and color of the final product. Quince (*Cydonia oblonga*) is one of the most popular fruits used for the production of jams which is rich in bioactive compounds. Since quince is hard and astringent, it is not commonly used in fresh form and is mostly used in the preparation of syrups and jams (19). Given the above-mentioned reasons as well as the beneficial properties of dates and fruits, the aim of this study was to investigate the feasibility of replacing sugar with date syrup at concentrations of 0 (control), 25, 50, 75, and 100% (w). Quince was added to the formulation of dietetic jam and the physicochemical and sensory properties of the samples were evaluated and compared to the control.

2. Materials and methods

2.1. Materials

The ingredients used for preparing quince and control jams were quince (*Cydonia oblonga*), sugar, date syrup, citric acid, and cardamom were prepared from the local market, Shahd-e-Sefid-e-Aria, Minoo, and Golha companies (Iran), respectively. The pH (4), moisture (24%), ash (5.2%), protein (2.2%), and soluble solids (75) of the date syrup were determined. The chemicals used for the tests included 0.1 N sodium, buffers 4 and 7, copper and sodium sulfate, phenolphthalein, hexane, hydrochloric acid, boric acid, 0.1 N sulfuric acid, Fehling A and B and methyl red (Merck company, Germany) and distilled water (Teb-e-shimi company, Iran).

2.2. Preparation of samples

The samples were prepared using the method of Homayouni Rad *et al*. (16) with some modifications. To produce 1500 g of control jam, the fruits were first peeled and cut into cubes; Then 500 g were mixed with 700 g of water and 300 g of sugar. 0.09 g of citric acid was added to the jam to modify the acidity. The baking process continued until the sugar was completely dissolved and reached Brix° 68. Finally, 0.3 g of cardamom powder was added to develop a better aroma. The jam was packed in glass jars at 85°C. The filled containers were put upside down for 1 min. To produce dietetic jams, the same procedure was repeated but date syrup at concentrations of 25, 50, 75, and 100% w/w was added instead of sugar used in the formulation of the control sample. It should be noted that all the jams were cooked in Teflon pots.

2.3. Physicochemical analysis

Acidity was measured according to Iranian National Standard No. 214 and the results were reported based on citric acid (20). pH, Brix, and viscosity of the samples were measured respectively by pH meter (Hana, USA) pre-calibrated with buffers 7 and 4 at 20°C, refractometer (Model Huaxi, China) at 20°C and based on the Brix° and viscometer (Myr Model VR3000, Spain) at 30°C. The protein of all treatments was measured by the Kjeldahl method and the sugar content was determined using the Fehling method according to Iranian national standard No. 214 (20). The calorie content of the samples was calculated based on their total sugar content as the calorie content of each sample was calculated by multiplying its total sugar by 4 (the energy content of each

gram of carbohydrate is expressed in calories) (21).

2.4. Color measurement

Transparency of jam samples was measured using a Hunterlab colorimeter (Model PT-1410, Parsian Technology, Iran). It was calibrated with two black and white tiles. Then some of the samples were placed in special cups covered by a black and opaque container to prevent the interference of the external lights and then L* index was measured (21).

2.5. Sensory evaluation

Sensory properties were evaluated by five-point hedonic method; (5: very good; 4: good; 3: intermediate; 2: weak; 1: very weak) and 10 semi-trained panelists (6 men and 4 women in the age range of 25 to 50 years). The samples were randomly coded and provided to the evaluators. The mineral water and salt-free biscuits were provided to the evaluators between each assessment (21).

2.6. Statistical analysis

Five treatments (4 treatments + 1 control) were designed in a completely randomized design and all tests were performed in triplicate. Data were analyzed by the Duncan test at 95% level. All tests were analyzed by Minitab software version 16.

3. Results and discussion

3.1. pH and acidity measurement

The results of changes in pH and acidity of treatments containing different concentrations of date syrup and control samples are shown in Table 1. There was a significant difference ($p\leq0.05$) in acidity and pH between the treatments and control sample as in all samples with increasing date syrup concentration, pH decreased and acidity increased gradually. The highest and the lowest pH values were observed for control and the sample containing 100% date syrup, respectively.

Table 1. Results of changes in pH and acidity of quince jam containing different concentrations of date syrup and sugar on day 1 after production.

