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Effect of Microwave Concentration on the Quality of Dibs

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ABSTRACT

Dates are a major fruit crop in Saudi Arabia and its dibs product represents one of the most important products. Local date dibs are produced in some Saudi regions using traditional method which results in products with darker color and a highly turbid. This study aimed at improving the quality of date dibs from two common varieties of data palm (Sufri and Silage). The experiment was designed to optimize extraction, clarification and concentration of date juice using microwave oven at 40, 70 and 100% Power Level (PL). Extraction, clarifying with active charcoal and concentration date juice with microwave at 40 or 70% PL improved the color of date dibs compared to local dibs. Also, the obtained dibs were characterized with its higher viscosity and TSS; and contained higher percentage of glucose and fructose. Storage time and temperature (25 and 45°C) had a little effect on the glucose and fructose levels; variation in viscosity and significant decrease in pH. Also, storage had a significant effect on the browning status of date dibs, the highest (55.34) browning values were found in local dibs. The total bacterial count of microwave concentrated dibs decreased during storage at 25 or 45°C to reach the lowest count after 6 months. The study concluded that, using microwave at 70% PL was able to improve physicochemical and microbiological properties of date dibs.

Key words: Date palm, microwave, date syrup, dibs, clarified juice, charcoal

INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is one of the oldest fruit trees that play a major role in life of Saudi Arabians. World production of dates increased largely during the last three decades, where it reached to 1839908, 2685466, 6670862 and 7857456 tons in 1963, 1983, 2003 and 2010, respectively (FAOSTAT, 2012). Date trees are spread in the hot arid area and it has always played an important part in the economic and social lives of the people of these regions. Date fruit is marketed all over the world as a high value confectionery and as a fresh fruit it remains an important subsistence crop in most of the desert areas. Date fruit is cherished as a high value confectionery, as a fresh fruit and it represent one of the most important crop in the desert areas (Erskine *et al.*, 2012).

Date palm fruits are well known as a staple food. Fruit is composed of a fleshy pericarp and seed. Erskine *et al.* (2012) stated that, dates are rich in sugar ranging from 65% to 80% on dry weight basis mostly of inverted form (glucose and fructose). Fresh varieties has a higher content of inverted sugars, the semi dried varieties contain equal amount of inverted and sucrose, while dried varieties contain higher sucrose. Water content is between 7% (dried) and 79% (fresh) depending on variety. The chemical composition and nutritional value of date flesh have been reported (Mohammed *et al.*, 1983; Fayadh and Al-Showiman, 1990; Al-Hooti *et al.*, 1995; Besbes *et al.*, 2004), however, these were focused on their chemical composition only and not their thermal and sensory properties.

Production of Date fruit in Saudi Arabia was about 829,000 tones in 2002 and most of this quantity is consumed internally after traditional packaging. There is a surplus of several thousand tones and, especially in the near future, this will increase substantially. This extra quantity needs processing in some way. At the present, just 6% of the total production is processed in modern factories. The major products in these factories are packed date and date paste which represents 80 and 8.6% of total processed amount, respectively and small quantities of other products such as dibs (date syrup), date jam and date vinegar (Ministry of Agriculture, 2005, 2006). Date dibs are characterized with its higher calories, vitamins and minerals and it could be used at industrial scale as a sweetener in bakeries, syrup and juice products. Barreveld (1993) studied the physicochemical characteristics of date dibs and he stated that, date dibs contains 76% TSS, 69.2% inverted sugar, 3.14% sucrose, 0.60% pectin, 1.80% ash and 4.14 pH. Date dibs are mostly produced by tradition method in some Saudi regions. The obtained dibs are characterized with its darker color and it's highly turbidity and consumed locally after dilution (Ali *et al.*, 1995). The processing of date dibs involves three stages namely, extraction of date juice with water, filtration and concentration (El-Shaarawy *et al.*, 1986; Al-Jasser, 1990). Benjamin *et al.* (1982) reported that, the yield of dibs could be maximized to reach 96% if seedless date palm crushed and cooked at 85°C for 50 min but the quality of dibs was affected. Abd-Elfatah (1994) found that, using apparatus of direct heating under atmospheric pressure to concentrate date palm juice gave low quality product due to sugar caramelization. Furthermore, Ramadan (1998) stated that, date palm dibs characterized with its higher stability during storage than sugar cane dibs.

The field and post-harvest losses of date fruits are high and utilization of date products need improvement especially in date dibs product. Therefore, this study aimed to improve the yield and quality of date dibs of two common palm dates varieties (Sufri and Silage).

MATERIALS AND METHODS

Date palm fruits: Two varieties of date palm fruits (Sufri and Silage) were obtained from date palm packaging company Al-Hassa, East of Saudi Arabia Kingdom. Date palm fruits were packed in polyethylene bags and carton box and kept in a deep freezer at -18°C.

Processing of date dibs: Date palm fruits (Sufri and Silage varieties) were soaked, washed in water and then air dried. The seeds were isolated from date palm fruits using mechanical separator of date palm seeds in Omar Asaad company for date palm, El-Madina El-Menawara city and then subjected to prepare date dibs as in Fig. 1. The obtained concentrated date syrup (dibs) were packaged in polyethylene pack and stored separately at three temperatures 5, 25 and 45°C, respectively for 6 months.

