Egypt. J. Chem. **Vol. 67**, No. 11 pp. 479 - 489 (2024)

Egyptian Journal of Chemistry

http://ejchem.journals.ekb.eg/

Overall Quality Characteristics of Nectar Produced by Some Date Cultivars

Tarek G. Abedelmaksoud[a,*], Mennatalh A. Hassan[a,b], Mostafa T.M. Assous[b], Abd El-Rahman M. Khalaf-Allah[a]

[a]*Food Science Department, Faculty of Agriculture, Cairo University, Giza 12613, Egypt*
[b] *Date fruit processing and marketing research Department, The Central Laboratory for Date Palm Research and Development, Agricultural Research Center, Egypt*

Abstract

During this study, the effect of pH levels on the quality of nectar produced by soft date (Barhi, Samani and Zaghloul) and semi-dry date (Siwi) cultivars after processing and during the storage period was investigated. The nectar (15.5 Brix) at different pH levels 6, 5.5., 5.0, and 4.5 and the initial 6:5.5 pH was organoleptically evaluated. The highest sensory assessments for date nectar samples were analysed physically, chemically, and microbiologically after processing and during storage at 4˚C for 6 months. The high taste, colour, Odor, consistency, and overall acceptability score was observed at a pH 6 for Barhi, Samani, and Zaghloul date nectar samples. At the same time, the high score for Siwi date nectar was at pH 5.5 (control sample). The results indicated no significant difference among four date nectar samples in the TSS, pH, TSS/acid ratio, titratable acidity, crude fibre and protein. There were significant differences among four date fruits nectar with the highest value of lightness (L) ordered as follows Barhi (20.5) >Samani (17.7) > Zaghloul (13.7) >Siwi (12.4). Also, the highest redness (a) value was in Siwi date nectar (0.47) followed by Zaghloul (0.42), Samani (0.28) and Barhi (0.25). The highest yellowness (b) value was observed in Barhi (1.87) compared to Samani (1.76) >Zaghloul (1.69) >and Siwi (1.56). The sucrose content of date nectar samples was ordered as follows Samani(7.35%) > Zaghloul (6.23%) > Barhi (5.03%)> Siwi (1.88%). Reducing sugar (fructose, and glucose) were ordered as follows Siwi >Barhi >Zaghloul > Samani. The total phenolic content and flavonoids of date nectar samples were ordered as follows Siwi > Zaghloul > Barhi> Samani. On the other hand, antioxidant values were consistent with total phenolic and flavonoid values. Total soluble solids of date nectar were slightly decreased during storage at 4ºC for 6 months. The percentage decrease of TSS ranged between 0.6 to 1.26% from the initial value. The same trend of pH value slightly declined to 5.9 for three soft date nectar samples and to 5.45 for Siwi nectar sample. The (L and b) values were decreased during the first 3 months of storage while a clear deficiency was observed in the second 3 months of storage period. A little gradual increase in a value was observed till 6 months of storage. The acidity of date nectar was slightly decreased during storage period. Reducing sugars was slightly increased, while total sugars were slightly decreased during storage. Total phenolic content, total flavonoids and antioxidant activity of date nectar samples gradually decreased, especially during the second 3 months of storage period. Total bacterial counts and Yeast and Mold were slightly increased during storage but were within specification range. The overall acceptability score was slightly decreased at the end of storage compared to zero time. Therefore, producing nectar from different Egyptian types of dates will increase the economic value of these dates, which have a limited shelf life.

*Keywords***:** Date; Nectar; Barhi; Samani; Zaghloul; Siwi

1. Introduction

Date fruits (Phoenix dactylifera L.) are an excellent source of nutritional and healthy food. Date fruit is oblong in shape with a single seed and becomes sweet when ripe. Since fruits are rich in carbohydrates and other nutrients, they are considered high-energy food. The chemical composition of date fruit includes carbohydrates, dietary fiber, proteins, fats, minerals, vitamins, phenolic compounds, and carotenoids [1]. Date fruit is a rich source of carbohydrates, most of which are in the form of simple sugar. Sugar contents about 40% in soft dates and 80% in dry date cultivars [2]. Egypt annually produces 1.7 million tons of date fruits [3]. Soft date (rutab stage), semi-dry, seed, and dry varieties represent 52%, 20%, 25%, and 3% of the total product, respectively [4]. Based on appearance and texture, dates can be primarily categorized into four

*Corresponding author e-mail: tareekgamal_88@agr.cu.edu.eg (Tarek G. Abedelmaksoud) ,
Receive Date: 03 January 2024, Revise Date: 29 March 2024, Accept Date: 12 May 2024
DOI: 10.21608/ejchem.2024.260427.9140

types: Fresh (fruits are consumed. immediately after harvesting, typical of the variety, Barhi); soft dates "wet" were those that passed through a rutab stage and remained soft and the sugars were mostly of the reducing sugar type; semi-dry dates were those varieties that passed through a Rutab stage but made a dryish Tamr (the sugar was generally of the reducing type) and dry dates were those varieties that did not pass through a Rutab stage and sugars were mostly of the sucrose type [5,6]. Date palm fruits are classified commercially based on moisture content as soft, semi-dry, or dry. The moisture content was ≥30%, 20-30%, and ≤20% in soft dates, semi-dry, and dry date types, respectively [7]. Based on the classification mentioned previously, Egyptian dates can be classified, into soft dates such as Zaghloul, Samani, and Barhi; semi-dry dates like Siwi, and Amry; dry dates such as Sakkoty, Malkaby, and Partimoda. Soft dates that are consumed at the khalal or rutab stage have high moisture content, are perishable, and deteriorate having a short harvest and marketing time. Semi-dry varieties have moderate moisture content and relatively longer shelf life compared to dry dates [8,3].

At present most of the date fruits are consumed directly with little processing. Different processing steps include sorting, pitting, disinfestation of insects, washing, grading, heat treatment, adjusting moisture content, coating, and packaging to produce different date products [9]**.** Date syrup and paste as the main by-products of date used for foodstuffs such as date powder, jams, beverages, chocolates, ice cream, confectioneries, liquid date sugar, and fermented date products (i.e., alcohol, organic acid, and fermented milk) [10**,**11**,**12**,**13**,**14].

