https://doi.org/10.48047/AFJBS.6.15.2024.11749-11761

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Physicochemical Characteristics and Sensory Evaluation of Pomegranate Jelly Made with Date Fruit Syrup

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Volume 6, Issue 15, Sep 2024

Received: 15 July 2024

Accepted: 25 Aug 2024

Published: 25 Sep 2024

doi: 10.48047/AFJBS.6.15.2024.11749-11761

Abstract

Date Syrup is a natural sweetener that is a suitable substitute for sugar in formulation of food products for reducing the harmful effect of sugar, and improving the nutrient properties. In this study a jelly is obtained by adding date syrup to pomegranate juice at a rate of 50 % (sucrose was completely replaced by date syrup). The physicochemical, and sensory characteristics of the prepared jellies (jelly control and jelly made with date syrup) were evaluated. It was concluded that the addition of date syrup affected the pH and color of jelly. A significant reduction in the $L*$ and $a*$ values in the reformulated products compared to the control was observed ($p < 0.05$)**.** Evaluation of sensory properties of the prepared jelly showed that the addition of date syrup reduced significantly the color and odor, while has no effect on taste and texture compared to a control jelly. The overall acceptability scores showed that, there was no significant difference between the control jelly (6.61) and the jelly made with date syrup (6.05).

Keywords: Date syrup, sucrose, substitution, pomegranate jelly, physicochemical characteristics, sensory analysis.

1. Introduction

Date fruit has great importance from nutritional and economic point of view. Dates are rich in certain nutrients and provide a good source of rapid energy due to their high carbohydrate content 70–80 % (El Arem et al., 2011). In addition, it contains fibers 6.4-11.5 %, proteins 2.3-5.6%, fat 0.2-0.5%, ash 1-1.9 %, vitamins (A, B_1, B_2, B_3 and C) and polyphenols (Noui et al., 2015). It constitutes the principal financial and food sources for oasis cultivators. Dates represent an important economic activity, especially the famous 'Deglet-Nour' variety which is marketed on the national and international markets. The other varieties (Degla-Beida, Itima, Mech-Degla, Tantboucht, etc.), known as common dates, are downgraded. This situation has created new agricultural trends and pushed farmers to cultivate Deglet-Nour cultivar, exposing other varieties to extinction (Noui et al., 2015). Studies have shown that dates can be processed into a variety of high-quality food products such as pasta, flour, syrup, juice, vinegar and jam, which can be easily marketed (Espiard 2002; Cheikh Rouhou et al., 2006; Al-Farsi et al., 2007; Benamara et al., 2008). Date syrup is a natural food by-product that can be extracted from all types of dates, preferably those of secondary quality (Espiard, 2002; Abbès et al., 2013). Date syrup is an excellent food with high nutritional and caloric value. Sugar was the predominant component, it contains 66 %, proteins 0.97-1.31 %, ash 1.20-2.40 %, and pectin 0.43-1.43 %. The mineral composition of date syrup consists mainly of potassium (0.8-1 g/100 g fresh weight) (Abbès et al., 2013; Noui et al., 2015). In addition to its nutritional components, it contains various biologically active compounds. Date syrup can be consumed directly or used as ingredient in some food formulations and pharmaceuticals products (Barreveld, 1993; Roukas and Kotzekidou,1997; Razavi et al., 2007; Alanazi et al., 2010).

Pomegranate (*Punica granatum* L.) is one of the oldest edible perennial fruits, how recently is gaining more interest for human health. Generally, the edible portion of pomegranate fruit represents on average 52-57% (w/w) of total fruit, comprising 45-78% of juice and 22-36% of seeds (El Nemr et al., 1990; Poyrazoglu et al., 2002; Pande and Akoh, 2015). Fresh juice from ripe fruits contain 83.7 % moisture, 14.6 % total sugar, 1.0 % protein, and 0.3 % ash, while the total moisture and protein in seeds were 77.7 % and 4.5 %, respectively (Pande and Akoh, 2015). Pomegranate fruits and their juice are important for human health due to their high polyphenol content and a strong antioxidant capacity. The antioxidants in pomegranate can remove free radicals and protect cells from damage caused by cancer and Alzheimer's disease (Çam et al., 2013).

Recently, the reduction of refined white sugar (sucrose) consumption is recommended. Sucrose is devoid of its nutrients (minerals, vitamins, polyphenols and fibers) by processing steps, its nutritional value is lower compared to brown sugar, honey and date syrup.

The aim of this study is to transform the common Mech-Degla dates of low market value available in large quantities, into syrup, itself used as a substitute of sucrose in the formulation of pomegranate jelly. The prepared jelly was evaluated for physicochemical and sensory properties in order to judge the organoleptic quality compared to a control jelly based on sucrose, the objective being to show the influence of the addition of date syrups on the degree of consumers acceptability.

