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Research Article
Physio-chemical and Quality Characteristics for Date Juice at Khalal Stage

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Abstract

Background and Objective: The importance of the date in human nutrition comes from its rich composition of carbohydrates, minerals, dietary fibre, vitamins, fatty acids, amino acids and protein. At khalal stage, the percentages of protein, fat and ash decrease to 2.7, 0.3 and 2.8%, respectively. Most dates are consumed at the rutab (semi-ripe) and tamr (fully-ripe) stages. Consumption of processed dates, however, is rapidly and steadily growing. The present investigation was to make a comparison between date juices extracted from Egyptian varieties (Zaghloul ,Samani and Hayany), effected with ascorbic acid added and evaluates the chemical composition, physical characteristics, mineral analysis, color and quality attributes. **Materials and Methods:** Chemical analysis such as protein, ash, total sugars and total phenols, physical characteristics i.e., T.S.S, pH, total acidity and total solids, organoleptic evaluation as appearance ,color, taste, flavor and overall acceptability and total microbiological counts were measured. Statistical analysis was done by using a one-way analysis of variance (ANOVA) and using Assistant computer programs and Least Significant Difference (LSD), statistical significance was set at $p \leq 0.05$. **Results:** Total Soluble Solids (T.S.S) % and Brix/acidity ratio were high in samani date juice. Zaghloul date juice had the highest contents of total soluble solids %, total sugars % and total phenols % while, Hayany date juice contained higher contents of total acidity % (as citric acid), protein and ash. Hayany date juice contained a high level of sodium, potassium, calcium, phosphorous and magnesium. Addition of ascorbic acid at level 1% improved all values of organoleptic properties determined for all different date juices compared with controls. Treatment of selected different varieties of date juices samples with pasteurization and potassium sorbate reduced total bacterial, yeast and mould counts to acceptable levels through the storage periods. **Conclusion:** Different varieties of date juices were produced from Zaghloul, Hayany and Samani at khalal stage rich in minerals and total sugars. Addition of ascorbic acids to date juices at level 1% slightly increased the total acidity % and all color parameters compared to controls. It improved the organoleptic properties for all different date juices. Pasteurization and potassium sorbate reduced total bacterial, yeast and mould counts and increased the storage periods for more than 6 months.

Key words: Date juice, Egyptian date varieties, pasteurization, physio-chemical properties, quality

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Date palm (*Phoenix dactylifera L.*) is one of most important plants of arid, desert area of the Middle East, Southern Asia and Northern Africa for over 5000 years[1,2] The date palm has travelled remarkably well as civilization moved out of the Middle East and reached places such as Spain, Italy, China, Australia and the United States of America[3]. Today, USA earns the highest export price for dates in the world[4]. The top 10 producing countries were Egypt, Saudi Arabia, United Arab Emirates, Pakistan, Algeria, Iraq, Sudan, Oman and Libya. They were produced 91.5% of total world production, 7.05 million metric t in 2008 [5]. In Nile valley, Oases and desert districts, date palm trees are distributed In Egypt, which cover an area of 78.915 acre with 12 million fruit bearing trees where 16 of 27 varieties are commercially cultivated varieties.

At present, approximately 2000 or more different cultivars of date palm are known to exist all over the world but only a few important ones have been evaluated for their performance and final quality[6]. Fruit of the date palm is composed of a flesh (pulp)and seed (pits)[7].

The importance of the date in human nutrition comes from its rich composition of carbohydrates, minerals, dietary fibre, vitamins, fatty acids, amino acids and protein[8,9]. At khalal stage, the percentages of protein, fat and ash decrease to 2.7, 0.3 and 2.8%, respectively[10]. Most dates are consumed at the rutab (semi-ripe) and tamr (fully-ripe) stages. Consumption of processed dates, however, is rapidly and steadily growing[11].

Over the past few years, the consumption of fresh date fruits decreased due the change of the local consumer habits; the consumer market has shown growing interest in products "ready to consume". Therefore, the demand for dates has not been matching the increasing production. Processed products, especially juice have become more popular because they are easier to be consumed and are products of a high nutritional quality[3].