Few studies have been conducted on the production and evaluation of date juices on a commercial scale and during storage. Date juice from Zaghloul at khalal stage without additional water or sugar was produced by Nadir et al [15], which they found that Zaghloul juice contained 0.5% citric acid and 1% ascorbic acid, and it was acceptable after processing as well as storage at 5ºC for six months. The addition of natural lemon juice to date juice particularly at 10% (w/w), significantly affected the composition of date juices. Alfadul and Hassan [16] and Abd Elhakim et al [17] indicated that beverages from date syrup fortified with roselle calyces, tamarind, carob pods and Doum extracts were high nutritional beverages value as well as low calories and healthy products. Burapalit and Tipvarakarnkoon [18]**.** produced Barhi date juice at TSS value was 10.5% from three stages and found no significant difference in overall sensory attributes. From the previous studies there was few studies about production of juice from Zaghloul and Siwi, while there is no research about Barhi and Samani. On the other hand, there is no research about date nectar produced from Barhi, Samani, Zaghloul and Siwi. Therefore, this study aimed to make trials to produce nectar from four Egyptian date fruit cultivars and evaluate sensory, physical, chemical, and microbiological properties as well as storage stability**.**

2 Material and methods

2.1 Material

Barhi, Samani, and Zaghloul dates cultivars at khalal stage as well as Siwi date at Tamr stage were obtained from the Central Laboratory for Date Palm Research and Development, Agricultural Research Center, Giza, Egypt.

2.2 Nectar preparation

Barhi, Samani, and Zaghloul were cleaned, washed, and boiled with water with ratio 1:2 (w: v) for 15 min at 75 ± 2 °C. The mixture was blended with a paddle impeller (moulinex 700w, made in France) at 90 rpm according to Sorour and Assous [19]. Seedless Siwi as semi-dry date was extracted with water at a ratio 1:3 (w: v) at the previous condition. The date extract was filtrated through a muslin cloth. All samples were quickly cooled to 4 °C (ice bath) and stored at -18 °C to stop all reactions until further analysis.

2.3 Total soluble solids and pH adjustment

The total soluble solids (TSS) of Barhi, Samani, and Zaghloul date extracts were adjusted to ~15.5% with the addition of sucrose according to Egyptian Standard, No: 650 [20] .The pH levels were adjusted to be 4.5,5, 5.5,6 using citric acid.

2.4 Date nectar Pasteurization.

Date nectar samples (100 ml) were heated at 95 °C for 5 minutes in a clean 150 ml glass bottle using a shaker water bath (Julabo, SW22, Germany) [21]. The experiments were performed in triplicate and then cooled quickly to 4 ˚C in an ice bath. Based on the sensory evaluation of different date nectar, the highest score was selected to evaluate quality parameters either at zero time or during storage at 4±2˚C for six months.

2.5 Physicochemical evaluation

Total soluble solids and pH values were measured according to AOAC [22]. Color parameters (L*, a*, b*) were measured by the Minolta colorimeter (Model CR-400, MINOLTA CAMERA, CO., OSAKA, Japan). The L* value represents lightness. The a* value represents redness (+ values) and greenness (- values). The b* value represents yellowness (+ values) and blueness (- values) [23]. The browning index was measured at 420 nm using UV/VIS spectrophotometer (Jenway, England) according to Schuina [24]. Moisture content, titratable

acidity crude fiber, fat, ash, and sugar (reducing, non-reducing, and total sugars) were determined according to AOAC [22]. Fractionation, identification, and determination of sugar content were carried out using the HPLC technique according to Weiß and Alt [25].

2.6 Phytochemical content

The total phenolic content (TPC) of date nectar samples was determined according to Mohsen et al [26] with some modifications using Folin- Ciocalteau reagent with Gallic acid as standard. For extraction, 2 g of Date nectar were homogenized in 20 ml methanol (80%) and was stirred using a magnetic stirrer for 1 h. The extract was filtered through filter paper (Whatman No.1) to obtain a clear solution, 0.1 mL of extract was mixed with 0.5 mL of Folin-Ciocalteau reagent, stand for 5 min and then 1.5 mL sodium carbonate (7.5%w/v) was added. The mixture was diluted to 10 mL with distilled water and kept in the dark at room temperature for 1 h. The absorbance was measured at 765 nm with a spectrophotometer (model UV-2401 PC, Shimadzu, Milano, Italia). The results were expressed as Gallic acid equivalents in mg GAE/100 sample. Total flavonoid content was determined according to Elsayed et al [27] briefly, 250µl of 5% NaNO2 was mixed with 500µl of extract. After 6 min, 2.5ml of a 10% AlCl3 solution was added. After 7 min, 1.25ml of 1M NaOH was added, and the mixture was centrifuged at 5000g for 10min. Absorbance of the supernatant was measured at 510nm against the solvent blank. The total flavonoid content was expressed as mg of Catechin equivalent (CE) per g of sample. The antioxidant activity of date nectar samples was determined according to the method of Abed Elmaksoud et al [28]. Date nectar samples (6 g) were homogenized in 75 mL of methanol and then filtered (Whatman No.1). After that, 0.2 ml of filtrate was mixed with 1 ml of 2,2-diphenyl-1-picrylhydrazyl (DPPH 2.4 mg/ 100 ml methanol) and 3 ml of methanol. The mixture was kept in the dark at room temperature for 30 min. The absorbance was measured at 517 nm. The antioxidant activity was expressed as% of inhibition according to the following equation:

Inhibition (%) = $(A_{control} — A_{sample} / A_{control}) \times 100$

Where $A_{control}$: the absorbance of the control; A_{sample}: the absorbance of the sample.

2.7 Sensory evaluation

Sensory parameters such as color, taste, odor, consistency, appearance, and overall acceptability were evaluated by 80 assessors (45 females, 35 males, aged 20 to 45 years) from the Food Science Department Faculty of Agriculture, Cairo University. A 9-point Hedonic scale was utilized for such a purpose; the rejection limit is less than 5 [29]. The date nectar samples were served at room temperature in polypropylene cups.

2.8 Microbiological evaluations

Total plate counts as well as yeast and mold counts were determined according to Lingle et al [30]. The plates for total plate count were incubated at 35 ºC for 48±2 hrs., while incubated at 25 ±2 ºC for 5 days in case of yeast and mold counts.

2.9 Statistical analysis

Experimental results were analyzed using analysis of variance (ANOVA) XLSTAT software version 2014, 5.03 (Addin soft, New York, NY, USA) in three repeats and expressed as the mean ± standard error of the mean. The significance of differences between samples means was calculated at p-value ≤ 0.05 and was considered significant.