Treatment	Acidity (% citric acid)	pH
100 % sugar	0.376±0.005^{e}	4.150±0.000^{a}
75 % sugar + 25 % date syrup	0.450±0.000^{d}	4.136±0.005^{b}
50 % sugar + 50 % date syrup	0.726±0.010^{c}	4.103±0.005^{c}
25 % sugar + 75 % date syrup	0.973±0.015^{b}	4.086±0.005^{d}
100 % date syrup	1.003±0.005^{a}	4.056±0.005^{e}

$^{a-e}$ Different small letters in each column represent significant differences ($p\leq0.05$).

Also, the highest and the lowest acidity were found for the sample containing 100% date syrup and the sample containing 100% sugar, respectively. The reason for the mild increase in acidity was the presence of pectin compounds in date syrup which can show acidic properties in aqueous media i.e., it can be converted into pectic or pectinic acids. Although these acids are very weak i.e., they are hardly ionized and have a low pKa and after ionization, the reaction quickly comes to equilibrium so a small but significant ($p\leq0.05$) decrease was observed among the samples. Our result is consistent with the findings obtained by Homayouni Rad *et al*. (16) who reported that with increasing concentration of date syrup, the pH value of the samples decreased significantly ($p\leq0.05$). Abdolfattah *et al*. (15) replaced sugar with date syrup in carrot jam formulation and stated that the reason for the small increase in acidity of carrot jam samples was the lack of acidic property of sucrose and the low acidity of date syrup.

3.2. Brix and viscosity

Brix or water-soluble solids is one of the parameters which directly affect the quality of foods. With reducing Brix in food systems, the fluidity of the product increases, and consequently, the viscosity decreases. The same situation is observed in jams. Soluble solids have a direct and significant effect on the texture of jam causing firmness and improving mouthfeel (16). The results of Brix changes of quince jam containing different concentrations of date syrup as well as control sample are given in Table 2.

Table 2. Results of changes in Brix and viscosity of quince jam containing different concentrations of date syrup and sugar on day 1 after production.

Treatment	Viscosity (Cp)	Brix
100 % sugar	395.33±1.53^{a}	67. 667±0.577^{a}
75 % sugar + 25 % date syrup	294.33±13.20^{b}	61.333±1.155^{b}
50 % sugar + 50 % date syrup	213.23±11.08^{c}	57.167±0.289^{c}
25 % sugar + 75 % date syrup	131.20±12.52^{d}	54.167±3.189^{d}
100 % date syrup	119.10±5.73^{e}	50.667±0.217^{e}

$^{a-e}$ Different small letters in each column represent significant differences ($p\leq0.05$).

The results revealed a significant difference ($p\leq0.05$) between dietetic and control samples. The highest and the lowest Brix values were found for control and the sample containing 100% date syrup, respectively. It is not surprising that, given the moisture content of date syrup (24%), the complete replacement of sugar with date syrup reduced the Brix value. Tayri Shahandasht *et al*. (17) reported that the decrease in Brix of samples containing date syrup was due to the presence of the syrup because the only difference between dietetic and control samples was date syrup. In another study, Homayouni Rad *et al*. (16) reported that the Brix value of sour cherry dietetic and control jams were 53 and 70, respectively, and stated that this reduction in Brix would reduce the energy content of the product. Yousef and Alghamdi (5) reported that the Brix values of the jelly sample containing date syrup and control sample were 64.8 and 68.6, respectively, and stated that adding date syrup to apple jelly reduced the Brix value. The results of the viscosity measurement are shown in Table 2. As results show, with increasing concentration of date syrup, the viscosity of the samples decreased showing a

significant (p≤0.05) difference. The decrease in viscosity of the dietetic jam could be attributed to the presence of date syrup with 24% more moisture than sugar in its formulation because the only difference between the dietetic and control jams was the presence of date syrup. Homayouni Rad *et al*. (16) reported the viscosity of dietetic sour cherry and control jams as 7233 and 8733 centipoises, respectively, and attributed the decrease in viscosity to the reduced amount of sugar in the treatments. Abdolfattah *et al*. (15) stated that with an increasing concentration of date syrup in dietetic carrot jam, the viscosity decreased significantly (p≤0.05) due to the higher moisture content of date syrup as compared to sucrose.