Fruit juices have an important role to play as part of a healthy diet. One glass of fruit juice is an important source of fluids and can provides vitamin C, folate, potassium and antioxidants. The Australian dietary guidelines[12] stated that fruit juice can count as 1 serve of fruit a day. Furthermore, fruit juices can play an important role in enhancing human health, for example, cranberry juice reducing the incidence of urinary tract infection in women[13] and grape juice having beneficial effects on markers of coronary heart disease[14,15]. Grape fruit juice intake protects against aflatoxin B1-induced DNA damage in rats[16] and also enhances the uptake of Co-enzyme Q10 in the human intestinal cell-line Caco-2[17].

In order to extend the short shelf life of date juice, reduce the quality loss and increase the utilization of date juice all around the year, so this study aimed to produce delicate and nutritive juice from 3 cultivars of date fruits (Zaghloul, Hayany and Samani) at khalal stage. The present investigation is to make a comparison between date juice extracted from Zaghloul variety and other Egyptian varieties (Samani and Hayany) before and after ascorbic acid addition and evaluates the chemical composition, physical characteristics, mineral analysis, color and quality attributes such as help to increasing shelf life, improved the organoleptic characteristics.

MATERIALS AND METHODS

Materials: Samani, Zaghloul and Hayany dates at Khalal stage were obtained from the local market, summer season and this study was carried out at Food Technology Department, National Research Centre. The dates were packaged in plastic bags and stored in refrigerator at 5±1°C until juice extraction. Citric and ascorbic acids and potassium sorbate were obtained from Sigma chemical Co. analytical grade.

Methods

Extraction of date juice: Different date varieties were pitted and washed in tap water. Depitted date of each variety was crushed and the juice extracted by using carrot juice extractor (Sanyo SJ-300E) and received in beaker. It was divided into 2 parts, the first part was control, the second part was mixed with ascorbic acid at levels 1% as a positive result from which had all good quality attributes.

The different date juice samples were treated with pasteurization process at 85°C for 15 min according to Egyptian organization for standardization and quality[18] and all analysis in this research were carried out.

Moisture, protein, ash, total sugars, reducing sugars and total acidity contents were determined[19] Total Soluble Solids (TSS %) expressed as °Brix (0-32) were determined using a hand refractometer (ATAGO, Japan). Non-reducing sugars were determined by difference between total sugars and reducing sugars. Total Solids (TS%) were determined by difference between moisture percent and 100. °Brix/acid ratio was calculated by dividing the value of total soluble solids on the total acidity value for each sample. The pH of samples was measured using a digital pH-meter (HANNA, H1902 m, Germany). Total polyphenols were extracted and estimated as mg Gallic acid equivalents kg^{-1} of sample according to the Folin-Ciocalteu Procedure[20].

Minerals content was determined by digestion samples with 5 mL sulphuric acid conc. and perchloric acid conc. 0.3 mL[21]and using Perkin Elmer 2380, Atomic absorption spectrophotometer[20] meanwhile, phosphorus content was determined spectrophotometrically[19].

The color of different samples measured using a spectrocolorimeter (tristimulus color machine) with CIE lab color scale (Hunter, Lab Scan XE, Reston VA.) calibrated with a white standard tile of Hunter Lab color standard (LXNO. 16379): X = 77.26, Y = 81.94 and Z = 88.14 (L = 92.71; a = -0.89; b = -0.18). Using Hunter-scofield's equation[22], color difference (ΔE) was calculated from a, b and L parameters, using Hunter-Scofield's equation[22] as follows:

$$\Delta E = (\Delta a^2+\Delta b^2+\Delta L^2)^{1/2}$$

Where $a = a-a_0$, $b = b-b_0$ and $L = L-L_0$.

Subscript "O" indicates color of control. The Hue angle (t^{-1g} b/a) and saturation index ($\sqrt{a^2+b^2}$) were calculated.

Carotenoids compounds and lutein were extracted and determined[19].

The provitamin A values, expressed as Retinol Equivalents (RE), were calculated according to NAS-NRC "US National Academy of Sciences, National Research Council"[23], for which 6 µg of β-carotene corresponds to 1 µg of Retinol Equivalent (RE). Considering that the only provitamin A precursor carotenoid present in palm date fruit is β-carotene, the following expression was used:

$$RE = \mu g\ \beta\text{-carotene}/6$$

All measurements were performed at least in triplicate and values were averaged. Results are given as Means±Standard Deviation (SD).