3 Results and discussion

3.1. Physical and chemical properties of date varieties

Data given in Table1 shows the physical, chemical, and phytochemical characteristics of four date varieties Barhi, Samani, and Zaghloul as soft date and Siwi as simi dry types. Total soluble solids (TSS) value was the highest in Siwi date (7.5.0%), while the (TSS) values ranged between 26.5 and 29.1% in soft date samples Barhi, Samani and Zaghloul. These results are related to the moisture content of the dates. The moisture content in each of Barhi, Samani, and Zaghloul were 66.58, 65.20, and 68.66%, respectively. While the moisture content in Siwi dates was 19.60%. Concerning the color parameters in Table 1, L value indicates the lightness of each sample.

A significant difference in L value among four dates fruits which are ordered as follows Barhi (55.4) <Samani (44.4) < Siwi (31.61) < Zaghloul (22.33). The highest a value was observed in Zaghloul (12.35) compared to other types Siwi (1.14) <Samani (9.57) <Barhi (2.26) and this is due to the red color of this type. The highest b value was Barhi (40.47) compared to Samani (34.37) <Siwi (16.14) < Zaghloul (3.63) due to the yellow pigment presents in this type of date fruits and this is consistent with Sakr et al [31].

The results in Table 1 show no significant difference in ash, fiber, fat, and protein contents among the four date varieties. The predominant sugar content of date cultivars was fructose and glucose rather than sucrose. The ratio of fructose and glucose in soft dates (Barhi, Samani, and Zaghloul) was lower than in semi-dry (Siwi date). The fructose content of soft dates ranged between 13.1 and 22.9% and glucose content between 13.3 and 21.6%, while the fructose and glucose content of Siwi date were 32.54 and 33.66%, respectively. On the other hand, the sucrose content of the Siwi date was higher than those other dates. Haider et al [32] showed that the

type and quantity of sugars vary according to the cultivar and their specific fruit developmental stage. Total phenolic content was in high quantities for the four varieties of dates and ordered as follows Siwi (965.9) <Zaghloul (591.2 <Samani (527.6) < Barhi (430.3). The observed pattern aligns with the findings pertaining to flavonoids, and this pattern is similarly evident in antioxidants, since both phenolic and flavonoids contents predominantly contribute to the antioxidative impact. These findings match several studies [33,34,35,36].

Table 1 Physicochemical and phytochemical properties of date fruit cultivars (on dry weight bases)

	Soft Date			Semi dry Date
Parameters	*Barhi cv.*	*Samani cv.*	*Zaghloul cv.*	*Siwi cv.*
TSS (%)	28.9± 0.66^{b}	29±0.55^{b}	26.5±0.50^{c}	75.0±0.51^{a}
pH value	6.23±0.29^{a}	6.47 ±0.37^{a}	6.58±0.33^{a}	5.67 ±0.32^{b}
L	55.4±0.51^{a}	44.40±0.54^{b}	22.33±0.59^{d}	31.6±0.56^{c}
a	2.26±0.25^{d}	9.57±0.25^{c}	12.35±0.23^{a}	11.14±0.23^{b}
b	40.47±0.31^{a}	34.37±0.29^{b}	3.63±0.24^{d}	16.55±0.27^{c}
Titratable acidity (%)	0.10±0.12^{a}	0.134±0.16^{a}	0.164±0.13^{a}	0.268±0.14^{a}
Ash (%)	1.67±0.24^{a}	1.81±0.22^{a}	1.62±0.25^{a}	1.95±0.30^{a}
Crude fiber (%)	2.48±0.15^{b}	2.74±0.12^{b}	2.42±0.11^{b}	3.61±0.14^{a}
Fat (%)	1.58±0.13^{a}	1.72±0.16^{a}	1.31 ±0.18^{a}	1.64±0.12^{a}
Protein (%)	2.30±0.25^{a}	2.13±0.21^{a}	2.51 ± 0.26^{a}	2.27±0.22^{a}
Moisture (%)	66.58±0.28^{b}	65.20±0.25^{b}	68.66±0.22^{a}	19.60±0.26^{c}
Fructose g/100g	14.5±0.42^{c}	22.9±0.40^{b}	13.1±0.45^{d}	32.54±0.45^{a}
Glucose g/100g	13.9±0.24^{c}	21.6±0.25^{b}	13.3±0.26^{c}	33.66±0.27^{a}
Sucrose g/100g	0.92±0.10^{c}	1.7±0.14^{b}	0.7± 0.15^{c}	4.01±0.13^{a}
Total sugars g/100g	29.32±0.29^{c}	46.2±0.25^{b}	27.2± 0.24^{c}	70.21±0.26^{a}
Total phenolic content (mg/100	430.3±0.50^{d}	527.6±0.49^{c}	591.2±0.52^{b}	965.9±0.53^{a}
Total flavonoid content (mg/100g)	6.37±0.24^{d}	7.58±0.26^{c}	9.44±0.25^{b}	12.6±0.28^{a}
Antioxidant activity (%)	55.6±0.35^{d}	57.3±0.60^{c}	64.3±.62^{b}	92.4±0.52^{a}

The experimental values (means and SD for n = 3) with small letter are significantly different ($P \leq 0.05$).

3.2 *Sensory* evaluation of date fruit nectar samples

Results in Fig. 1 show the sensory evaluation of date fruit nectar samples at different pH values. The high taste, color, odor, consistency, and overall acceptability score was observed at a pH 6 for Barhi, Samani, and Zaghloul date nectar samples. At the same time, the high score for Siwi date nectar was at pH 5.5 (control sample). Regardless of the type of date nectar, the decrease in pH value resulted in a less palatable taste. This improvement in sensory parameters is attributed to the balance between the total soluble solids and the acidity content. In this respect Nadir et al [15] found that the addition of citric acid to Zaghloul date nectar improved sensory parameters. Based on the results in Fig. 3, Barhi, Samani, and Zaghloul date nectar samples at pH 6 as well as Siwi date nectar at pH 5.5 were selected as the highest sensory score and subjected to physical, chemical, sensorial, and microbiological evaluation after processing and during storage at 4±2ºC for 6 month.