2. Materials and methods

2.1. Plant material

Raw materials

The variety of date fruit used in this study is dried namely Mech-Degla (moisture inferior to 20 %). The pomegranate fruit is the smooth variety. These fruits were purchased from a local fruit supplier in Batna (Algeria). Samples were stored in a tightly closed container at 4°C until use.

Pomegranate juice and date syrup preparation

From sound arils, juice was mechanically extracted by using hand operated fruit juicer. After that, the juice was centrifuged and stored at 4°C until use.

Dates are properly cleaned and pitted to remove dust, dirt, and pits. The obtained pulp is crushed and extracted using 1:3 of pulp water ratio at 70°C for 30 min with periodic stirring. The raw syrup was collected and filtered through a sieve of 50 µm and concentrated in rotary evaporator (IKA-WERK) under vacuum at 70 °C. The produced date syrup was stored in glass bottles inside the freezer until use.

2.2. Fundamental Physicochemical Analysis

The moisture content was determined by measuring the mass of the sample before and after removing the water by evaporation in an oven (Memmert) at 105 °C. The pH was measured at 20 °C (ISO, 1991). The soluble solids content (SS) was determined by using a digital refractometer (Reichert, AR 200). Total sugars were determined by Dubois et al. (1956) method using Shimadzu spectrophotometer and the absorbance was measured at 490 nm. The reducing sugars content was assessed using the 3,5-dinitrosalycilic acid assay (Miller, 1959). The percentage purity of syrups was determined by the following formula: Purity = (Total sugars/Total solids) x 100 (Al-Farsi, 2003).

The ash is determined by AOAC official method (1998). Minerals (K, Na, and Ca) were analyzed using Jenway flame emission spectrophotometer. And finally, Color was measured with Minolta Chroma Meter (CR10). Results are expressed according to CIELAB system (L^*, a^*, and b^*).

2.3. Extraction and measurement of total phenolics

The extraction of phenolic compounds was carried out according to the method described by Biglari et al. (2008): 10 g of date syrup was crushed and macerated in 30 mL of methanol-water solution (80:20, v/v) at room temperature for 5 hours with continuous stirring. The obtained extracts were then centrifuged and concentrated at 40°C under reducing pressure in a rotary evaporator (IKA-WERK).

The total polyphenolic content was determined according to the method described by Teow et al. (2007): 0.5 mL of dates extract was diluted with distilled water to 5 mL, to which 0.5 mL of Folin-Ciocalteu reagent was added and allowed to react at room temperature for 3 min. After, 1 mL of solution of sodium carbonate (7.5%) was added, and the mixture was stirred and incubated in darkness for1 hour. Then, the absorbance was measured at 760 nm. The total phenolic content was determined as mg gallic acid equivalents per 100g of fresh weight (mg GAE/100 g fw).

2.4. Evaluation of antioxidant activity by DPPH radicals

1.95 mL methanolic solution of DPPH (0.2 mmol) was added to 50 µL of each extract. The mixture was incubated in darkness at room temperature for 30 min, then its absorbance was measured at 515 nm. The absorbance of the DPPH radical without sample was measured. Methanol was used to zero the spectrophotometer (Mansouri et al., 2005). The following formula was used to compute the percentage of antioxidant activity:

$$\%\ of\ antioxidant\ activity = [(A_0 - A_1)/A_0]\ x\ 100$$

Where A_0 is the absorbance of the control and A_1 is the absorbance of the sample.

Formulation of jellies

Jelly was prepared as follow: Stirring sugar or syrup date in pomegranate juice at the ratio 50/50 (W/W), with adding 2 g of lemon juice. After, the samples were then cooked to about 80° Brix. Before finishing cooking for a few minutes, pectin (HM) is added. Finally, the hot jelly was poured into glass jars with screw caps and stored at 4 °C until use.

2.5. Sensory evaluation

A trained panel composed of 20 members were used to evaluate the sensory properties of pomegranate jelly sweetened with date syrup. The samples were scored for their color, odor, taste, texture and overall acceptability. The evaluation encompassed attributes such as color, odor, taste, texture, and overall acceptability, employing a 9-point hedonic scale. In this scale, a rating of 9 corresponded to “like extremely”, 8 to “like very much”, 7 to “like moderately”, 6 to “like slightly”, 5 indicated “neither like nor dislike”, 4 represented “dislike slightly”, 3 signified “dislike moderately”, 2 was “dislike very much”, and 1 indicated “dislike extremely”.

2.6. Statistical Analysis

Statistical analysis was carried out using SPSS statistical software (Version 21.0). Values are expressed as mean ± standard deviation. The test T of Student is used to evaluate the significance of various variables, differences at p values < 0.05 were considered to be significant.

3. Results and discussions

3.1. Physicochemical evaluation of date fruit

Results from biochemical analysis of the date fruits are listed in table 1.