Physicochemical analysis of date dibs: Moisture content, pH, ash and total soluble solids were determined using the standard methods according to AOAC (1995). Pectin was determined as described by Carre and Haynes (1922). Fructose, glucose and sucrose were determined according to the methods of AOAC (1995) by using HPLC (Model 10AD, Japan) at the following conditions: detector was Refractive Index (RID-6A), column was 30 cm 15 (6 mm×cm) Shimpack LC-NH2, mobile phase was acetonitrile: H_2O (75:25) and its flow rate was at 2 mL min^{-1}.

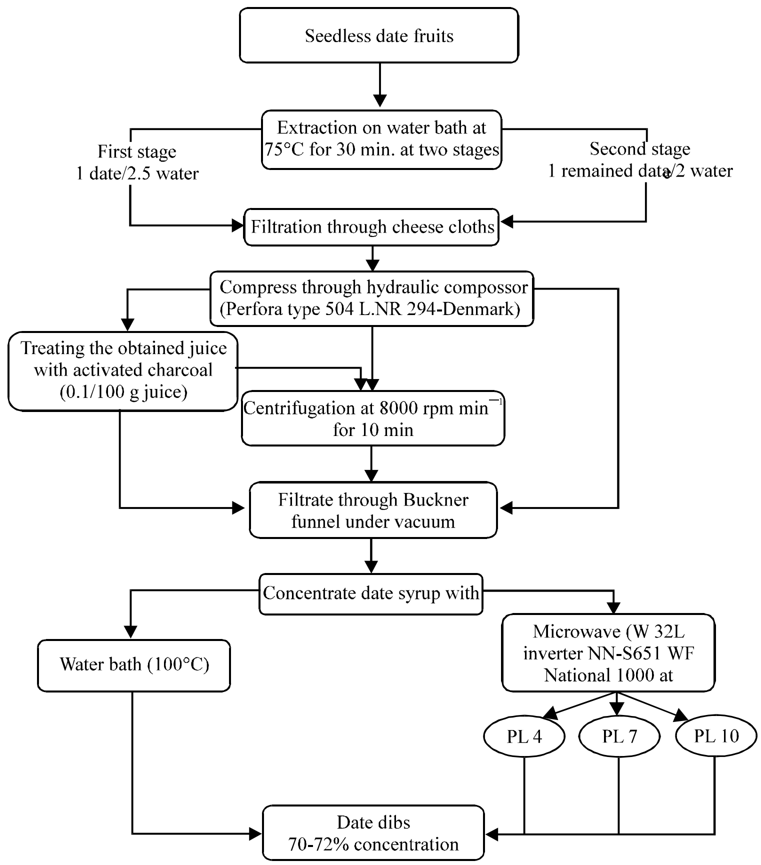

Fig. 1: Flow chart of preparing date dibs on laboratory scale

Viscosity was determined using viscometer (model Lvdv11, Brookfield, Stoughton, USA). Color of date dibs samples was determined using Hunter color machine (Minolta Chroma Meter CR-300-Japan). Hunter color parameters (L, a and b) were measured in the reflection mode. The instrument was standardized each time with white tile of Hunter Lab Color Standard (LX No. 16379). Delta E was calculated from a, b and L parameters using Hunter-Scotfield equation (Hunter, 1975) as follows:

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

where, $a-a_0$, $b-b_0$ and $L-L_0$, subscript "0" indicates color of control or untreated sample.

The Hue (H)*, chroma (C)* and Browning Index (BI) were calculated according to the method of Maskan (2001).

Sensory evaluation of date dibs: Sensory evaluation was carried out using two tests; the first one was Simple Ranking Test (Meilgaard *et al*., 1991). In this experiment 5 samples were introduced to 15 trained people from department of food sciences and nutrition, Faculty of Food and Agriculture, Saudi University. They were asked to arrange the samples according to their preferences, where the best samples numerated as No. 1 and the followed sample take No. 2 ... etc. The sensory evaluation parameters were color, taste, flavor and consistency.

The second sensory evaluation test was Scoring Test (Larmond, 1980) that carried out during dibs storage. Dibs samples were randomly introduced to the same trained panelist to evaluate color, flavor and general acceptance of stored dibs samples, where the excellent, very good, good-accepted and unaccepted scores were 9, 7, 4 and 1, respectively.

Microbiological analysis of date dibs: Microbiological tests were carried out in dibs samples produced from Sufri, Silage and local product that stored for 6 months as stated by Vanderzant and Splittstoesser (1992). The experiments include; Total Plate Count (TPC) of mold and yeast and osmophilc yeast.

Statistical analysis: Statistical analysis were carried out using analysis of variance (ANOVA), Duncan's New Multiple Range Test to identify least significance differences between the mean value at $p \leq 0.05$ (McClave and Benson, 1991).

RESULTS AND DISCUSSION

Extraction of date palm juice was evaluated at two stages. Table 1 showed that, the first extraction stage (1:2.5 date/water at 75°C for 15 min) of date juice (Sufri class) contained 23.86% Total Soluble Solids (TSS) and continuing extraction for the second stage on the remaining dates for a period of 15 min (1:2 remained date/water) led to extract juice containing 7.33% TSS. On the other hand, increasing extraction time to 30 min. for first and second extraction stages were accompanied by a simple addition in the percentage of TSS reached to 25.30 and 8.43%, respectively. The obtained results agreed with those reported by Benjamin *et al.* (1982).