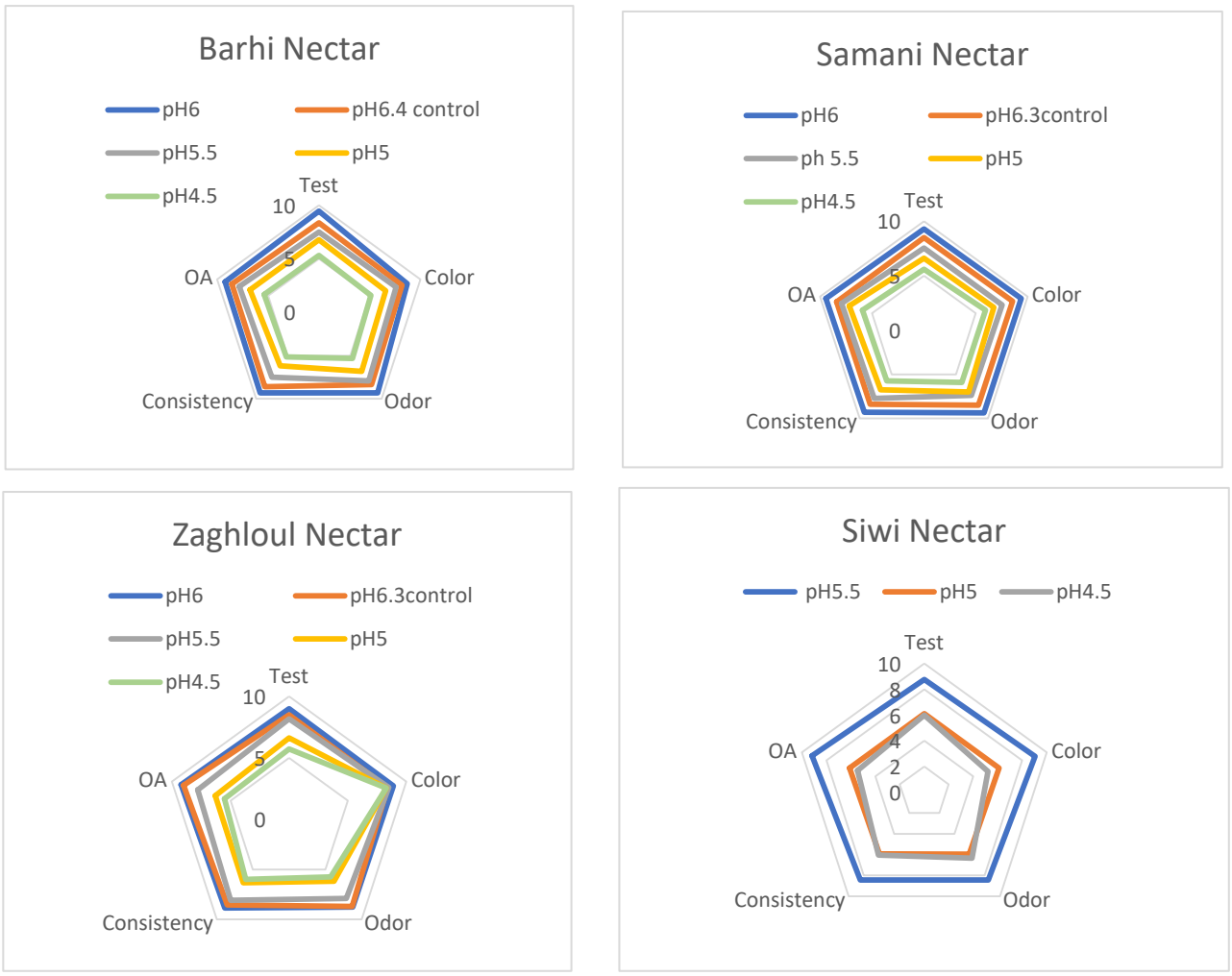

Fig.1. Sensory evaluation of date fruit nectar samples at different pH values

3.3 Physicochemical and microbial evaluation of date fruit nectar samples.

Table 2 shows physicochemical and microbial evaluation of the different date fruit nectar. The results indicated that there was no significant difference among four date nectar samples in the TSS, pH, TSS/acid ratio, titratable acidity, crude fiber, and protein. The original TSS of crude nectar were 9.5% in Barhi date nectar, 7.5 % in Zaghloul and Samani date nectar and 15.8% in Siwi date nectar. There were significant differences among four date fruits nectar with the highest value of lightness (L) ordered as follows Barhi (20.5) >Samani (17.7) > Zaghloul (13.7) >Siwi (12.4). Also, the highest redness (a) value was in Siwi date nectar (0.47) followed by Zaghloul (0.42), Samani (0.28) and Barhi (0.25), the red color is attributed to anthocyanins pigment presented in this type of date fruits. The highest yellowness (b) value was observed in Barhi (1.87) compared to Samani (1.76) >Zaghloul (1.69) >and Siwi (1.56), the yellow pigment is attributed to carotenoids which are a class of natural fat-soluble pigments providing bright color to the plants [37]. The ash content of date nectar ranged from 0.22% to 036%. The profile sugars of date nectar contain variance in sucrose, fructose, and glucose. The sucrose content (as non-reducing sugars) of date nectar samples was ordered as follows Samani(7.35%) > Zaghloul (6.23%) > Barhi (5.03%) > Siwi (1.88%). Reducing sugar (fructose, and glucose) were ordered as follows Siwi >Barhi > Zaghloul >Samani. The total phenolic content and flavonoids of date nectar samples were ordered as follows Siwi > Zaghloul > Barhi> Samani. On the other hand, antioxidant values were consistent with TP and flavonoid values [38, 39].

Table 2 Physicochemical and microbial evaluation of date fruit nectar samples (on fresh weight bases)