3.3. Total sugar and calorie measurement

The results of changes in total sugar and calories of all samples one day after production are shown in Table 3. As shown in the Table, with increasing concentration of date syrup in jams, total sugar content decreased significantly (p≤0.05). Also, by adding 25, 50, 75, and 100% of date syrup in place of sugar, 13.88, 21.43, 37.188, and 38.42% decrease in calories were observed, respectively as compared to control being statistically significant (p≤0.05). Abdolfattah *et al*. (15) reported that with an increasing concentration of date syrup in dietetic carrot jam, the calorie content decreased significantly (p≤0.05) due to the reduction in sugar content in samples containing date syrup. Homayouni Rad *et al*. (16) reported a reduction in the calorie content of dietetic sour cherry jam compared to control due to a decrease in Brix value. Asgari *et al*. (14) stated that replacing 50% of sucrose with date syrup and fructose-rich corn syrup in carrot jam significantly (p≤0.05) reduced the calories as compared to the control sample.

Table 3. Results of changes in total sugar, calories, and protein of quince jam containing different concentrations of date syrup and sugar on day 1 after production.

Treatment	Protein (%)	Total sugar (%)	Calories (kcal)
100 % sugar	0.640±0.020^{e}	75.76±0.17^{a}	303.04±0.12^{a}
75 % sugar + 25 % date syrup	0.933±0.015^{d}	65.24±0.15^{b}	260.97±5.37^{b}
50 % sugar + 50 % date syrup	1.143±0.011^{c}	59.52±1.17^{c}	238.08±8.05^{c}
25 % sugar + 75 % date syrup	2.343±0.013^{b}	47.58±0.60^{d}	190.34±3.19^{d}
100 % date syrup	2.486±0.005^{a}	46.65±0.25^{e}	172.61±6.15^{e}

$^{a\text{-}e}$ Different small letters in each column represent significant differences (p≤0.05).

3.4. Protein measurement

Given the results shown in Table 3, with the increasing concentration of date syrup in the formulation of jams, the protein content also increased due to the addition of date syrup with 2.2% protein. Homayouni Rad *et al*. (16) reported an increase in protein content of dietetic sour cherry jam compared to control when date syrup replaced sucrose.

3.5. Color measurement

The results of color measurement are given in Table 4. As shown in the Table, with increasing concentration of date syrup in jams, the L* value (lightness) of the samples decreased significantly (p≤0.05). The reason could be the whiteness and lightness of sucrose as well as the lack of pigments compared to pigments found in date syrup. Date syrup color has resulted from natural red pigments such as anthocyanins and pigments produced by the Maillard reaction. In general, the reaction between the amino group of the amino acids including lysine and alanine (totally 12% in date) with the carbonyl furfural group during the Maillard reaction produces red pigment melanoidin. On the other hand, anthocyanins, which are the natural red pigment of dates, are destroyed under alkaline conditions but are stable under acidic conditions (13). Therefore, the accumulation of anthocyanins along with the pigments produced by the Maillard reaction increased the intensity of the red color. Benali *et al*. (18) reported that with an increasing concentration of date syrup in orange jelly, the L* value decreased significantly (p≤0.05). Abdolfattah *et al*. (15) attributed the dark color of dietetic carrot jam to the presence of pigments in date syrup. Homayouni Rad *et al*. (22) studied Kooshab drink and reported that the color of samples containing date syrup was significantly (p≤0.05) darker than that of the control sample which attributed it to the color of date syrup as well as the browning reaction. Yousef and Alghamdi (5) reported that L* index decreased significantly (p≤0.05) as compared to the control sample when the concentration of date syrup in apple jelly increased.

Table 4. Results of changes in the color of quince jam containing different concentrations of date syrup and sugar on day 1 after production.