Date palm fruits contain some pigments responsible for the colors during growth stages, such as chlorophyll, anthocyanins, leucosyanidin and zanthovel. Large portion of these pigments could be extracted during juice extraction from fruits, thus the color density of the juices may changed depending on condition of extraction, filtration and concentration (Al-Hekhady, 2000). The effect of some filters speed and centrifugation on extracted date juice (Sufri class) with hot water (75°C) was studied to improve its color properties. Table 2 filter paper impact on the removal of turbidity and impurities if compared with the unfiltered sample (control), where whiteness (L) score of the filtrated date juice samples were 24.08, 24.06 and 23.93 using slow, medium and speed filter paper, respectively. Also, redness (a) and yellowness (b) scores were less dark in filtrated juice than unfiltered samples. This can be explained by small porosity of filter paper which contributes to separate more material that affect the color and degree of date juice purity.

Table 2 showed also the centrifugal effect on the color quality of date juice, where the color scores (L, a and b) of date juice has increased following the increase in centrifuges to 3000 and 8000 rpm, while 13000 rpm did not have any effect on the color scores (L, a, b). This result could be explained by the ability of centrifugal deposition of suspended particles on the juice which facilitates the disposal of it and access to the net juice color to some extent.

Table 1: Effect of extraction palm juice (Sufri class) on its total soluble solids (TSS)

Date:water	Extraction time (min)	TSS (%)	Date juice weight (kg)	Remained date weight (kg)
1:2.5	15	23.86±0.15	2.881±0.078	0.465±0.009
	30	25.30±0.34	2.785±0.094	0.449±0.035
1:2	15	7.33±0.20	1.864±0.007	0.438±0.022
	30	8.43±0.05	1.825±0.027	0.432±0.022

Value are Mean±SD of three replicates

Table 2: Effect of filter paper, centrifuge speed for 10 min and charcoal on the color quality of date juice (Sufri class)

	Color		
Parameter	L	a	b
Filter paper			
Unfiltrated (Control)	23.14±0.06	1.52±0.05	4.03±0.14
Whatman No. 4 (fast)	23.93±0.04	2.67±0.02	5.85±0.11
Whatman No. 2 (medium)	24.06±0.37	2.86±0.08	5.82±0.25
Whatman No. 5 (slow)	24.08±0.24	2.81±0.04	5.75±0.27
Centrifugation speed			
Control	23.14±0.06	1.52±0.05	4.03±0.14
3000 rpm	23.95±0.14	2.73±0.11	5.20±0.03
8000 rpm	24.34±0.27	3.04±0.08	5.63±0.14
13000 rpm	24.30±0.00	3.51±0.11	6.22±0.22
Charcoal (g/100 g juice)			
Control	24.08±0.03	2.86±0.03	5.82±0.04
0.1	24.66±0.16	2.95±0.13	5.96±0.18
0.4	25.32±0.70	3.02±0.30	6.09±0.31
0.7	25.45±0.04	3.04±0.16	6.17±0.19

Value Mean±SD of three replicates, L: White (100) to black (-80), a: Red (100) to green (-80), b: Yellow (70) to blue (-80)

Table 3: Effect of microwave concentration at different power level on the concentration rate and yield of date dibs (Sufri class)

	Power level (%)			
Date dips properties	40	70	10	LSD at $p \geq 0.01$
Yield (%)	31.00±1.32[a]	28.60±0.36[b]	27.97±1.10[b]	2.053
TSS (%)	70.60±0.96	70.63±0.30	72.03±0.40	ns
Water evaporated (%)	69.00±1.32[b]	71.40±0.36[a/]	72.03±1.10[a]	2.053
Concentration rate (100 g min^{-1})	10.00±0.29[b]	6.50±0.29[a]	5.50±0.00[a]	1.158

Values are Mean±SD of three replicates, ns: Not significant, Yield (%) = % of dibs resulting from 25% TSS date juice, Values in each row having different letters are significant at $p \geq 0.05$

The effect of charcoal to limit juice color in order to improve the transparency and color of the juice was also studied. Table 2 showed that, the use of three quantities of activated charcoal 0.1 and 0.4 and 0.7 g/100 g juice may increase whiteness values (L) of date juice to reach 24.66 and 25.32 and 25.45, respectively, indicating slight improvement in the degree of purity of the date juice color, i.e., the previous three charcoal quantity increased to 2.4 and 5.1 and 5.7% if referred to control sample, respectively. There was also a slight improvement in the color parameters (a and b). These results are consistent with those noted by Benjamin and Zubair (1973) that the treatment of active charcoal dates juice has improved the color of dibs. Mohamed and Ahmed (1981) also found that, the treatment of active charcoal to dates juice may adsorb part of the vehicle color and they recommended removing the remaining with suitable chemicals. Also, Ibrahim and Khalif (2004) stated that the active charcoal can be used to improve the color of date juice to remove a section of the turbidity-causing substances.

Microwave was used at three power levels (40, 70 and 100%) to reach to dibs contains 70-72% TSS.