Parameter	Soft Date			Semi-dry Date
	Barhi nectar	*Samani nectar*	*Zaghloul nectar*	*Siwi nectar*
TSS %	15.7 ±0.26^{a}	15.3 ±0.22^{a}	15.5 ±0.23^{a}	15.8±0.25^{a}
pH value	6.0±0.11^{a}	6.03±0.12^{a}	6.0±0.17^{a}	5.5± 0.13^{a}
TSS/ acids ratio	120.76±0.13^{a}	127.50±0.15^{a}	124.0±0.11^{a}	92.93±0.12^{b}
L	20.5 ±0.34^{a}	17.5 ±0.31^{b}	13.7 ±0.30^{c}	12.4 ±0.33^{c}
a	0.25 ±0.15^{d}	0.28 ±0.12^{c}	0.42 ±0.13^{b}	0.47 ±0.17^{a}
b	1.87 ±0.25^{a}	1.76 ±0.27^{a}	1.69 ±0.24^{a}	1.56 ±0.23^{a}
Titratable acidity (g/100g)	0.13 ±0.13^{a}	0.12 ±0.12^{a}	0.125 ± 0.11^{a}	0.17±0.14^{a}
Crude fiber (g/100g)	0.12 ±0.05^{a}	0.11 ±0.06^{a}	0.15±0.09^{a}	0.14± 0.03^{a}
Protein (g/100g)	0.07±0.06^{a}	0.10 ± 0.05^{a}	0.14 ± 0.02^{a}	0.11±0.03^{a}
Ash (g/100g)	0.24±0.012^{c}	0.30±0.011^{b}	0.22±0.015^{d}	0.36±0.014^{a}
Fructose (g/100g)	5.00 ±0.33^{b}	3.20± 0.35^{d}	4.67± 0.32^{c}	6.10±0.31^{a}
Glucose (g/100g)	4.53± 0.22^{b}	3.30 ±0.25^{c}	2.85± 0.27^{d}	5.90±0.23^{a}
Sucrose (g/100g)	5.03 ± 0.23^{c}	7.35±0.27^{a}	6.23±0.25^{b}	1.88±0.22^{d}
Reducing sugar (g/100g)	9.5±0.21^{b}	6.71±0.27^{c}	7.63± 0.25^{c}	12.65 ±0.20^{a}
Non -reducing sugar (g/100g)	5.13±0.12^{c}	7.60±0.11^{a}	6.70± 0.13^{b}	2.02 ±0.15^{d}
Total sugars (g/100g)	14.63±0.48^{a}	14.11 ±0.46^{a}	14.33± 0.45^{a}	14.67± 0.5^{a}
Phenolic content (mg/100g)	55.9±0.36^{c}	43.8±0.36^{d}	77.4± 0.33^{b}	159.0 ± 0.35^{a}
Total flavonoid content (mg/100g)	1.40±0.17^{c}	1.1±0.15^{d}	1.94±0.16^{b}	3.98±0.18^{a}
Antioxidant activity (%)	48.4±0.21^{c}	42.5±0.25^{d}	52.4±0.22^{b}	59.6±0.26^{a}
Total plate count (log cfu/g)	0.6±0.23^{a}	0.5±0.24^{a}	0.4±0.20^{a}	0.5±0.22^{a}
Mold & yeast (log cfu/g)	0.40±0.21^{a}	0.25±0.24^{b}	0.30±0.28^{b}	0.23±0.26^{b}
Moisture (g/100g)	83.32±0.21^{a}	83.76±0.25^{a}	83.55±0.23^{a}	83.23±0.26^{a}

The experimental values (means and SD for n = 3) with small letters are significantly different ($P \leq 0.05$).

3.4 Effect of storage period on physical properties of date fruit nectar samples

Table 3 shows the effect of storage period (at 4˚C for 6 months) on physical properties of date fruit nectar samples. Total soluble solids of date nectar were slightly decreased during storage at 4ºC for 6 months. The percentage decrease of TSS ranged from 0.6% to 1.26% from the initial value. The same trend of pH value slightly declined to 5.9 for three soft date nectar samples and to 5.45 for Siwi nectar sample. This may be due to the browning reaction [40].

showed that total soluble solids and pH values were slightly decreased during the storage of guava nectar. The (L and b) values were decreased during the first 3 months of storage while a clear deficiency was observed in the second 3 months of storage period. A little gradual increase in value was observed till 6 months of storage. Colour degradation in nectar may be due to nonenzymatic Maillard browning. Chia et al [41] indicated that hue angle and chroma are the parameters associated with a* and b* values that were significantly affected by the storage time of pineapple nectar.

Table 3 Effect of storage period (at 4˚C for 6 months) on physical properties of date fruit nectar samples

Parameters	Storage (month)	Soft Date			Sime Dry
		Barhi Nectar	Samani Nectar	Zaghloul Nectar	Siwi Nectar
TSS (%)	0	15.7±0.25[a]	15.3±0.22[a]	15.5±0.23[a]	15.80±0.24[a]
	3	15.6±0.21[a]	15.3±0.25[a]	15.5±0.21[a]	15.70±0.22[a]
	6	15.6±0.22[a]	15.2±0.21[a]	15.4±0.23[a]	15.60±0.26
pH value	0	6.00±0.14[a]	6.03±0.16[a]	6.00±0.17[a]	5.50±0.11[a]
	3	5.94±0.11[a]	5.92±0.14[a]	6.00± 0.12[a]	5.50±0.15[a]
	6	5.9±0.16[a]	5.90±0.15[a]	5.90±0.09[a]	5.45±0.07[a]
L	0	43.5 ±0.12[a]	37.5±0.17[a]	17.70±0.15[a]	28.40±0.13[a]
	3	41.8±0.25[b]	35.7±0.15[b]	16.60±0.20[b]	25.50±0.21[b]
	6	35.4±0.21[c]	30.90±0.25[c]	12.90±0.22[c]	18.20±0.24[c]
a	0	1.45 ±0.15[b]	4.38±0.12[c]	7.42±0.13[c]	5.37±0.17[c]
	3	1.9±0.13[a]	4.90±0.12[b]	7.60±0.15[b]	5.66±0.11[b]
	6	2.12±0.14[a]	5.35±0.14[a]	8.0±0.16[a]	6.09±0.12[a]
b	0	37.37 ±0.12[a]	31.66 ±0.15[a]	1.65±0.13[a]	14.66±0.17[a]
	3	30.17±0.27[b]	27.28±0.22[b]	1.58±0.25[a]	10.7±0.21[b]
	6	25.25±0.17[c]	22.52±0.12[c]	1.40±0.16[ab]	9.1±0.13[b]

The experimental values (means and SD for n = 3) with small letters are significantly different ($P \leq 0.05$).

3.5 Effect of storage period on chemical properties of date fruit nectar samples

Table 4 shows the effect of storage period (at 4˚C for 6 months) on chemical properties of date fruit nectar samples. The acidity content of date nectar was slightly decreased during storage period. Reducing sugars was slightly increased during storage. This increment in reducing sugars may be due to the inversion of non-reducing sugars into reducing during the same period of storage, due to the acid hydrolysis of disaccharides into monosaccharides such as fructose and glucose.

The total sugars were slightly decreased during storage. It may be due to Maillard's reaction. Total phenolic content and total flavonoids of date nectar gradually decreased, especially during the second 3 months of storage period. Antioxidant activities are very important for human health, they distinguish one nectar from another. The antioxidant activity value in four date nectar samples was not less than about 40 % at the end storage period [40].