Table 1. Physicochemical characteristics of Mech-Degla date

Parameters	Values
Moisture (%)	14.03 ± 2.75
Dry matter (%)	85.97 ± 2.75
Total sugar (%)	61.57 ± 0.61
Reducing sugar (%)	14.02 ± 0.88
Ash (%) *	1.37 ± 0.08

*: On dry matter

The moisture content of the studied Mech-Degla is 14.03 %. This result is in agreement with those (11.53 and 11.55 %) reported by Al-Hooti et al. (2002), respectively, in two dry dates Birhi and Safri imported from the Kingdom of Saudi Arabia. In this study, common Mech-Degla dates were characterized by their high sugar content. The rate of total sugar varies from 61.57% of the fresh weight, in which 14.02 % are reducing sugars. These values are almost similar to those cited by Noui et al. (2015), with values of 63.10 and 14.29 %, respectively, for the same variety. Dates also contain a significant amount of ash 1.37 % on DM. This result was slightely higher than for Kentichi Tunisian variety (dried date) with 1.20 % (Besbes et al., 2009).

3.2. Physicochemical evaluation of pomegranate juice

The physicochemical characteristics of pomegranate juice are presented in Table 2. Pomegranate juice contain 85.24 % of moisture. This value is consistent with that given by Pande et Akoh (2015), with contents of 85.40 %. The registered pH of the used juice is 4.09, this result is in the range of those (4.0-4.1) presented by Hasnaoui et al. (2011) in juices of four Tunisian pomegranate cultivars and higher than those reported (2.81-3.85) by Cam et al. (2009), in pomegranate juices from ten cultivars grown in Turkey. The total soluble solid content of pomegranate juice is 18.00 %, this outcome aligns closely with those cited by Labbé et al. (2016), with values ranging between18-18.70% of the three Chilean varieties (Wonderful, Chaca and Codpa). The rate of total sugars is 15.14 % which is quite similar to Al-Maiman and Ahmad (2002) finding, with14.60 % for juice obtained from Taifi cultivars (Saudi Arabia). The level of reducing sugar is 8.63 %, this content is less then that reported by Dhinesh Kumar et al. (2016), with values ranging between 10.20-12.50 % of Ganesh variety (India). The ash rate was 0.41 % of the fresh weight, higher to those reported by Al-Maiman and Ahmad (2002), with value of 0.32 % for the Saudi variety Taifi. These differences in pomegranate juice composition are due to fruit varieties, farming practices and climatic conditions.

Table 2. Physicochemical characteristics of pomegranate juice

Parameters	**Pomegranate juice**
Moisture (%)	85.24 ± 0.16
Dry matter (%)	14.76 ± 0.16
pH	4.09 ± 0.03
Brix (%)	18.00 ± 0.01
Total sugar (%)	15.14 ± 0.02
Reducing Sugar (%)	8.63 ± 1.11
Ash (%)	0.41 ± 0.05

3.3. Physicochemical evaluation of date syrup

The results obtained are shown in Table 3. The physicochemical characteristics of date syrups indicate that sugars are the main components with a percentage of 65.57 %, of which 19.39 % are reducing sugars. Theses contents were slightly lower than those reported by Noui et al. (2015), which gave values of 66.24 % and 22.39 % of fresh weight for syrup obtained from the same variety of date. The moisture of syrup is 22.29 %, which is favorable for good preservation. The pH of Mech-Degla syrup is 4.96, this result is comparable to those reported by Abbès et al. (2011), who gave values of 4.82 and 4.87 for date syrups obtained respectively, from two Tunisian varieties, Kentichi and Deglet-Nour. The purity of obtained date syrup is 87.43 %, this value is lower than that (93.42 %) found by Mohamed and Ahmed

(1981), in Libyan date syrup. Ash content of Mech-Degla syrup is 1.21 %, this value is less than that (1.77 %) given bay Noui et al., (2015) in Degla-Beida syrup. Differences between biochemical composition of date syrup appear to be due to dates varieties. The mineral profile indicate that potassium was the highest mineral in date syrup, with value of 658 mg/100g, followed by calcium and sodium. Several studies have shown that potassium is the most abundant mineral in date syrups (Khalil et al., 2002; Abbes et al., 2011). Compared to white sugar, date syrups are richer in mineral elements, White sugar contains only trace amounts: 2.2 and 0.6 mg/100 g respectively for potassium and calcium (Vierling, 2003).