Table 3 showed that, increasing the power level of microwave was accompanied by an increase in the rate of concentration, where 100 g date juice required for the concentration 10, 6.5 and

Table 4: Effect of microwave concentration at different power level on color parameter of date dibs that not treated or treated with active charcoal

	Color		
Power level	L	a	b
Silage			
Microwave			
PL 40%	21.60[b]	1.01[b]	2.43[b]
PL 70%	21.56[b]	0.97[b]	2.59[b]
PL 100%	18.94[c]	1.33[a]	3.42[a]
Charcoal+microwave			
PL 40%	21.96[a]	0.54[c]	2.39[b]
PL 70%	21.91[a]	0.70[c]	2.84[a]
PL 100%	21.66[b]	0.86[b]	2.59[b]
Sufri			
Microwave			
PL 40%	21.87[a]	0.64[b]	2.04[c]
PL 70%	21.40[b]	0.45[c]	2.22[b]
PL 100%	21.38[b]	0.77[c]	2.08[bc]
Charcoal+microwave			
PL 40%	23.18[a]	0.42[c]	2.14[bc]
PL 70%	23.05[a]	0.49[c]	2.36[b]
PL 100%	22.54[ab]	0.50[c]	2.40[b]
Local dibs	21.38[b]	0.24[d]	2.45[b]

Values in each column having different letters are significant at $p \geq 0.05$, L: White (100) to black (-80), a: Red (100) to green (-80), b: Yellow (70) to blue (-80)

5.5 min at power levels 40, 70 and 100%, respectively. Therefore, we can say that the use of 100% power level led to the highest concentration due to the influence of microwave energy on all parts of the date juice at one time and thus facilitated the movement of water vapor out of juice within the center to the external surfaces which helps to reduce the time of concentration. This result agreed with those obtained by Ali *et al.* (1995), who explained that, using the full (100%) energy of microwave led to highest temperature and high concentration rate in date juice for dibs production.

Date Juices contain some pigments that may change depending on the density during concentration, in addition to the compounds responsible for browning as a result of chemical reactions that occur during concentration at high temperature. Therefore, date juice (Silage and Sufri classes) was selected to study the effect of concentration date juice with microwave at different power levels and they compared with local dibs that are concentrated with boiling.

Table 4 showed that there was no significant difference in the whiteness score (L) for different Power Levels (PL) that used to concentrate dates dibs (Silage class) but there was a slight difference in case of using microwave at power level 40%, where L was 21.60, while the darker color of dibs was found at power level 100% where L decreased to 18.94. The same trend was also observed in redness (a) and yellowness (b) of concentrated date dibs with microwave, where (a) and (b) of concentrated dibs at full power level (100%) was higher than those concentrated at 40 and 70% PL. This result agreed with Maskan (2006) who found that the concentration of pomegranate juice leads to a darker color. The obtained results of Silage class were agreed with Sufri class. These results could be explained by the changes in juice during heating with microwave that lead to

Table 5: Effect of date juice concentration on some physicochemical properties of date dibs

	Physicochemical parameters									
Dibs	Moisture (%)	Viscosity (cmp)	TSS (%)	TS (%)	pH	Pectin (%)	Suc. (%)	Glucose (%)	Fructose (%)	Ash (%)
Local	16.36 ± 0.29^{d}	1503.3 ± 7.63^{a}	80.36 ± 0.23^{a}	83.64 ± 0.29^{a}	4.65 ± 0.01^{e}	0.88 ± 0.01^{a}	ND	35.33 ± 0.50^{a}	43.02 ± 0.38^{a}	1.88 ± 0.01^{a}
Silage										
40% PL	25.09 ± 0.31^{a}	110.63 ± 3.57^{d}	70.66 ± 0.05^{d}	74.57 ± 0.48^{d}	4.83 ± 0.00^{a}	0.26 ± 0.00^{c}	ND	31.40 ± 0.80^{bc}	38.14 ± 0.02^{c}	1.59 ± 0.02^{b}
70	23.77 ± 0.06^{bc}	141.36 ± 15.01^{c}	71.20 ± 0.00^{c}	76.22 ± 0.06^{bc}	4.68 ± 0.00^{c}	0.25 ± 0.01^{c}	ND	32.00 ± 0.38^{b}	38.11 ± 0.38^{c}	1.43 ± 0.03^{d}
100	23.24 ± 0.38^{c}	161.90 ± 0.30^{b}	72.03 ± 0.05^{b}	76.76 ± 0.38^{b}	4.66 ± 0.00^{d}	0.24 ± 0.01^{c}	ND	30.22 ± 1.05^{c}	40.64 ± 0.21^{b}	1.41 ± 0.02^{d}
Sufri										
40% PL	25.62 ± 0.47^{a}	115.13 ± 2.83^{d}	70.53 ± 0.11^{e}	74.37 ± 0.47^{d}	5.28 ± 0.01^{c}	0.65 ± 0.01^{b}	ND	32.00 ± 0.62^{c}	36.84 ± 0.31^{c}	1.72 ± 0.03^{d}
70%PL	24.58 ± 0.79^{ab}	110.10 ± 4.40^{d}	71.46 ± 0.05^{c}	76.16 ± 0.64^{bc}	5.34 ± 0.01^{b}	0.65 ± 0.04^{b}	ND	38.04 ± 0.19^{a}	37.39 ± 0.39^{b}	1.67 ± 0.01^{e}
100% PL	23.84 ± 0.64^{b}	116.16 ± 2.51^{d}	72.03 ± 0.05^{b}	75.42 ± 0.79^{c}	5.41 ± 0.01^{a}	0.65 ± 0.03^{b}	ND	32.34 ± 0.27^{c}	38.04 ± 0.96^{b}	1.65 ± 0.02^{e}

Value are Mean±SD of three replicates, having different letters in each column are significant at $p\geq0.05\%$, Suc.: Sucrose, ND: Not detected, PL: Power level

decompose some pigments i.e., anthocyanin with other phenols. These findings agreed with the conclusion of Ancos *et al.* (1999), who stated that microwaves heating have a minor effect on the fruits color (**β**-carotene and anthocyanin) and increasing power level rate is not essential to affect on the color.