A comparison between pasteurization process at 85°C for 15 min, potassium sorbate treatment at level 0.5% and their effects on total bacterial, yeast and molds counts during storage periods for juice samples were determined.

The total bacterial count of date and date juice samples were carried out using nutrient agar medium[24], potato dextrose agar medium[25] was used for counting yeast and molds present in the products.

Appearance, color, taste, flavor and overall acceptability were evaluated[25]. The organoleptic scores involved 10 grades for each sensory property for different date juice sample.

Statistical analysis: The main values for each of the parameters in organoleptic analysis were subjected to statistical analysis using a one-way analysis of variance (ANOVA) using Assistant computer programs[26] and Least Significant Difference (LSD), statistical significance was set at $p \leq 0.05$

RESULTS AND DISCUSSION

Gross chemical composition of different date juice varieties are given in Table 1. Hayany date juice contained higher values of protein and ash than those of other date juices. Zaghloul date juice contained total sugars and reducing sugars, which were the highest and the same trend was found in Samani date juice for non-reducing sugars. Little variation was observed in results of total phenols values for different date juices in this study. Generally, the last observed results in this study were higher than the results obtained by Nadir *et al.*[27] for protein and ash contents only and the removal of fibers during juice extraction process may be responsible of decreased the other chemical constituents.

Table 1: Gross chemical composition and mineral contents for different varieties of date juice samples (on dry weight basis)

Components (%)	Samani date juice	Zaghloul date juice	Hayany date juice
Protein	3.60±0.54	3.41±0.46	4.51±0.61
Ash	2.69±0.13	1.99±0.18	3.10±0.27
Total sugars	12.22±0.23	13.36±0.07	11.71±0.20
Reducing sugars	9.14±0.38	10.51±0.41	8.95±0.50
Non-reducing sugars	3.08	2.85	2.76
Total phenols (mg kg^{-1})	2.16±0.30	2.21±0.19	2.19±0.25
Elements(mg/100g)			
Sodium	41.56	27.78	52.68
Potassium	1633.96	1297.44	2166.57
Calcium	123.37	100.17	195.77
Phosphorus	149.73	116.36	213.99
Magnesium	104.56	77.05	161.13
Iron	2.28	1.99	3.57
Copper	0.97	0.91	1.69
Zinc	1.18	1.08	1.97
Manganese	1.38	1.25	2.82

Mean±Standard Division

These results are in agreement with those obtained by Al-Shahib and Marshall[8], Nadir *et al.*[27], Abd El-Fattah[28], Al-Farsi[29] and Kulkarni *et al.*[30]. Minerals content of different date juice samples are shown in the same table. The results indicated that, Hayany date juice had high values of sodium, potassium, calcium, phosphorus and magnesium compared to the other date juices (Samani and Zaghloul). Potassium was represented the highest content followed by phosphorus, calcium and magnesium in different date juice samples. Copper was the lowest micro-element found between the other micro-elements determined in Samani, Zaghloul and Hayany date juices. The opposite trend of the last results was observed in iron content in all different date juices samples. It was observed that Hayany date juice had also the highest content of iron, copper, zinc and manganese. Ash content was responsible for increasing mineral contents of different date juice samples; it ranged from 1.99-3.10% in this study while it was between 1.80-2.10% for the same varieties as date fruits[27]. These results are in agreement with those obtained by Ahmed *et al.*[31], Al-Shahib and Marshal[8] and Nadir *et al.*[27].

Physical characteristics of different date juice controls varieties are shown in Table 2. Total Soluble Solids content (TSS)% was higher than that present in Zaghloul and Hayany date juices. Low value of total solids for Hayany date juice was noticed compared to for samani and Zaghloul date juices. Total acidity content of Hayany date juice was doubled for the same content in other 2 date juices varieties. No great change in pH values between 3 date juices. Brix/ acidity ratio of Hayany date juice was approximately reached to half of their ratios for other 2 date juices used in this investigation.

