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Production And Evaluation Of Date Powder

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Abstract

This study was carried out to produce date powder from Tamr El Wadi and El Sakkoti varieties at tamr stage, which is low moisture content, rich in sugars and minerals. Pretreatments and drying methods were studied on the physical, chemical, sensory, properties and quality of products. Results indicated that the best additions starch were 30% for date paste methods and the 20% for cooling methods regardless date type or drying methods. Results indicated that additions of starch to dates before drying reached moisture content to< 6.5% of date powders and drying time to<8 hours. Results indicated that cooled and crushed dates then additions of starch20% to dates before drying had good quality of physical phytochemical, chemical and sensory properties of products regardless date type or drying methods.

Key words: dates, powder, drying.

Introduction

Dates (*Phoenix dactylifera* L.) are considered one of the most popular fruits. The annual production of dates in Egypt was estimated to be 1465030 tons representing about 18.89% of the total World's production (7756964 tons). Egypt lies in the first largest date producers among Arab countries followed by Iran (1156996 tons) and Saudi Arabia (766800 tons) in 2013 (FAO, 2014). Date fruits assume great importance in human nutrition owing to their rich content of essential nutrients which include carbohydrates, salts and minerals, dietary fiber, vitamins, fatty acids, amino acids and protein .They have enormous scope and potential for use as food for generations to come due to their remarkable nutritional, health and economic value (Al-Shahib and Marshall a, b 2003). Date pulps hold easily digestible sugars (70%), mostly glucose, sucrose and fructose; dietary fibers and enclose less protein and fats (Al- Farsi and Lee, 2008). They also enclose vitamins like riboflavin, biotin, thiamine,

ascorbic and folic acid that are essential for the body. The pulps of the fruit are rich in calcium, iron, copper, cobalt, magnesium, fluorine, manganese, phosphorus, potassium, copper, sodium, boron, sulfur, zinc and selenium (Al Farsi and Lee, 2008; Ali- Mohamed and Khamis, 2004; Elias, 2008). Most of the dates produced used directly for human consumption with little or no further processing. Recently, the date producing countries gave some attention to the improvement and development of date processing. New date packing and processing plants are being established and new products such as date syrup, vinegar, alcohol, liquid sugar, jelly, date paste and date powder are successfully marketed, a small amount of the produce is processed (Yousif et al. 1987). The traditional open-sun drying method of humid dates is controlled by a number of external factors (solar radiation, ambient temperature, wind velocity, and relative humidity) and internal factors (initial moisture content and the mass of product per unit exposed area). This method does not allow for obtaining a suitably high and reproducible product quality, mainly because of the inherent limitation in controlling the drying process (Jain and Tiwari, 2003). Solar drying as a healthy mean of food preservation has considered one of the most promising areas for utilization of solar energy. A properly designed solar dryer can alleviate the drawbacks associated with open sun drying, and improve the quality of the dried product considerably (Hossain et al., 2005; Janjai and Tung, 2005). Chouicha et al., (2014) showed that the solar drying with indirect natural convective dryer provides a good product (deglet-nour dates) quality with acceptable duration, and it is satisfactory and competitive to a forced convective solar drying process. A good microbiological quality was observed on the final product obtained by each of the three different solar driers. Dehydration in air driers at controlled temperatures and airflow will ensure appropriate level of moisture in dates and better preservation of the product quality. It would be possible to attain faster drying with increased drying temperature up to 70 ◦C, after which the drying mechanism changed, probably, due to case hardening (Falade and Abbo, 2007). Processing of dates by blanching in water at 96±1◦C and subsequent dehydration at 60±2 ◦C for 18–20 h resulted in good quality dehydrated dates as compared to the dates dried without heat treatment. The dehydrated dates were found to be acceptable with respect to color, flavor, taste and overall quality (Kulkarni et al., 2008). Sulieman et al., (2011) used date powder at 5% and 10% replacement levels of wheat flour for production of biscuits. The sensory evaluation of the different biscuit samples revealed that there were no significant differences between biscuit made from the different blends of wheat flour and date powder. However, panelists gave higher scores to the 5% date powder (Jawa) than the biscuit made from other blends.

Adiba et al., (2011) produced food tablets from date powder and /or spirulina powder could be of various uses: (1) consumption as such by all categories of consumers, (2) feeding of patients for whom it is difficult to chew or swallow food, knowing that these tablets can be either sucked or swallowed, and (3) as possible natural and cheap drug delivery carriers. Thus, the objective of the present study was to explore the effect of pretreatments of dates (Sakkoti and Tamr El Wadi dates at tamr stages) and drying methods on quality of date powders.