Treatment	L*
100 % sugar	11.920±0.113^{a}
75 % sugar + 25 % date syrup	11.635±0.035^{b}
50 % sugar + 50 % date syrup	11.005±0.007^{c}
25 % sugar + 75 % date syrup	8.200±0.000^{d}
100 % date syrup	7.055±0.035^{e}

$^{a\text{-}e}$ Different small letters in each column represent significant differences (p≤0.05)

3.6. Sensory evaluation

The results of the changes in sensory properties (scores) of quince jam containing different concentrations of date syrup and sugar one day after production are given in Table 5. As shown in the Table, the scores for color, aroma, taste, consistency, and sweetness decreased with the increasing concentration of date syrup in the formulation. Replacement of 50% sugar with 50% date syrup had no significant (p<0.05) effect on the scores given to taste and total acceptance compared to the control sample. Changes in color, aroma, taste, consistency and sweetness of the samples containing high amounts of date syrup were not accepted by the panelists. This was not surprising because high concentrations of date

syrup caused the darker color of the product and reduced its viscosity; also, the jam samples were slightly sour due to their lower pH value. Homayouni Rad *et al*. (16) stated that replacing 50% of sugar with date syrup in the formulation of dietetic sour cherry jam had no adverse effect on the sensory parameters of the product. A study conducted on carrot jam suggested that increasing the concentration of date syrup increased the acidity thereby increasing the sour taste of the product and reducing its consumer acceptance (15). Benali *et al*. (18) suggested 25% replacement of sucrose with date syrup in orange jelly because higher percentages of date syrup darkened the color of the product and were not accepted by

Table 5. Results of changes in sensory parameters of quince jam containing different concentrations of date syrup and sugar on day 1 after production

Treatment	Color	Aroma	Taste	Viscosity	Sweetness	General acceptance
100 % sugar	4. 80±0.42^{a}	4.70±0.38^{a}	4.00±0.41^{a}	4.66±0.67^{a}	4.70±0.37^{a}	4.20±0.35^{a}
75 % sugar + 25 % date syrup	4.00±0.66^{b}	4.00±0.46^{b}	3.90±0.52^{ab}	4.20±0. 32^{a}	4.40±0.69^{ab}	4.10±0.28^{a}
50 % sugar + 50 % date syrup	3.40±0.53^{c}	3.40±0.96^{cb}	3.80±0.23^{a}	3.50±0.94^{b}	4.11±0.29^{b}	4.00±0.17^{a}
25 % sugar + 75 % date syrup	2.40±0.84^{d}	2.30±0.82^{c}	3.10±0.34^{b}	3.0±0.64^{b}	3.70±0.21^{c}	3.60±0.17^{b}
100 % date syrup	2.62±0.74^{cd}	2.12±0.73^{c}	2.37±1.06^{b}	2.45±0.23^{c}	3.53±0.38^{c}	3.50±0.15^{b}

a-e Different small letters in each column represent significant differences ($p \leq 0.05$)

the panelists. Asgari *et al*. (14) reported that 25% substitution with date syrup and 25% and 50% substitution with fructose-rich corn syrup in the formulation of carrot jam caused no significant ($p<0.05$) difference in aroma, taste, texture, and total acceptance compared to control sample, however, there was a significant ($p \leq 0.05$) difference in color so sucrose in jam could be partly replaced with fructose-rich corn and date syrups.

4. Conclusion

In the present study, date syrup was used in place of sugar in the formulation of quince jam to improve its physicochemical and sensory properties. The results showed that with increasing concentration of date syrup, the pH value, viscosity, Brix value, total sugar content, calorie content and L* index decreased while the acidity and protein content increased. Also, the results of the sensory evaluation showed that the treatment containing 50% date syrup and 50% sugar did not have an adverse effect on taste and total acceptance compared to the control sample therefore it was selected as the superior treatment. Also, since the sample containing 100% date syrup had the lowest calorie content (38.42% decrease compared to the control sample) and the highest amount of protein compared to the other treatments, it could be desirable in terms of nutritional and health properties.