Physical characteristics of different date varieties (Samani, Zaghloul and Hayany) juice samples contained 1% ascorbic acid are shown in the same table. Results show that all total acidity % (as citric acid) in juice samples were slightly increased with addition of 1% ascorbic acid as compared with their present in control samples. As a general observation, there is no effect on TSS % for all juice samples when 1% ascorbic acid added. The pH values and Brix/acidity ratios for the different juice samples were lowered than their found in control samples. The highest values of reduction for pH and Brix/ acidity ratio were noticed in samani date juice treated with 1% ascorbic acid. All acidic date juice samples had little changes for values of total solids % from those present in all control samples.

Results of Yu and Rupasinghe[32] and Da Costa *et al.*[33] showed that the addition of different organic acids like ascorbic and citric acids did not affect TSS% or TS% values but it was increased the total acidity ratio and decreased the pH values for orange and carrot juices.

These results are in agreement with Yu and Rupasinghe[32], Da Costa *et al.*[33] Color values for different varieties of date juice samples are given in Table 3. The results revealed that, Lightness (L), yellowness (b) and saturation values were increased in Samani date juice control sample while, Zaghloul date juice control sample had high values of redness (a) and (a/b) as compared to those values occurred in other control samples in this study. All acidic different date juice samples had higher values for lightness (L), redness (a), yellowness (b), (a/ b) and saturation than that of the control samples. Also, the results showed a reduction in all values of hue for acidic different date juice samples where, its percentages were 9.47, 1.33 and 5.75% when compared with their hue values for Samani, Zaghloul and Hayany date juices control samples, respectively.

Table 2: Physical characteristics for different varieties of date juice Samples contained 1% ascorbic acid

Constituents	Samani date juice (control)	Samani date juice+ascorbic acid at level 1%	Zaghloul date juice (control)	Zaghloul date juice+ascorbic acid at level 1%	Hayany date juice (control)	Hayany date juice+ascorbic acid at level:1%
T.S.S.%	19.54±1.28	19.56±1.24	18.24±0.35	18.46±0.14	16.50±1.18	16.53±1.19
pH	5.77±0.17	5.43±0.35	5.71±0.18	5.38±0.52	5.62±0.05	5.30±0.36
Total acidity (as citric acid)%	0.21±0.44	0.29±0.08	0.22±0.08	0.29±0.07	0.43±0.04	0.49±0.06
Brix/acidity ratio	93.05±0.00	67.44±0.00	82.90±0.00	63.65±0.00	38.37±0.00	33.73±0.00
Total solids%	14.46±0.58	14.70±0.41	17.60±0.29	17.94±0.64	10.65±0.37	10.85±0.13

Mean±Standard Division

Table 3: Hunter color values for different varieties of date juice samples before and after 1% ascorbic acid addition

Samples	L*	a*	b*	a/b	Saturation	Hue	ΔE**
Samani date juice (control)	59.17	1.77	30.03	0.06	30.08	86.63	-
Samani date juice+ ascorbic acid at level 1%	63.57	6.64	32.43	0.20	33.10	78.43	6.99
Zaghloul date juice (control)	56.00	5.63	24.17	0.23	24.82	76.89	
Zaghloul date juice+ ascorbic acid at level 1%	61.28	7.51	29.84	0.25	30.77	75.87	7.97
Hayany date juice (control)	57.64	3.86	26.50	0.15	26.78	81.72	-
Hayany date juice+ ascorbic acid at level:1%	62.37	7.16	31.07	0.23	31.88	77.02	7.36

L*: Lightness, a*: Redness, b*: Yellowness, **: Color difference

The great change in color difference (Δ E) was found in acidic Zaghloul date juice sample. Color of date juice samples due to the accordance of natural pigments like yellow color in Samani date juice referred to carotenoids, red color in Zaghloul and Hayany juice samples due to the presence of anthocyanins. Results of color parameters for acidic different date juice samples may be due to the effect of ascorbic acid added and caused some change in values of pH and total acidity which affect in their color attributes.