Table 4 Effect of storage period (at 4˚C for 6 months) on chemical properties of date fruit nectar samples (g/100 on fresh weight bases)

Parameters	Storage (month)	Soft Date			Sime Dry
		Barhi Nectar	*Samani Nectar*	*Zaghloul Nectar*	*Siwi Nectar*
Titratable acidity (%)	0	0.130±0.011^{a}	0.12±0.012^{a}	0.125± 0.011^{a}	0.17±0.013^{a}
	3	0.100±0.025^{ab}	0.100±0.023^{a}	0.130±0.022^{a}	0.12±0.021^{a}
	6	0.080±0.013^{b}	0.09±0.015^{ab}	0.100±0.017^{ab}	0.11±0.016^{ab}
Reducing sugar (%)	0	9.40±0.21^{a}	6.51±0.22^{a}	7.63± 0.27^{a}	12.55 ±0.24^{a}
	3	9.83±0.21^{b}	7.50±0.20^{b}	7.9±0.22^{a}	12.6±0.17^{a}
	6	9.73±0.23^{b}	7.62±0.17^{b}	8.17±0.29^{b}	12.83±0.29^{a}
Non-reducing sugar (%)	0	5.13±0.12^{a}	7.60±0.11^{a}	6.80± 0.13^{a}	2.02 ±0.15^{a}
	3	4.74±0.15^{b}	6.47±0.13^{b}	6.35±0.16^{b}	1.84±0.19^{ab}
	6	4.53±0.18^{b}	6.30±0.17^{b}	5.93±0.12^{c}	1.50±0.15^{b}
Total sugars (%)	0	14.53±0.23^{a}	14.11 ±0.21^{a}	14.43± 0.25^{a}	14.57± 0.27^{a}
	3	14.60±0.24^{a}	14.0±0.23^{a}	14.22±0.28^{a}	14.37±0.29^{a}
	6	14.30±0.32^{a}	13.92±0.35^{a}	14.10±0.32^{a}	14.35±0.33^{a}
Phenolic content (mg/100g)	0	55.9±0.36^{a}	43.8±0.34^{a}	77.4± 0.33^{a}	159± 0.32^{a}
	3	48.6± 0.12^{b}	40.3±0.16^{b}	65.1±0.14^{b}	126.7±0.15^{b}
	6	44.7±0.16^{c}	35.8±0.13^{c}	52.3±0.12^{c}	110.1±0.15^{c}
Total flavonoid content (mg/100)	0	1.40±0.27^{a}	1.1±0.28^{a}	1.94±0.31^{a}	3.98±0.30^{a}
	3	1.12±0.15^{ab}	1.0±0.17^{a}	1.63±0.18^{b}	2.67±0.12^{b}
	6	1.00±0.17^{b}	0.9±0.12^{a}	1.16±0.19^{c}	2.10±0.14^{c}
Antioxidant activity (%)	0	48.4±0.14^{a}	42.5±0.11^{a}	52.4±0.12^{a}	75.6±0.15^{a}
	3	42.2±0.17^{b}	40.9±0.14^{b}	50.3±0.13^{b}	72.2±0.12^{b}
	6	40.6±0.30^{c}	37.5±0.34^{c}	48.5±0.35^{c}	70.9±0.32^{c}

The experimental values (means and SD for n = 3) with small letters are significantly different ($P \leq 0.05$).

3.6 Effect of storage period (at 4˚C for 6 months) on microbial load of date fruit nectar samples

The results of the microbial evaluation of different date nectar are shown in Table 5. Total bacterial counts were1.778, 1.698, 1.602 and 1.69 in Barhi, Samani, Zaghloul, Siwi nectar samples at zero time respectively, while yeast and molds were1.602, 1.397, 1.477 and 1.301 Barhi, Samani, Zaghloul, Siwi nectar samples at zero time respectively. Low counts in total bacterial count and yeast and molds were due to the effect of pasteurization of nectar at zero time before storage.

Total counts were increased during the storage period, but the increasing value was not more than 450 CFU/100ml juice at the end of storage (at 4˚C for 6 months). Also, yeast and molds were slightly increased during storage, the maximum value was 150CFU/100ml juice. It may be due to the growth of mold and bacterial spores as a result of temperature fluctuations during storage time. These results agreed with Nadir et al [15]. The counts of microorganisms of juice after storage were acceptable according to Egyptian Standard, No: 650 [20].

Table 5 Effect of storage period (at 4˚C for 6 months) on microbial load of date fruit nectar samples (log cfu/ml)

Parameters	Storage (month)	Soft Date			Sime Dry
		Barhi Nectar	*Samani Nectar*	*Zaghloul Nectar*	*Siwi Nectar*
Total counts	0	1.778±0.23^{a}	1.698±0.21^{a}	1.602±0.25^{a}	1.69±0.27^{a}
	3	2.301 ±0.31^{b}	2.477±0.33^{b}	2.497±0.35^{b}	2.475±0.34^{b}
	6	2.544±0.12^{b}	2.602±0.11^{b}	2.653±0.18^{b}	2.653±0.15^{b}
Mold & Yeast	0	1.602±0.53^{a}	1.397±0.51^{a}	1.477±0.58^{a}	1.301±0.51^{a}
	3	2.00±0.42^{b}	2.114±0.43^{b}	2.000±0.40^{b}	2.114±0.41^{b}
	6	2.146±0.12^{b}	2.096±0.12^{b}	2.176±0.20^{b}	2.161±0.33^{b}

The experimental values (means and SD for n = 3) with small letters are significantly different (P ≤ 0.05).

3.7 Sensory evaluation of date fruit nectar samples during storage at 4˚C for 6 months

Sensory parameters of date nectar during the storage period were evaluated and presented in Table 6. The taste score decreased after the first 3 months of storage while the reduction of taste score was not significant. The taste score of the second storage period was slightly significant compared to the score of zero time for all date nectar. The taste score was no less than 8.18. The color parameter was not significant after 3 months while the color score was significantly decreased at the end of storage. The color scores after the end storage were 7.9, 8.0, 8.05, and 8.01 for Barhi,
Samani, Zaghloul, and Siwi nectar, respectively. Results in the same table indicated that odor and consistency scores of date nectar were similar during storage and acceptable after 6 months from storage. The overall acceptability score was slightly decreased at the end of storage compared to zero time. Thus, producing date juice from soft and semi-dry dates at pH values 6.0 and 5.5 respectively and TSS 15.5% were highly sensory after processing as well as storage.