Table 4 showed the effect of microwave concentration method on the date dibs color after treating with active charcoal. The results showed that, lightness (L), redness (a) and yellowness (b) scores of dates dibs that treated with active charcoal and concentrated with microwave at different power levels were higher than date dibs that were not treated with charcoal and concentrated with microwave at the same power level, where L value increased and a and b values decreased in treated date dibs with charcoal of both Silage and Sufri classes compared to the same sample of untreated date dibs.

Table 5 shows the effect of microwave concentration method on the physicochemical properties of date dibs. The obtained result indicated that local date dibs contain the lowest moisture content for using a higher temperature during concentration, while concentration date dibs with microwave at higher PL (7 and 10) gave lower moisture content when compared with 4 PL. This result could be explained by the ability of microwave waves to make a vibration between water molecules results in temperature in all parts of the depths of a food item at a time and thus the temperature at all distances equal to the internal juice (Finot and Merabet, 1993).

Viscosity is one of the quality factors in date dibs manufacture. Juices viscosity is due to the colloidal properties of fruit, e.g., pectin, protein and gum in addition to the viscosity of the sugars (Al-Hekhady, 2002). Table 5 showed that, significant higher viscosity of date dibs was found at higher microwave power levels (70 and 100%). This result could be explained by the inverse relationship between viscosity and moisture content, i.e. the more decreased moisture content in the sample is the more concentration to TSS and TS, resulting in an increase in the value of the viscosity of date dibs. The results of all date dibs treatments were within acceptable limits of TSS as recommended by Saudi Standards (2005) which states that the proportion of TSS in the date dibs should not be less than 70%. The obtained results showed also that, date dibs were characterized with its higher percentage of glucose and fructose.

Date dibs concentrated using microwave at 70% power level were studied microbiology and compared with a random sample of local dibs during storage at different periods (up to 6 months)

Table 6: Effect of storage period and temperature on a number of bacteria and yeasts in date dibs concentrated with microwave at power level 70%

		Temperature of storage					
	Storage	5°C		25°C		45°C	
Dibs classes	period (month)	Log TPC	Log OSMO	Log TPC	Log OSMO	Log TPC	Log OSMO
Sufri	0	1.98±0.01	0	1.98±0.01	0	1.98±0.01	0
	2	1.16±0.02	0	1.17±0.12	0	0.39±0.12	0
	4	1.11±0.27	0	0.60±0.15	0	0	0
	6	1.14±0.04	0	0	0	0	0
Silage	0	1.60±0.34	0	1.60±0.34	0	1.60±0.34	0
	2	1.23±0.15	0	0.65±0.06	0	0.81±0.37	0
	4	1.08±0.05	0	0.39±0.12	0	0	0
	6	0.98±0.03	0	0	0	0	0
Local	0	1.54±0.08	0	1.54±0.08	0	1.54±0.08	0
	2	1.57±0.08	1.30±0.01	1.56±0.01	1.11±0.09	1.06±0.07	0
	4	*	1.13±0.16	*	0.30±0	0.60±0.42	0
	6	1.51±0.01	1.06±0.13	1.56±0.01	0.47±0.21	0	0

* Spread, TPC: Total plate count, cu: Colony unit mL^{-1}, OSMO: Yeasts loving the high concentration of sugar, Value are Mean±SD of three replicates

and at different temperatures (5, 25, 45°C) that have been selected to match the temperatures actually used during the handling and storage of some materials food, including date dibs. Table 6 showed that, at the beginning of storage Total Bacteria Count (TPC) of date dibs class Sufri was higher than Silage and local dibs. During Sufri dibs storage at 5°C, Total Bacterial Count (TPC) decreased slightly without significant differences to 1.16, 1.11 and 1.14 Log cu mL^{-1} after 2, 4 and 6 months, respectively. The same trend was also observed during storing Silage dibs and local dibs. Decreasing the total number of bacteria during storage could be explained by the lack of optimal conditions for the growth and increasing numbers of bacteria as a result of the high concentration of date dibs, where osmotic pressure on cell walls of microbial role in decreasing the activity and killing large numbers of bacteria. Also, total bacterial count in date dibs decreased during storage at 25 or 45°C to reach the lowest count after 6 months. This result could be explained by the effect of temperature and osmotic pressure on the microbial plasma cells and inhibition of its activity and kill it. This explanation confirmed by the Korber *et al*. (1996) which reviewed a number of studies on the effect of osmotic pressure on the bacteria, where they stated that high concentrations solutions lead to morphological changes on a wide range of bacteria and most important of these changes deflation in the cytoplasm of the cell which leads to loss of water.

Effects of storage conditions on the osmophilic yeast count in date dibs were also studied as shown in Table 6. The obtained results showed that osmophilic yeast was not detected in date dibs of Sufri and Silage varieties during processing and storage. It was also observed that, local date dibs contained a number of osmophilic yeast during storage at 5 and 25°C, while storage at a higher temperature (45°C) decreased osmophilic yeast count to reach 0 cu mL^{-1} after 6 months. These results could be explained by the high sugars and low humidity percentage in date dibs, especially after storage at elevated temperatures. Also, Microbiological analysis of date dibs (Sufri, Silage classes and local dibs) showed that there were no growth yeasts and molds during storage periods at 5, 25 and 45°C. This may be due to the heat treatment used in the concentration of date juice to get date dibs and in accordance with Morsi and Al-Sahn, 2003 they explained that food concentration at high temperature (100°C or higher) able to destroy bacteria but bacteria spores not destroyed.