Materials and methods

Date Palm Fruits (*Phoenix dactylifera* L.) of Tamr El Wadi and El Sakkoti varieties at tamr stage were obtained from New Valley, Egypt in November 2013and Starch were purchased from local market, Giza, Egypt., Tri calcium phosphate was purchased from Lianyungang Debang Fine Chemical Co., Ltd. China. The aluminum foil three layers (polyester/ aluminum foil/ polyethylene) (PET/AL/PE) was provided from Pharmaceutical packing company, 6 October to packaged date powder products.

Processing methods

Primary studies

Starch was added at different ratio 10, 20, 30, 40 and 50% (wt: wt) to dates varieties which cooled at 2±2 ◦C, minced or homogenized with water at 50°C only to produce the best quality date dried product with a minimum ratio of starch.

Production of date powder

Dates (Tamr El Wadi and El Sakkoti varieties) were divided into three groups, (each group contain a sample control)

1-The 1st group of El Sakkoti and Tamr El Wadi varieties were homogenized with at 50°C water for 15 min, then flesh part was mixed with 30% of starch (the best ratio was added to dates) until obtaining a homogeneous paste mix was then spread to a thickness of about 5 mm.

2-The 2nd group of El Sakkoti and Tamr El Wadi varieties were cooled, minced, crushed.

3- The 3rd group of El Sakkoti and Tamr El Wadi varieties were cooled, minced, crushed dates with mixer (K45SS, 250 W, Kitchen Aid, Inc., MI) and mixed with 20% of starch (the best ratio was added to dates).

All samples were dried till constant weight with oven drying at 70°C ± 3°C and Solar drying at 60°C ± 3°C.

Packaging date powders

All the previous treated samples were ground with 450 mesh then Calcium Tri phosphate was added to all samples of dates powder by 0.2% to prevent caking and packed in laminate sacs (PET/AL/PE) packing material (15 x 20 cm).

Analytical methods

Moisture content, pH value, total acidity, total sugars, reducing and non- reducing sugars, starch, protein, fat, ash and crude fiber contents were determined according to the methods of the A.O.A.C (2010). Non-enzymatic browning of the samples was determined according to the method of Ranganna (1977).Minerals content, sodium, potassium and calcium were determined using the Flame Photometer (Gallenkamp, FGA 330, England). Iron, copper, manganese, magnesium and zinc were determined using Perkin Elmer Atomic Absorption Spectrophotometer (model 80, England) as described in A.O.A.C. (2010), while phosphorus by using visible spectrophotometer Specolle 11. Bulk density was determined according to (Bencini 1986) by weighing 50 ml of the dried samples and expressed as g/L. Oil absorption capacity (OAC) The fat absorption capacity was calculated and expressed as a percentage of original weight (Hulse et al., 1977) or as the volume of oil absorbed per gram of sample (Lin et al., 1974). Water absorption capacity (WAC) was determined according to the method of (Hulse et al., 1977). Hygroscopicity was determined according to Sablani et al., (2008). Antioxidant capacity was determined by the 1, 1-diphenyl-2-picrylhydrazyl (DPPH) method according to Ao. et al., (2008). Total phenols were extracted according to the procedure described by (Maier and Metzler 1965) and determined according to (Swain and Hillis 1959).The concentration of total phenols was calculated from a standard curve prepared by using known concentrations (0.05 to 1 mg/ml) of pyrogallol. The sensory evaluation of the product was statistically analyzed by analysis of variance (ANOVA) according to the method of SAS program (1998) and Duncan's Multiple Range Test was applied to assess significant differences between means at 5% level of probability (Duncan, 1952). Each experiment in triplicate repeated at least twice and the values presented in terms of means ± standard error Steel et al., (1996).

Results and dissections

Physio-chemical properties of El Sakkoti and Tamr El Wadi date fruits at tamr stage

The non- enzymatic browning and the chemical properties of the studied fresh date fruits at tamr stage (El Sakkoti and Tamr El wadi) were illustrated in the Table (1).