Table 6 Statistical analysis of sensory evaluation of date fruit nectar samples during storage at 4˚C for 6 months

Parameters	Storage (month)	Soft Date			Sime Dry
		Barhi Nectar	*Samani Nectar*	*Zaghloul Nectar*	*Siwi Nectar*
Taste	0	9.41±0.30^{a}	9.38 ± 0.55^{a}	9.00 ± 0.59^{a}	9.35 ±0.58^{a}
	3	9.17±0.25^{a}	9.13 ± 0.30^{a}	8.59 ± 0.38^{a}	8.67 ±0.41^{ab}
	6	8.59±0.57^{b}	8.18 ± 0.56^{b}	8.25 ± 0.52^{b}	8.30 ±0.41^{b}
Colour	0	8.73±0.47^{a}	9.38 ± 0.42^{a}	8.95 ± 0.35^{a}	8.44 ±0.53^{a}
	3	7.53±0.51^{ab}	8.68 ± 0.51^{ab}	8.59 ± 0.44^{ab}	8.15 ±0.41^{ab}
	6	7.90±0.26^{b}	8.00 ± 0.60^{b}	8.05 ± 0.35^{b}	8.1 ±0.21^{b}
Odor	0	9.30±0.54^{a}	9.31 ± 0.48^{a}	8.77 ± 0.68^{a}	8.55 ±0.60^{a}
	3	7.16±0.71^{ab}	8.42 ± 0.49^{ab}	8.45 ± 0.47^{ab}	8.25 ±0.35^{a}
	6	7.40 ±0.52^{b}	8.32 ± 0.63^{b}	8.09 ± 0.44^{b}	8.15 ±0.58^{a}
Consistency	0	9.30±0.35^{a}	9.46 ± 0.43^{a}	8.86 ± 0.55^{a}	8.45 ±0.55^{a}
	3	7.38±0.21^{ab}	8.38 ± 0.45^{ab}	8.45 ± 0.47^{ab}	7.95 ±0.37^{ab}
	6	7.27±0.44^{b}	8.28 ± 0.57^{b}	8.23 ± 0.34^{b}	7.95 ±7.95^{b}
Overall acceptability	0	9.21±0.57^{a}	9.46 ± 0.43^{a}	9.23 ± 0.61^{a}	9.20 ±0.54^{a}
	3	7.34±0.59^{ab}	8.42 ± 0.30^{ab}	8.41 ± 0.44^{ab}	8.05 ±0.37^{ab}
	6	6.96±0.52^{b}	8.10 ± 0.52^{b}	8.26 ± 0.45^{b}	7.9 ±7.90^{ab}

The experimental values (means and SD for n = 3) with small letters are significantly different (P ≤ 0.05).

4 Conclusion

The current study concluded the production of date nectar using the semi-dry variety (Siwi), which has unique chemical, physical, and phytochemical properties, as well as soft date types (Barhi, Samani, and Zaghloul). In addition, the results reported that the chemical, physical, microbiological, and sensory characteristics of different types of used date nectar during a storage period at 4°C for 6 months were maintained. Therefore, producing nectar from different Egyptian types of dates will increase the economic value of these dates, which have a limited shelf life.

5 Conflicts of interest

The authors declare no conflicts of interest.

6 Formatting of funding sources

the Academy of Scientific Research, Ministry of Higher Education, and Scientific Research for funding.

7 Acknowledgments

The authors are grateful to the Academy of Scientific Research, Ministry of Higher Education, and Scientific Research for funding and supporting project ID: 4664 (Improving the quality and safety of Egyptian dates and dates products).

8 References

[1] Ibrahim,S.A. , Ayad,A.A., Williams,L.L., Ayivi, R.D., Gyawali, R., Krastanov,A. and Aljaloud,S.O.(2021). Date fruit: a review of the chemical and nutritional compounds, functional effects, and food application in nutrition bars for athletes. International Journal of Food Science and Technology, 56, 1503–1513

[2] Aleid, S. M., and Kader, A. A. (2013). Dates: postharvest science, processing technology and health benefits. John Wiley & Sons.

[3] El-Sharabasy S.S.H and Rizk, R. M. (2019). Atlas of date palm in Egypt.FAO, ISBN: 978-92-5-131599-6.

[4] Ministry of Agriculture and land reclamation (2017). Economic Affairs Sector (EAS), Agriculture Planning Central Administration, General Administration of Agric. Economic Resources, National Agricultural Income, 74-79.

[5] Cohen, Y. (2020). Phoenix dactylifera date palm. In Biotechnology of fruit and nut crops (pp. 107-117). Wallingford UK: CAB International.

[6] Aribi, M. M. (2023). Date Harvest. Date Palm. GB: CABI, 399-453.

[7] Rambabu, K., Bharath, G., Hai, A., Banat, F., Hasan, S. W., Taher, H., & Mohd Zaid, H. F. (2020). Nutritional quality and physico-chemical characteristics of selected date fruit varieties of the United Arab Emirates. Processes, 8(3), 256.

[8] El-Sharabasy S.S.H and Rizk, R. M. (2005). Morphological diversity of date palm (Phoenix dactylifera L.) in Egypt: Soft date palm cultivars. Mansoura Horticulture Journal, 30(11)7001-7027

[9] Ashraf,Z. and Hamidi-Esfahani,Z.(2011). Date and date processing: A Review, Food Reviews International, 27:101–133.

[10] Besbes,S. , Drira, L. Blecker,C. Deroanne,C.and Attia,H (2009). Adding value to hard date (Phoenix dactylifera L.): Compositional, functional and sensory characteristics of date jam. Food Chemistry, 112, 406–411.

[11] Asouss,M.T.M. and. Sorour, M.A (2014). Effect of concentration methods on quality of date syrup (dibs). The Transactions of the Egyptian Society of Chemical Engineers. 40(3):51-76

[12] Rabie, S. M., Salem, Eman M., Assous, M. T.M., Afifi, M. F. M.and Asrar Y. I. Mohamed (2018). Technological and economical studies on production of date powder and paste from some low-quality Egyptian varieties. The Second Egyptian International Date Palm Conference.1-10.

[13] Assous, M.T.M., Mohamed, A. Kenawi; Fowzy, A. H. El Sokkary, Mohamed, N. Kenawi and Zeinab, A. H. Abd el galil (2021). Production and evaluation of date powder. International Journal of Family Studies, Food Science and Nutrition Health. Volume 4, Issue 1, 19 – 39.

[14] Magdy Ramadan Shahein, M.G., Atwaa,E.S., Elkot ,W.F., Hijazy,H.H.A.,Kassab , R.B., Alblihed,M.A. and Elmahallawy,E.K.(2022). The impact of date syrup on the physicochemical, microbiological, and sensory properties, and antioxidant activity of bio-fermented camel milk. Fermentation, 8, 192

[15] Nadir, A., Abdelmagauid, N.A., Helmy, I.M.F. and Shalaby, A. R. (2017). Production of juice from zaghloul date at khalal stage. Asian Journal of Scientific Research,10(4):281-289.

[16] Alfadul,S.M. and Hassan,B.H. (2016). Chemical composition of natural juices combining lemon and datesInternational Journal of Food Engineering,2 (1);9-15

[17] Abd Elhakim,H.I, Gado,G,B.A. and Ramadan,I.E. (2017). Utilization of date syrup to increase the nutritional value of some natural beverages. The International Journal of Science & Technology,5(3):118-127.