Storage periods have a clear effect on the browning status of date dibs. Table 7 showed that there were significant differences between their browning values for different storage periods at 5°C. The highest browning values for all samples under study were found in local, Sufri and Silage date dibs samples that stored for 4 months (55.34 and 39.47 and 23.97, respectively). There were significant differences in the browning values of local dibs as a result of storage periods at 25 and 45°C. The highest brown coloration was noted in the local dibs that stored for 2 months at 25°C (15.45±0.36). Also, browning values was higher in Sufri dibs stored for 2 months at 25°C (12.82±0.28) and at the beginning of storage at 45°C (11.17±0.56). Browning values of local, Sufri and Silage dibs stored at 45°C were decreased gradually by increasing storage time.

Table 7 showed that, there were significant differences in the measurement of hue angle as a result of storage time at 5, 25, 45°C in dibs samples under study. The highest hue angle was found at the beginning of storage, this may be attributed to the occurrence of browning reactions.

The highest chroma values (intensity of color) in dibs samples under study was found during storage at 5°C for different periods up to 4 months and in that they change the pattern of similarity with the values of browning. While during storage at 25°C it was observed that the highest chroma were found in local and Sufri dibs after 2 months and Silage dibs at the beginning of storage. Gradual decline in chroma values for different storage periods were observed for all samples under study during storage at 45°C.

The highest color difference (ΔE) values in all dibs samples under study attributed to storage at 5°C for 4 months and in that they change the pattern of similarity with the values of browning and chroma. While during storage at 25°C, the higher color difference (ΔE) was found after 6 months in local dibs and after 4 months in Silage and Sufri dibs.

Table 8 showed the effect of storage period and temperature on physicochemical properties of Sufri dibs that concentrated with microwave at 70% PL. The obtained results indicated that, the percentage of fructose in Sufri dibs ranged between 32.94-36.19, 36.19-36.91 and 36.19-38.52 during storage at 5, 25 and 45°C, respectively. While the percentage of glucose ranged between 28.20-33.79, 33.79-34.57 and 33.79-34.89 during storage at 5, 25 and 45°C, respectively. Hence, we can conclude that the storage periods and temperatures had little effect on the percentage of sugars (glucose and fructose). Slight decreasing of glucose and fructose during storage at 5°C, may be due to crystallization of some of these simple sugars, while this does not happen during storage at 25 and 45°C. This may mean that storage at high temperatures (25 and 45°C) prevents the union of glucose and fructose at high acidity.

Table 8 indicated also that, Total Soluble Solids (TSS) ranged between (70.90-71.63%), (71.63-73.13%) and (71.63-75.06%) during storage at 5, 25 and 45°C, respectively and viscosity ranged between (36.14-118.46 cp), (57.20-118.46 cp) and (69.20-118.46 cp) during storage at 5, 25 and 45°C, respectively. Results showed that there was variation in the viscosity; this variation could be due to the influence of several factors such as pectin ratio, temperature, presence of impurities or sediments in dibs sample. Values of pH ranged between (4.97-5.03), (4.78-5.01) and (2.4-1.5) during storage at 5, 25 and 45°C, respectively. These values indicated that there was significant decrease in pH during storage at 45°C. Also, a significant decrease was observed in pH during storage at 25°C at the end of storage compared to onset. Furthermore, it was noticed that there is a slight decrease in the weight of Sufri dibs but a slight drop does not mention with the length of storage period as a result of moisture loss.

Table 7: Effect of storage periods and temperature on color characteristics of date dibs concentrated by microwave at 70% power level