It could be seen that the non- enzymatic browning value of El Sakkoti was higher (0.274) than Tamr El Wadi date (0.122) and moisture contents were 13.19 and 14.99%; respectively;

these values were in the range of dried date's calcification. The results are in accordance with those of Salem and Hegazi (1971) and Khattab et al., (1983) whom found that the moisture content of Barakawi (Sakkoti) and Balady dry dates were 13.0% and 9.5% at tamr stage respectively. Nour et al., (1986) reported that the moisture content of Balady dry date was 13-16%. However, Abd- Ellah, (2009) reported that the moisture contents of five date cultivars grown in Sudan (Wadkhatieb, Wadlaggai, Barakawi, Pitamoda and Gondalia) were found to be between 13.53- 16.59%; respectively.The data showed that the total sugar contents were 87.08 and 86.10%, while reducing sugars were 36.21and 41% and non- reducing sugars were 50.86 and 45.10%; for El Sakkoti and Tamr El wadi (on dry weight basis). Abd- Elwahid, (2007) found that the dry Sikkut, Sunta and poor date cultivars (grown in Sudan) ranged between 59.18- 71.0, 35.88- 42.22 and 17.34- 34.0% for total, reducing and non-reducing sugars; respectively. These results were comparable to those reported by Besbes et al., (2009) with some differences related to the date variety, agro-climatic and environmental conditions. While Gadalla et al., (2013) found that total, non-reducing and reducing sugars of Sakkoti date (dry cultivar) were 70, 46 and 24%; respectively at tamr stage.

Table (1): Gross chemical composition and antioxidant activity of El Sakkoti and Tamr El wadi date varieties at tamr stage (on dry basis).

Date varieties / Properties	Tamr El Sakkoti	Tamr El Wadi
Non-enzymatic browning (at 420 nm)	0.274±0.003	0.122±0.004
Moisture%	13.19±0.15	14.99±0.05
Reducing sugars %	36.21±0.009	41.00±0.1
Non- reducing sugars%	50.86±0.06	45.10±0.05
Total sugars%	87.07±0.08	86.10±0.2
Crude fiber%	4.85±0.057	4.76±0.009
Protein %	2.13±0.14	2.07±0.26
Fat %	2.16±0.07	2.26±0.04
Ash%	1.82±0.06	2.09±0.036
Total acidity (as malic acid)%	0.55±0.009	0.43±0.003
pH value	5.43±0.02	5.72±0.01
Total phenols mg/g	0.408±0.009	0.451±0.01
Antioxidant activity %	79.61±0.2	76.15±0.1

The data showed that the fiber contents were 4.85 and 4.76% for the two dates; respectively (on dry weight basis). These results higher than those reported by Sawaya, et al., (1983), who showed great variation for crude fiber in tamr stage of twenty-five date fruits grown in Saudi Arabia, which ranged between 2.04 to 3.82% on dry weight basis. The data also revealed that the protein contents were 2.13 and 2.07% for the Sakkoti and Tamr El wadi date varieties; respectively (on dry weight basis). These results in the same line of those obtained by Abd- Ellah (2009) that he found the protein contents were 3.03, 3.03, 3.33, 2.01 and 3.38% in 5 dates, cultivars Walkhateib, Wadlaggai, Barakawi, Pitamoda and Gondalia; respectively. Elleuch, et al. (2008) found that the protein contents of Deglet-Nour and Allig cultivars grown at Degach region (Tunisia) were 2.10 and 3.0%; respectively. Whereas Al-Farsi et al., (2007) found that the protein contents in Mabseeli, Um-Selah, and Shahal dates were 1.15, 1.79, and 1.10% on fresh weight; respectively. Sulieman et al., (2009) and Sulieman et al., (2012) reported that the protein levels in five Sudanese date were ranged between 1.86 to 3.72%, (on dry weight basis). Whereas, the fat contents were 2.16 and 2.26% in the both studied dates respectively (on dry weight basis). This in accordance with El-Sohaimy and Hafez, (2010) who reported that the low level of lipids content (2.90 %) compared with its content of sugars means that, the date fruit palm is safe to heart and blood patients because it containing a very low level of fatty acids and cholesterol. The data also showed that the ash contents of the studied Tamr were 1.82 and 2.09% (on dry weight basis). These results are in agreement with Leminel et al., (2014) who found that the ash contents of twenty-eight date palm cultivars were collected at Tamr stage from Mauritania were between 1.23 - 3.14%. Sulieman et al., (2009) reported that the ash contents of Barakawi, Mishriqi Wad Khateeb and Jawa date cultivars were 2.66, 2.71and 2.91%; respectively. The data illustrated that the total acidity for the El Sakkoti and Tamr El wadi were 0.55 and 0.43%; respectively (on dry weight basis). Mahdy (2015) found that acidity of Tamr date palms (dry cultivar) grown in sandy soil in a commercial orchard in Dakhla oasis, El-Wadi El-Gadid. were 0.46 and 0.36% in season 2013 and 2014; respectively . The pH values for the studied tamr were 5.43 and 5.72; respectively. Besbes et al., (2009) determined the pH values of three Tunisian date cultivars were 5.63, 5.79 and 5.78; respectively. Leminel et al., (2014) found that the pH values of twenty-eight date palm cultivars collected at Tamr stage in Mauritania were between 5.1- 7.2. The data in the Table (1) showed that the values of the total phenols of El Sakkoti and Tamr El wadi were 0.408, 0.451 mg/g; respectively. The study showed that the antioxidant activity for El Sakkoti and Tamr El wadi were 79.61and 76.15%; respectively. An antioxidant, can quench reactive free radicals, and prevent the oxidation of other