[18] Burapalit, K. KitsawadK. and Tipvarakarnkoon,T. (2020). Physicochemical and sensory properties of juice from different types of date. Food and Applied Bioscience Journal, 8(2): 40−52.

[19] Sorour, M.A. and Assous, M.T.M. (2008). Effect of mixing during extraction on the quality of date juice. Journal of Engineering and Applied Science. Cairo University, vol. 55:93-108.

[20] Egyptian Standard, No: 650 (2013). General standard for fruit juices, concentrated and nectars. Egyptian Organization for Standardization and Quality, Arab Republic of Egypt

[21] Vegara, S., Martí, N., Mena, P., Saura, D., & Valero, M. (2013). Effect of pasteurization process and storage on color and shelf-life of pomegranate juices. LWT-Food Science and Technology, 54(2), 592-596.

[22] AOAC (2016). International Official methods of analysis, 20th Edition. 2016 (online). AOAC International, Rockville, Maryland 20850–3250, USA.

[23] Abedelmaksoud T G, Mohsen S M, Duedahl-Olesen L, Elnikeety M M and Feyissa A H (2018). Effect of ohmic heating parameters on inactivation of enzymes and quality of Not-From-Concentrate mango juice. Asian Journal of Scientific Research, 11 (3), 383-392. doi: 10.3923/ajsr.2018.383.392

[24] Schuina, G. L., Moraes, V. P., Silva, P. I., & Carvalho, R. V. (2021). Effect of thermosonication on pectin methylesterase activity and on quality characteristics of orange juice. Revista Ciência Agronômica, 52, e20207376.

[25] Weiß, K., & Alt, M. (2017). Determination of single sugars, including inulin, in plants and feed materials by high-performance liquid chromatography and refraction index detection. Fermentation, 3(3), 36

[26] Mohsen, S. M., Murkovic, M., El-Nikeety, M. M., & Abedelmaksoud, T. G. (2013). Ohmic heating technology and quality characteristics of mango pulp. Journal of Food Industries and Nutrition Science, 3(1), 69-83

[27] Elsayed, N., Marrez, D. A., Ali, M. A., El-Maksoud, A. A. A., Cheng, W., & Abedelmaksoud, T. G. (2022). Phenolic profiling and in-vitro bioactivities of corn (Zea mays L.) tassel extracts by combining enzyme-assisted extraction. Foods, 11(14), 2145

[28] Abedelmaksoud, T. G., Mohsen, S. M., Duedahl-Olesen, L., Altemimi, A. B., Elnikeety, M. M., Cacciola, F., & Feyissa, A. H. (2022). Positive Influences of Ohmicsonication on Phytochemical Profile and Storage Stability of Not-from-Concentrate Mango Juice. Molecules, 27(6), 1986.

[29] Hasani, A. Kongoli, R. and Beli, D. (2018). Organoleptic analysis of different composition of fruit juices containing wheatgrass. Food Research 2 (3), 294 – 298.

[30] Lingle, C. K., Schumacher, A. J., Rosauer, M. L., Silbernagel, K. M., & Blackburn, J. (2023). 3M™ Petrifilm™ Rapid Yeast and Mold Count Plate Method for the Enumeration of Yeast and Mold on Selected Surfaces: AOAC Official Method 2014.05. *Journal of AOAC International*, *106*(2), 389-400

[31] Lingle, C. K., Schumacher, A. J., Rosauer, M. L., Silbernagel, K. M., & Blackburn, J. (2023). 3M™ Petrifilm™ Rapid Yeast and Mold Count Plate Method for the Enumeration of Yeast and Mold on Selected Surfaces: AOAC Official Method 2014.05. Journal of AOAC International, 106(2), 389-400.

[32] Haider, M.S., Khan, I.A., Jaskani , M.J., Naqvi,S.A. and Khan,M.M. (2014). Biochemical attributes of dates at three maturation stages. Emir. J. Food Agric. 26 (11): 953-962

[33] Ashour, N.E., Hassan, H.S.A. and Mostafa, E.A.M. (2008). Effect of some pollen carriers on yield and fruit quality of zaghloul and Samani date palm cultivars. American-Eurasian J. Agric. And Environ. Sci., 4 (3): 391-396.

[34] Al-Wasfy, M.M. and Mostafa, R.R.A. (2009). Effect of different methods of fruit thinning on zaghloul date palm production and fruit quality. Assiut J. of Agric. Sci., 39 (1) 97-106

[35] El-Hamzy, EM.A., Ashour, M.M.S., Moawadand R.K. and Abd El Moniem, G.M. (2013). Physico-chemical, sensorial and antioxidative characteristics of date syrups as affected by pectinase/cellulase enzymes treatments. Journal of Applied Sciences Research, 9(11): 5835-5849

[36] Radwan, E.M.A. (2017). Response of bent aisha and sewy date palm to some fruit thinning treatments. Assiut J. Agric. Sci., 48 (2) 115-126

[37] Baliga, M.S., B.R. Baliga, S.M. Kandathil, H.P. Bhat, and P.K. Vayalil. (2011). A review of the chemistry and pharmacology of the date fruits (Phoenix dactylifera L.). Food Res. Int. 44(7):1812–1822. doi: 10.1016/j.foodres.2010.07.004. [Crossref] [Web of Science ®], [Google Scholar]

[38] Hashem, H. A., Abd El-Daym, H. H., El-Sharnouby, G. A., Farghal, S. M., & Badr, H. A. (2017). The Effect of Extraction Method, Bleaching and Clarification Processes on Quality Second Grade Siwi Date Dibs. Ind. Eng, 1, 17-23.

[39] Abedelmaksoud, T. G., Hesarinejad, M. A., and Shokrollahi Yancheshmeh, B. (2022). The effect of cold plasma on the enzymatic activity and quality characteristics of mango pulp. Research and Innovation in Food Science and Technology. 10(4): 341-350.

[40] El-Gendy, M. A. and El-Hadidy, E.M. (2016). enhancement of guava nectar characteristics by reducing heat processing and addition of juniper (Juniperus communis) extracts. Journal of Food Sciences; Suez Canal University. 3 (1): 57-66.

[41] Chia, S. L., Rosnah, S., Noranizan, M. A., & Ramli, W. W. (2012). The effect of storage on the quality attributes of ultraviolet-irradiated and thermally pasteurised pineapple juices. International Food Research Journal, 19(3), 1001.