		Storage temp. (°C)											
	Storage periods	5				25				45			
Dibs	(month)	Browning	Hue angle	Chroma	ΔE	Browning	Hue angle	Chroma	ΔE	Browning	Hue angle	Chroma	ΔE
Local	0	12.77±0.30^{Da}	1.47±0.01^{Aa}	2.46±0.04^{Da}	21.52±0.10^{Da}	12.77±0.30^{Ba}	1.47±0.01^{Aa}	2.46±0.04^{Ba}	21.52±0.10^{Da}	12.77±0.30^{Aa}	1.47±0.01^{Aa}	2.46±0.04^{Aa}	21.52±0.10^{Ba}
	2	23.96±0.71^{Ca}	1.21±0.02^{Bc}	4.28±0.11^{Ca}	23.05±0.12^{Ca}	15.45±0.36^{Ab}	1.38±0.01^{Bb}	2.90±0.07^{Ab}	22.15±0.21^{Cb}	10.66±0.42^{Bc}	1.48±0.01^{Aa}	2.06±0.06^{Bc}	21.13±0.06^{Cc}
	4	55.34±1.94^{Aa}	0.95±0.01^{Cba}	11.43±0.40^{Aa}	30.97±0.44^{Aa}	8.88±0.41^{Db}	1.10±0.05^{Ca}	1.71±0.05^{Db}	23.76±0.12^{Bb}	3.35±0.18^{Cc}	0.79±0.13^{Bb}	0.64±0.02^{Cc}	23.16±0.14^{Ac}
	6	46.18±1.91^{Ba}	0.91±0.01^{Db}	9.42±0.39^{Ba}	29.19±0.23^{Ba}	10.90±0.84^{Cb}	1.01±0.05^{Da}	2.11±0.16^{Cb}	24.23±0.15^{Ab}	2.74±0.24^{Dc}	0.29±0.02^{Cc}	0.64±0.06^{Cc}	22.81±0.32^{Ac}
Sufri	0	11.17±0.56^{Ca}	1.43±0.02^{Aa}	2.13±0.08^{Ca}	21.42±0.15^{Ca}	11.17±0.56^{Ba}	1.43±0.02^{Aa}	2.13±0.08^{Ba}	21.42±0.15^{cA}	11.17±0.56^{Aa}	1.43±0.02^{Aa}	2.13±0.08^{Aa}	21.42±0.15^{Ca}
	2	10.56±0.57^{Cb}	1.26±0.04^{Bb}	1.90±0.12^{Cb}	21.55±0.13^{Ca}	12.82±0.28^{Aa}	1.33±0.03^{Aba}	2.33±0.03^{Aa}	21.44±0.08^{Ca}	7.53±0.83^{Ac}	1.40±0.04^{Aa}	1.39±0.17^{Bc}	20.76±0.04^{Db}
	4	39.47±0.62^{Aa}	0.95±0.00^{Ca}	7.93±0.10^{Aa}	28.08±0.03^{Aa}	4.08±0.95^{Db}	0.78±0.21^{Ca}	0.79±0.14^{Db}	23.39±0.26^{Ab}	2.77±0.36^{Cb}	0.77±0.01^{Ba}	0.52±0.06^{Cc}	22.64±0.03^{Ac}
	6	18.90±0.89^{Ba}	0.92±0.04^{Cb}	3.59±0.16^{Ba}	24.42±0.04^{Ba}	5.27±0.44^{Cb}	1.11±0.02^{Ba}	1.00±0.08^{Cb}	23.05±0.04^{Bb}	2.46±0.37^{Cc}	0.59±0.05^{Cc}	0.48±0.07^{Cc}	22.36±0.17^{Bc}
Silage	0	13.37±0.10^{Ba}	1.38±0.05^{Aa}	2.44±0.06^{CBa}	21.27±0.01^{Da}	13.37±0.10^{Aa}	1.38±0.05^{Aa}	2.44±0.06^{Aa}	21.27±0.01^{Da}	13.37±0.10^{Aa}	1.38±0.05^{Aa}	2.44±0.06^{Aa}	21.27±0.01^{Ca}
	2	11.19±0.96^{Cb}	1.36±0.02^{Aa}	2.12±0.17^{Ca}	21.94±0.21^{Ca}	12.04±0.17^{Bba}	1.31±0.02^{Aba}	2.17±0.04^{Ba}	21.51±0.05^{Cb}	13.08±0.97^{Aa}	1.25±0.04^{Ab}	2.25±0.14^{Ba}	20.91±0.110^{Ab}
	4	23.97±1.70^{Aa}	0.94±0.03^{Ba}	4.61±0.35^{Aa}	25.22±0.35^{Aa}	7.90±0.38^{Cb}	0.94±0.02^{Ba}	1.48±0.07^{Cb}	23.34±0.01^{Ab}	2.73±0.27^{Bc}	0.42±0.09^{Bb}	0.59±0.03^{Cc}	23.10±0.12^{Ab}
	6	13.52±0.27^{Ba}	0.95±0.00^{Ba}	2.55±0.05^{Ba}	23.85±0.11^{Ba}	6.13±0.24^{Db}	0.94±0.08^{Ba}	1.15±0.04^{Db}	23.20±0.10^{Bb}	2.82±0.13^{Bc}	0.60±0.17^{Bb}	0.56±0.05^{Cc}	22.88±0.06^{Bc}

Value are Mean±SD of three replicates, Values in each column and row having different capital and small case letters are significant at $p \geq 0.05$, respectively

Table 8: Effect of storage period and temperature on the physicochemical characteristics of microwave concentrated (70% PL) Sufri dibs

Storage (month)	Fructose (%)	Glucose (%)	Viscosity (cp)	pH	TSS (%)	Weight (g)
5°C						
0	36.19±0.15^{A}	33.79±0.15^{A}	118.46±0.85^{A}	5.01±0.00^{b}	71.63±0.15^{a}	100.00±0.00^{a}
2	36.14±0.48^{Ab}	33.60±0.48^{Aa}	56.60±0.30^{Bb}	4.97±0.00^{Ca}	71.40±0.51^{BAb}	99.94±0.06^{ABa}
4	32.94±0.93^{Bb}	28.51±0.21^{Cb}	36.30±0.45^{Cc}	5.03±0.00^{Aa}	70.90±0.20^{Bc}	99.89±0.04^{Ba}
6	33.57±0.23^{Bc}	28.20±0.18^{Bb}	36.14±4.34^{Cc}	5.02±0.01^{Aa}	71.36±0.15^{Ac}	99.42±0.13^{Ca}
25°C						
0	36.19±0.15^{B}	33.79±0.15^{A}	118.46±0.85^{A}	5.01±0.00^{A}	71.63±0.15^{B}	100.00±0.00^{A}
2	36.36±0.18^{Ba}	33.84±0.18^{Aba}	57.20±0.30^{Db}	4.85±0.00^{Bb}	71.86±0.15^{Bb}	99.80±0.20^{ABb}
4	36.60±0.20^{ABba}	34.20±0.27^{Ab}	64.73±0.35^{Cb}	4.84±0.01^{Bb}	72.46±0.15^{Ab}	99.59±0.34^{Bab}
6	36.91±0.60^{Ab}	34.57±0.78^{Aa}	73.93±0.41^{Bb}	4.78±0.01^{Cb}	73.13±0.66^{Ab}	99.29±0.19^{Ba}
45°C						
0	36.19±0.15^{D}	33.79±0.15^{a}	118.46±0.85^{b}	5.01±0.00^{a}	71.63±0.15^{D}	100.00±0.00^{A}
2	36.74±0.23^{Ca}	34.27±0.22^{Aa}	69.20±0.45^{Da}	4.27±0.00^{Bc}	72.66±0.11^{Ca}	99.12±0.49^{Ac}
4	37.19±0.13^{Ba}	34.76±0.14^{Aa}	73.10±0.30^{Ca}	4.14±0.01^{Cc}	73.60±0.26^{Ab}	98.37±0.40^{Bb}
6	38.52±0.10^{Aa}	34.89±1.74^{Aa}	23.88±3.81^{Aa}	4.02±0.01^{Dc}	75.06±0.05^{Aa}	98.16±0.19^{Bb}