Table 3. Physicochemical characterization of dates syrup

Parameters	**Date syrup**
Moisture (%)	22.29 ± 1.98
Dry matter (%)	77.71 ± 1.98
pH	4.96 ± 0.04
Brix (%)	75.00 ± 0.00
Total sugar (%)	65.57 ± 3.22
Reducing sugar (%)	19.39 ± 0.96
Purity (%)	87.43
Ash (%) *	1.21 ± 0.21
K (mg/100g) *	658.06 ±11.22
Na (mg/100g) *	21.05 ± 0.69
Ca (mg/100g) *	71.78 ± 2.10
Total phenolic (mg GAE/100g)	15. 87 ± 0.64
Antioxydant activity (%)	32.70 ± 1.97

* : On dry matter

Total phenolic content of date syrup is 15.87 mg EAG/100g (fw). This value is much less than those (96, 141 et 162 mg EAG/100g of fresh weight) cited by Al-Farsi et al. (2007) for syrups obtained respectively from the following Omani date varieties: Shahal, Um Sellah et Mabseeli. The result of the antiradical activity is 32.70 %, it is lower than that given by Abbès et al. (2013) which is 43.17 % for the syrup obtained from the Tunisian variety Allig. This difference between total phenolic compounds and antioxidant activity can be explained by various factors such as date variety, maturity, geographical origin, storage conditions, and processing. Phenolic compounds in fruits and vegetables have important health benefits potentials. They play a significant role in the prevention of many chronic diseases (degenerative and cardiovascular diseases) due to their antioxidant, anti-inflammatory and anti-carcinogenic properties (Ndhlala et al., 2007; Ben Thabet et al., 2009).The date syrup is a good source of phenolic compounds and could be considered as a functional food (Abbès et al., 2011).

The overall results show that the date syrup is a good source of nutrients due to its richness in sugars, minerals (potassium and calcium) and polyphenols. Date syrup, is a promising product that offers several advantages over refined sugar, and can be used in a variety of dietary preparations (Khalil et al., 2002; Alanazi, 2010).

3.4. Physicochemical characteristics of prepared jellies

The physicochemical parameters of jellies are presented in table 4. The pH value of the jelly sweetened with date syrup was significantly higher than sample control. This difference appears to be a consequence of date syrup addition, which contain organic acids and minerals. The prepared jellies revealed that total soluble solids ranged from 78.66 to 85.75° Brix, respectively for jelly prepared with date syrup and control jelly. These results are very higher than those reported (65.80 and 76.60 %) by Yousif et al., (1990), for date jelly obtained from Ruzeis variety cultivated in Saudi Arabia.

Table 4. Physicochemical characteristics of jellies

Parameters	**Values**	
	Jelly Control	**Jelly DS**
pH	4.17 ± 0.04^{b}	$3.55 \pm 0{,}06^{a}$
Brix %	85.75 ± 0.50^{b}	78.66 ± 0.50^{b}
Color		
*L**	33.06 ± 0.41^{b}	31.63 ± 0.15^{a}
*a**	10.00 ± 0.88^{b}	0.50 ± 0.17^{a}
*b**	13.80 ± 1.65^{a}	12.20 ± 0.95^{a}

The values with different superscript letters are significantly different ($p < 0.05$).
Jelly control: Jelly made with sucrose; **Jelly SD:** Jelly made with date syrup.

The Study of color index (*L**, *a**, *b**) parameters show that the use of date syrup in the jelly formulation resulted in changes in the color of the samples. The results indicate that *a**, *b** factors increased and *L** factor decreased. This decrease is due to brown pigments such as melanoidins found in the date syrup and resulting from the Maillard reaction. These compounds are the major part of colorant of date juice (Raiesi Ardali et al., 2014) and are formed (during the concentration) by the interaction between reducing sugars and amino acids, which may reduce the clarity of the jellies. Other study shows that iron-polyphenol complexes induce dark colors (Cheng and Crisosto, 1997).

3.5. Sensory evaluation

The effects of sugar replacement with date syrup on the sensory characteristics of the prepared jelly are presented in Table 5. The substitution did not have significant effects on the sensory scores of individual attributes except for the color.

Table 5. Sensory properties of pomegranate jellies

Parameters	**Values**	
	Jelly Control	**Jelly DS**
Color	7.91 ± 0.94^{b}	6.10 ± 1.64^{a}
Taste	5.91 ± 2.42^{a}	5.91 ± 2.02^{a}
Odor	5.54 ± 2.29^{a}	5.09 ± 1.30^{a}
Texture	7.09 ± 1.51^{a}	7.09 ± 1.51^{a}
Overal acceptability	6.61 ± 2.05^{a}	6.05 ± 1.73^{a}

The values with different superscript letters are significantly different ($p < 0.05$).
Jelly control: Jelly made with sucrose; **Jelly SD:** Jelly made with date syrup.

4. Conclusion

The substitution of sucrose by date syrup in pomegranate jelly is quite possible, but it many affect the color of the obtained product, which can be corrected by optimizing the substitution rate of sucrose with date syrup and controlling of the temperature of cooking step in order to improve its organoleptic quality. Moreover, date syrup will add many nutritional attributes to the new products.

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