These results are in agreement with Khalil[34] and Sakr *et al.*[35] Carotenoids, Lutein and provitamin A value contents are tabulated in Table 4. Compounds of α-carotene and β-carotene reached to their highest values in Samani date samples while, the same results for lutein compound was found in Zaghloul date sample. Samani date sample contained total carotenoids and provitamin A value which considered the highest contents for these compounds.

Samani, Zaghloul and Hayany date juice samples had lower values for all the last compounds compared to those occurred in the same date samples. The reduction rate was ranged from 5.45-13.45, 8.83-19.14 and 1.12-13.19% for β-carotene, α-carotene and lutein compounds respectively. Values of the same last compounds in Zaghloul, Hayany and Samani date juice which represented the lowest values for the last compounds. The same trend was noticed for contents of total carotenoids with decreasing rate 9.30, 5.62 and 7.54% from Samani, Zaghloul and Hayany date samples, respectively. Also, the same last different samples had provitamin A values with reduction rate 5.48, 12.56 and 13.27% from Samani, Zaghloul and Hayany date samples, respectively. These results are in agreement with Vyawahare *et al.*[36], Abdul-Allah[37] and Chandrasekaran and Bahkali[38].

Table 5 showed the organoleptic properties of different date juice samples before and after 1% ascorbic acid addition. It could be observed that, addition of ascorbic acid improved organoleptic properties for all juices samples compared with their controls. The highest total score for all organoleptic properties values was present in ascorbic acid 1% samani date juice sample. For this reason, it was selected the last different date juice samples for pasteurization, potassium sorbate treatments and microbiological examination as compared with their controls.

There was no significant differences at regarding appearance color, taste, flavor and overall acceptability between samples of Samani and Zaghloul date juices treated with 1% ascorbic acid. A significant differences at ($p \leq 0.05$) were found for appearance, color, taste and overall acceptability between Hayany date juice sample and Samani and Zaghloul date juices samples treated with 1% ascorbic acid. In regard to flavor, no significant differences were detected between all different varieties of date juices samples contained 1% ascorbic acid.

Table 6 shows the results of the microbiological examination for prepared different varieties of date juice samples. From these results, the total counts of bacteria, yeast and mold were increased generally in different date juice samples (controls) at zero time which were increased gradually during the months of the storage periods. Total bacterial counts were ranged from 2.12-3.11 log10 CFU mL^{-1}, total yeast and mold counts were ranged from

Table 4: Carotenoids and provitamin A value contents in different varieties of date and date juice samples

	Date samples (μgg^{-1})			Date juice samples (μgg^{-1})		
Compounds	Samani	Zaghloul	Hayany	Samani	Zaghloul	Hayany
β-carotene	70.08±2.52	23.40±0.81	26.24±0.78	66.26±1.83	20.45±0.15	22.71±0.45
α- carotene	57.81±3.25	47.93±1.24	14.00±0.35	51.94±1.21	43.70±1.12	11.32±0.63
Lutein	56.72±3.18	70.40±1.56	54.43±1.52	49.24±1.10	69.61±0.92	53.50±1.27
Total carotenoids	184.61±0.00	141.73±0.00	94.67±0.00	167.44±0.00	133.76±0.00	87.53±0.00
Provitamin A value	11.68±0.21	3.9±0.27	4.37±0.32	11.04±0.75	3.41±0.40	3.79±0.51

Mean±Standard Division

Table 5: Organoleptic properties of different varieties of date juice samples before and after 1% ascorbic acid addition

Organoleptic properties	Samani date juice (control)	Samani date juice+1% ascorbic acid	Zaghloul date juice (control)	Zaghloul date juice+1% ascorbic acid	Hayany date juice (control)	Hayany date juice+1% ascorbic acid	LSD 0.05
Appearance	15.4^{c}	19.7^{a}	14.9^{c}	19.4^{a}	14.3^{d}	18.8^{b}	0.88
Color	15.6^{c}	19.5^{a}	14.7^{d}	19.2^{a}	14.2^{d}	18.6^{b}	0.85
Taste	14.8^{c}	19.6^{a}	14.2^{c}	19.3^{a}	13.8^{cd}	18.5^{b}	1.10
Flavor	16.3^{b}	19.8^{a}	15.6^{bc}	19.5^{a}	15.1^{c}	19.0^{ab}	1.20
Overall acceptability	16.1^{c}	19.4^{a}	15.5^{cd}	19.0^{a}	15.0^{d}	18.7^{b}	0.70
Total	78.2	98.0	74.9	96.4	72.4	93.6	