References

1. Yosefi Asli M, Goli S, Kadivar M. Optimization of low-calorie quince jam production with Sativoside sweetener. *Journal of Food Science Researches*. 2012;22(2):155-64.
2. Akbari F, Aghajani AR. Replacing sucrose with date and grape juice in traditional Ardeh halva formulation. National Conference on Technical Achievements of Iranian Food Science and Technology. 2015;1,34-37. (In Persian)
3. Mesbahi GH, Mansouri H, Majzoobi M, Farahnaky A. Effect of sucrose replacement with date syrup and date liquid sugar on rheological properties of biscuit dough. *Iranian Journal of Food Science and Technology*. 2016;85(13),45-55. (In Persian)
4. Eugenia M, Mamede O, Dib L, Alves L. Production of dietetic jam of Umbu-Caja: Physical, physicochemical and sensorial evaluations. *Food and Nutrition Sciences*. 2013;4,461-8.
5. Yousef A, Alghamdi A. Suitability of some date cultivars for jelly Maing. *Journal of Food Science and Technology*. 1999;36,515-8.
6. Abdullah A, Cheng TC. Optimization of reduced calorie tropical mixed fruits jam. *Food Quality and Preference*. 2001;12(1),63-8.
7. Rudkowska I. Functional foods for health: Focus on diabetes. *Maturitas*. 2009;62 (3),263-9.
8. Hoseini A, Jamalian J. Use of glycyrrhizin, sorbitol and fructose in the preparation of diet cherry jam and its evaluation in non-insulin dependent diabetic patients. *Journal of Crop Production and Processing*. 2006;10(3),211-21. (In Persian)
9. Mahmoudi H, Hosseininia GH, Azadi H, Fatemi M. Enhancing date palm processing, marketing and pest control through organic culture. *Journal of Organic Systems*, 2008;32,29-39.
10. Al- Shahib M, Marshal RJ. The fruit of the date palm: Its possible use as the best food for the future. *International Journal of Food and Nutrition*. 2003;54(4),247-59.
11. Gohari Ardabili A, Habibi Najafi MB, Haddad Khodaparast MH. Effect of date syrup as a substitute for sugar on the physicochemical and sensory properties of soft ice cream. *Iranian Journal of Food Science and Technology Research*. 2005;1(2),32-3. (In Persian)
12. Baliga MS, Baliga BRV, Kandathil SM, Bhat H, Vayalil PK. A review of the chemistry and pharmacology of the date fruits *Phoenix dactylifera* L. *Food Research International*. 2011;44,1812-22.
13. Shafie S, Hojatoleslami M, Shokrani R, Sharifan A. The effect of different palatable processes on the physicochemical properties of candy produced from it. *Journal of Nutrition Sciences and Food Technology of Iran*. 2011;8,63-70.
14. Asgari F, Habibi A, Mohammadi R, Kargar GR. The effect of sugar substitution with date juice and fructose-rich syrup on the physical and sensory properties of carrot jam. Twenty-second National Congress of Food Science and Technology. Gorgan University. Iran. 2014. (In Persian)
15. Abdulfattah R, Mohamad H, Mehia A. Improving carrot jam characteristics and its nutritional value by using date paste instead of sugar. *Journal of Agricultural and Veterinary Sciences, Qassim University*. 2008;1(1),13-8.
16. Homayouni-Rad A, Bazrafshan M, Vahid F, Khoshgozaran Abras S. Effect of sucrose substitution by date sugar on the physicochemical and sensory properties of sour cherry jam. *Quarterly Journal of Food Science and Technology*. 2014;43(11),25-31.
17. Tayeri Shandesht N, Ahmadi M, Ariyayi P. Production of raspberry diet jam and a variety of natural and artificial sweeteners. The first scientific research conference of Iranian food sciences and industries, Amol University. Iran. 2015. (In Persian)
18. Benali S, Benamara S, Madani KH. Feasibility study of date (*Phoenix dactylifera* L.) fruit syrup-based natural jelly using central composite design. *Journal of Food Science and Technology*. 2015;52(8), 4975–84.
19. Yousefi asli M, Goli SAH, Kadivar M. Optimization of low-calorie quince jam production with Stevioside sweetener. *Journal of Food Industry Research*. 2012;22(2),155-64. (In Persian)

20. ISIRI. 1991. Jam, marmalade and jelly. Specification and measuring methods. National Standard of Iran-number 214. Institute of Standards and Industrial Research of Iran. (In Persian)
21. Yazdi AG, Hojjatoleslamy M, Keramat J, Jahadi M. Effect of sucrose substitution by sucralose-maltodextrin mixture on rheological properties and calorie of Iranian traditional cookie, Ghottab. *Journal of Innovative Food Science and Technology*. 2010;1(2),49-58. (In Persian)
22. Homayoni Rad A, Haji Eghrari F, KHodavardivand Keshtebian A. Study of the effect of sugar replacement with date saps on rhognus and sensory characteristics of Koushab. *Journal of Food Science and Technology*. 2017;64(14):1-8.