molecules and may, therefore, have health- romoting effects in the prevention of degenerative diseases (Biglari, et al, 2008). Therefore, date palm fruit may serve as a good source of antioxidant (Saafi et al., 2009).

Effect of starch addition levels on the sensory evaluation of date varieties after primary laboratory tests

Sensory evaluations for taste, odor, texture, color, and overall acceptability of the powders from El Sakkoti and Tamr El wadi dates were affected by the different levels of starch on the two methods (date paste and cooling methods) and done in the order to determine consumer acceptability. Starch was added at different ratios ranged between 10, 20, 30, 40 and 50% (wt: wt) to date varieties which cooled at 2±2°C, then minced and sprayed with water at 50°C prior to produce the best quality of date dried product with a minimum ratio of starch. The aim of addition anti- caking (starch) to make less stickiness in the dates powder whose mainly due to the presence of low molecular weight sugars, such as fructose, glucose and sucrose. These sugars are very hygroscopic in their amorphous state and have a low glass transition temperature (Roos and Karel, 1991a, b, and Roos, 1995). It could be seen from the results in Table (2) that the increase percentage of adding starch was significantly ($P \leq 0.05$) reduced the taste and the odor scores, while it was significantly ($P \leq 0.05$) improved the texture scores at levels of 10, 20 and 30%. The increase of starch percentage had no significant ($P \leq 0.05$) change between levels 30, 40, 50% with date paste method.

Whereas in the cooling method the scores of texture had significant ($P \leq 0.05$) different between levels 10 and 20% only. From the same Table it could noticed that the increase of adding starch percentage was significantly ($p \leq 0.05$) improved the color scores of the date paste and cooling methods. It could be seen that the addition of starch at 30% to date paste method had the highest (36.20 and 36.30) overall acceptability value for El Sakkoti and Tamr El Wadi; respectively, while the addition of starch with 20% had the highest (36.0 and 36.20) overall acceptability for El Sakkoti and Tamr El wadi; respectively. In the light of these results, it could be briefly concluded that the addition of starch at percentage 30% was the best for date paste method while the percentage 20% was the best for cooling method.

Effect of pretreatments and drying methods on the quality of dates powder

The effect of the two different methods of drying (oven drying and solar drying) and pretreatments (date paste with addition 30% starch, cooled and minced and cooled, minced and addition of 20% starch) on the physical and functional properties of the studied dates (El Sakkoti and Tamr El wadi) were illustrated in Tables (3 and 4).

Table (2): Effect of starch addition levels on the sensory evaluation of date varieties after primary laboratory tests.