Values are Mean±SD of three replicates, Values in each column and row having different capital and small letters are significant at $p \geq 0.05$, respectively

Table 9: Effect of storage period and temperature on the physicochemical characteristics of local dibs

Storage (month)	Fructose (%)	Glucose (%)	Viscosity (cp)	pH	TSS (%)	Weight (g)
5°C						
0	43.41±0.83	35.30±0.22^{b}	1503.00±7.63^{a}	4.65±0.01^{a}	80.36±0.23^{b}	100.00±0.00^{a}
2	35.43±0.87^{Bab}	35.43±0.87^{Ba}	1344.00±2.64^{Ba}	4.64±0.00^{Aa}	80.16±0.87^{Bb}	99.98±0.02^{ABa}
4	35.62±0.08^{Bb}	35.62±0.56^{Bb}	979.66±17.55^{Ca}	4.55±0.00^{Ba}	80.83±0.05^{Bb}	99.94±0.04^{Ba}
6	43.74±0.25^{Aa}	36.27±0.25^{Aa}	597.00±17.76^{Dc}	4.53±0.00^{Ca}	81.66±0.25^{Ab}	99.83±0.03^{Ca}
25°C						
0	43.41±0.83	35.30±0.22^{b}	1503±7.63^{a}	4.65±0.01	80.36±0.23	100.00±0.00^{a}
2	35.33±0.58^{Bb}	35.33±0.58^{Ba}	798±22.11^{Cc}	4.51±0.00^{Bb}	79.33±0.57^{Cb}	99.93±0.07^{Ab}
4	35.75±0.26^{Ba}	35.75±0.25^{Bb}	707±7.81^{Db}	4.52±0.01^{Bb}	80.36±0.25^{Bb}	99.87±0.02^{Bb}
6	43.53±0.59^{Aa}	36.48±0.38^{Aa}	1151±20.55^{Bb}	4.46±0.01^{Cb}	81.43±0.40^{Ab}	99.77±0.08^{Ca}
45°C						
0	43.41±0.83	35.30±0.22^{d}	1503.00±7.63^{b}	4.65±0.01^{a}	80.36±0.23^{c}	100.00±0.00^{a}
2	36.15±0.25^{Ca}	36.15±0.25^{Ca}	969.86±9.60^{Cb}	4.31±0.01^{Bc}	81.46±0.25^{Ab}	99.87±0.03^{Bc}
4	37.93±5.98^{Ba}	37.93±0.40^{Ba}	677.66±5.50^{Dc}	4.13±0.01^{Cc}	81.40±0.43^{Ab}	99.42±0.10^{Cc}
6	37.12±0.73^{Bb}	37.12±1.20^{Ba}	1840.00±73.45^{Aa}	4.00±0.00^{Dc}	83.36±0.77^{Aa}	98.29±0.40^{Db}

Value are Mean±SD of three replicates, Values in each column and row having different capital and small case letters are significant at $p \geq 0.05$, respectively

On the other hand, the effect of storage period and temperature on physicochemical properties of local date dibs was studied. Table 9 indicated that, the percentage of fructose in local dibs ranged between 35.62-43.41, 35.75-43.41 and 37.93-43.41 during storage period at 5, 25 and 45°C, respectively. While the percentage of glucose ranged between 35.30-36.27, 35.30-36.48 and 35.30-37.93 during storage period at 2, 25 and 45°C, respectively.

Viscosity of local date dibs ranged between 597-1503 cp, 707-1503 cp and 677-1503 cp during storage at 5, 25 and 45°C, respectively. It was noticed that, there has been a significant reduction of descending values of viscosity during progress of storage period at 5°C, while significant decrease in viscosity was observed during the first 4 month storage at 25 and 45°C, then significantly increased at the end of storage. Also, pH values ranged between 4.53-4.65, 4.46-4.65 and 4.00-4.65

during storage period at 5, 25 and 45°C, respectively. It was also observed a significant reduction of descending values of pH during progress of storage period at 45°C and this is similar to what happened to the Sufri dibs of microwave concentration. Local date dibs showed a significant decrease in pH value at the end of storage at 5°C compared to onset. Local date dibs weight showed a slight decrease in weight during storage period following the same pattern of Sufri dibs that concentrated with microwave.

CONCLUSIONS

In conclusion, extraction date juice could be optimized by using heated water at 75°C for 30 min at two stages, the first stage was 1:2.5 date/water (25.30% TSS) and the second stage was 1:2 remained date/water (8.43% TSS). Extraction, clarification and concentration with microwave at 70% PL were able to improve physicochemical and microbiological properties of date dibs during different storage periods and temperature.

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