*Any two means have the same letters at the same raw are not significant at $p \leq 0.05$

Table 6: Microbiological examination for prepared different varieties of date juice samples

	Bacterial counts (log_{10} CFU mL^{-1})				Yeast and mold counts (log_{10} CFU mL^{-1})			
	Storage period (months)				Storage period (months)			
Samples	0	2	4	6	0	2	4	6
Samani date juice (control)	2.13	2.40	2.76	3.09	1.39	1.75	2.09	2.27
Pasteurized Samani date juice	0.30	0.30	0.30	0.30	N.D*	0.47	0.47	0.48
Samani date juice+potassium sorbate	0.47	0.47	0.47	0.47	N.D*	0.30	0.30	0.30
Zaghloul date juice (control)	2.26	2.46	2.84	3.11	1.54	1.87	2.10	2.24
Pasteurized Zaghloul date juice	0.30	0.47	0.47	0.47	N.D*	0.30	0.47	0.47
Zaghloul date juice+potassium sorbate	0.47	0.47	0.47	0.47	N.D*	N.D*	0.30	0.30
Hayany date juice (control)	2.12	2.49	2.78	3.08	1.50	2.06	2.20	2.28
Pasteurized Hayany date juice	0.30	0.30	0.30	0.47	N.D*	0.30	0.30	0.47
Hayany date juice+potassium sorbate	0.47	0.47	0.47	0.47	N.D*	0.30	0.30	0.47

*All data in this table are average of two determinations, *All processed date juice samples in this table were samples of date juice + ascorbic acid at level 1% which selected from the best results of organoleptic properties evaluation. *ND: Not Detected

1.39-2.28 log10 CFU mL^{-1} for all different date juices through the storage period. Pasteurization process caused a reduction in total counts of bacteria until reached to 0.30 log10 CFU mL^{-1} during all the storage periods (6 months) as present in pasteurized Samani date juice. Little increasing in total bacterial counts were observed in pasteurized Zaghloul date juice during all the storage periods. The total bacterial counts were increased in the final storage period (6 months) for pasteurized Hayany date juice. Similar results were observed in potassium sorbate treatment for all different date juice in this study which were little higher than the other pasteurized samples. It was observed that, values of total yeast and mold counts for the different of date juices treated with pasteurization and potassium sorbate were similar at zero storage period. The same trend was found in results of Samani and Hayany juices treated with potassium sorbate during the 6 months. The reduction rate for total yeast and mold counts during the storage period for different date juices were ranged between 73.14-86.36% and between 79.39-86.78% for pasteurization process and potassium sorbate treatment, respectively. Fruit juice can be spoiled due to moulds, lactobacillus, leuconostoc and thermophillic bacillus are common spoilage microorganisms of orange juice[39]. *E. coli*, *Saccharomyces cerevisiae* and *Listeria innocua* are associated with apple juice or apple cider spoliage[40,41]. Thermal treatment is by far the most common method used in food preservation being very effective against enzymes and microorganisms[42]. These outcomes are in concurrence with those published with Piyasena *et al.* [43], Etez-Martinez *et al.*[44], Nguyen and Mittal[45], Mosqueda-Melgar *et al.*[46] and Zhang *et al.*[47].

CONCLUSION

Different varieties of date juices were produced from Zaghloul, Hayany and Samani at khalal stage rich in protein, mineral and total sugars. Addition of ascorbic acids to different date juices at level 1 % slightly increased the total acidity% and all color parameters compared to controls. Addition of 1% ascorbic acid and improved the organoleptic properties for all different date juices. Pasteurization and potassium sorbate when added to date juices reduced total bacterial, yeast and mould counts and increased the storage periods more than 6 months.

SIGNIFICANCE STATEMENT

This study is concerned with the use of Pasteurization and potassium sorbate technology so as to kill microorganisms such as Bacteria and fungi. These two last techniques keep date juices from unacceptable appearance, deterioration in taste, unpleasant flavor and dark in color.

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