Treatments		Taste	Odor	Texture	Color	Overall acceptability
Date paste method						
El Sakkoti	10%	$9.10^{a}\pm0.26$	$8.50^{ab}\pm0.1$	$7.25^{c}\pm0.15$	$7.0^{e}\pm0.36$	$31.85^{d}\pm0.69$
	20%	$9.20^{a}\pm0.26$	$8.40^{abc}\pm0.17$	$8.50^{b}\pm0.2$	$8.5^{d}\pm0.17$	$34.60^{c}\pm0.53$
	30%	$9.10^{a}\pm0.44$	$8.20^{cd}\pm0.26$	$10.0^{a}\pm0.0$	$8.9^{bc}\pm0.2$	$36.20^{a}\pm0.44$
	40%	$8.50^{b}\pm0.17$	$7.90^{d}\pm0.2$	$10.0^{a}\pm0.0$	$9.1^{b}\pm0.26$	$35.5^{b}\pm0.2$
	50%	$8.0^{c}\pm0.22$	$7.50^{e}\pm0.13$	$10.0^{a}\pm0.0$	$9.5^{a}\pm0.13$	$35.0^{bc}\pm0.41$
Tamr El Wadi	10%	$9.0^{a}\pm0.23$	$8.60^{a}\pm0.13$	$7.35^{c}\pm0.13$	$7.25^{e}\pm0.09$	$32.2^{d}\pm0.26$
	20%	$9.15^{a}\pm0.17$	$8.45^{ab}\pm0.1$	$8.65^{b}\pm0.1$	$8.7^{cd}\pm0.05$	$34.95^{bc}\pm0.13$
	30%	$9.05^{a}\pm0.1$	$8.25^{bc}\pm0.1$	$10.0^{a}\pm0.0$	$9.0^{bc}\pm0.13$	$36.30^{a}\pm0.3$
	40%	$8.40^{b}\pm0.1$	$7.85^{d}\pm0.2$	$10.0^{a}\pm0.0$	$9.15^{b}\pm0.2$	$35.40^{b}\pm0.26$
	50%	$7.90^{c}\pm0.18$	$7.40^{e}\pm0.22$	$10.0^{a}\pm0.0$	$9.60^{a}\pm0.18$	$34.9^{bc}\pm0.40$
LSD		0.3967	0.2931	0.1603	0.3353	0.6726
Cooling method						
El Sakkoti	10%	$9.60^{a}\pm0.09$	$8.50^{ab}\pm0.3$	$8.50^{b}\pm0.26$	$7.50^{e}\pm0.3$	$34.1^{c}\pm0.76$
	20%	$9.10^{ab}\pm0.46$	$8.50^{ab}\pm0.26$	$10.0^{a}\pm0.0$	$8.80^{d}\pm0.23$	$36.4^{a}\pm0.25$
	30%	$9.0^{ab}\pm0.4$	$8.0^{bcd}\pm0.4$	$10.0^{a}\pm0.0$	$9.0^{cd}\pm0.1$	$36.0^{a}\pm0.70$
	40%	$8.50^{bc}\pm0.28$	$7.80^{cd}\pm0.25$	$10.0^{a}\pm0.0$	$9.30^{bcd}\pm0.18$	$35.60^{ab}\pm0.61$
	50%	$8.0^{c}\pm0.22$	$7.50^{d}\pm0.23$	$10.0^{a}\pm0.0$	$9.80^{ab}\pm0.2$	$35.30^{abc}\pm0.18$
Tamr El Wadi	10%	$9.50^{a}\pm0.2$	$8.70^{a}\pm0.4$	$8.60^{b}\pm0.41$	$7.70^{e}\pm0.44$	$34.51^{bc}\pm1.27$
	20%	$9.0^{ab}\pm0.0$	$8.50^{ab}\pm0.46$	$10.0^{a}\pm0.0$	$9.0^{cd}\pm0.35$	$36.5^{a}\pm0.35$
	30%	$8.95^{ab}\pm0.31$	$8.15^{abc}\pm0.15$	$10.0^{a}\pm0.0$	$9.10^{cd}\pm0.44$	$36.2^{a}\pm0.55$
	40%	$8.45^{bc}\pm0.41$	$7.90^{cd}\pm0.41$	$10.0^{a}\pm0.0$	$9.45^{abc}\pm0.41$	$35.8^{a}\pm0.54$
	50%	$7.95^{c}\pm0.9$	$7.55^{d}\pm0.44$	$10.0^{a}\pm0.0$	$9.95^{a}\pm0.05$	$35.45^{ab}\pm1.24$
LSD		0.685	0.5869	0.2635	0.511	1.251

Moisture content

Results in Table (3) showed the moisture content of date powder of El Sakkoti and Tamr El wadi dried with oven drying at 70± 3°C. It is clear that the moisture content were about 9.5% for control STO (El Sakkoti), 4.71% for T1 (date paste with addition 30% starch), 8.0% for T2 (cooled and minced), 4.43% for T3 (cooled, minced and addition of 20% starch), 9.76% for control WTO (Tamr El Wadi), 5.46% for T1 (date paste with addition 30% starch), 8.15% for T2 (cooled and minced), 5.26% for (cooled and minced with addition of 20% starch). Results in Table (4) showed the moisture content of date powder of El Sakkoti and Tamr El wadi dried with solar drying at 60± 3°C. It's clear that the moisture content were 10.25% for control STO (El Sakkoti), 7.58% for T1 (date paste with addition 30% starch), 8.86% for T2 (cooled and minced), 6.11% for T3 (cooled, minced and with addition of 20% starch), 11.01% for control WTO (Tamr El wadi), 7.75% for T1 (date paste with addition of 30% starch), 9.11% for T2 (cooled and minced), 6.53% for T3 (cooled and minced with addition of 20% starch). From this data it could be noticed that the pretreatment T3 had the lowest moisture contents followed by T2 comparing with other treatments and this could be due to two reasons the first one, the pretreatment cooling could increase the Tg of the dates in the mixing which caused lowering the stickiness and led to the crushing became more easy and led to increase the surface area for the mixing. The second reason was starch addition which could increase the competition for the moisture with date powder and the moisture evaporation much easier because the starch is not hygroscopic materiel. T2 was lower in moisture content than T1 and control because of the effect of pretreatment cooling as mentioned before. These results are agreement with those of (Sablani et al., 2008).

Total phenols content

Data in the Tables (3 and 4) showed the total phenolic content of dates powder of El Sakkoti and Tamr El Wadi dried by the two different methods (solar and oven drying). The data showed that the cooling process reduced the drying time and kept of the phenolic compounds, therefor T2 and T3 were kept the phenolic compounds compared to the other treatments, while the addition of starch to date powder in T1 led to a reduction of the total content of phenols.

Antioxidant activity

Data in the Tables (3 and 4) showed the antioxidant activity of the studied samples. The conclusion regarding the antioxidant activity is comparable to the conclusion which mentioned before in the total phenols.

Non- enzymatic browning (at 420nm)

Most of the browning occurring in food during drying is due to Maillard reactions. Browning can also appear during long storage, and generally is dependent upon the product characteristics and storage conditions (Koca et al., 2007). The non-enzymatic browning (NEB) of the studied dates powder of El Sakkoti and Tamr El Wadi, as affected by drying process and addition of starch are presented in Tables 3 and 4. It could be seen from the Table (3) that the effect of pretreatments on the NEB value of control and the three treatments with oven drying at 70± 3°C ranged from 0.173 to 0.486. The data in Table (4) presented the effect of pretreatments on the NEB of dried date varieties with solar drying at 60± 3°C. It is clear from the data that all the used pretreatments reduced the NEB value compared to the control. Cooled, minced and addition of 20% starch to Tamr El Wadi had the lowest value (0.193) followed by cooled, minced and addition of 20% starch to El Sakkoti (0.331.The three treatments decreased the NEB value compared to control and Tamr El Wadi was lower than El Sakkoti date. Cooled, minced with addition of 20% starch had the lowest value of NEB followed by date paste with addition of 30% starch. Additions of starch affect the color and reduced the time of drying as T1 and T3 which lower the effect of Maillard reactions and caramelization.

Drying ratio

Drying ratio of the studied dates powder of El Sakkoti and Tamr El Wadi was given in Tables (3 and 4). From the Table (3), it could be seen that the drying ratio values for dried date varieties with oven drying at 70± 3 °C were about 1.04 for control STO (El Sakkoti), 1.09 for T1 (date paste with addition of 30% starch), 1.05 for T2 (cooled and minced), 1.08 for T3 (cooled, minced and addition of 20% starch), 1.06 for control WTO (Tamr El Wadi), 1.08 for T1 (date paste with addition of 30% starch), 1.07 for T2 (cooled and minced), 1.09 for (cooled and minced with addition of 20% starch).It could be seen from Table (4) that the drying ratio values for dried date varieties with solar drying at 60± 3 °C were about 1.03 for control STS (El Sakkoti); 1.05 for T1 (date paste with addition of 30% starch), 1.05 for T2 (cooled and minced), 1.14 for T3 (cooled, minced and with addition of 20% starch), 1.04 for control WTS (Tamr El Wadi), 1.06 for T1 (date paste with addition of 30% starch), 1.06 for T2 (cooled and minced), 1.08 for (cooled and minced with addition of 20% starch).It can conclude from the results that the drying ratio is dependent on the moisture content of the fresh, dried food materials and starch addition levels.

Bulk density

Knowledge of the physical properties of food particles such as bulk density assumes fundamental importance in the design, modeling and optimization of many food processing operations such as drying and storage. Bulk density is the ratio of the mass of a sample to the volume occupied by the sample when poured into a container (Rapusas et al., 1995) .The bulk density of the studied date powder was determined by measuring the weight of the sample occupying a container of known volume and the results are presented in Tables (3 and 4). It could be noticed from Table (3) that the bulk density values of dates powder obtained from dried date varieties with oven drying at 70± 3 °C were about 0.71g/cm3 for control STO (El Sakkoti), 0.78g/cm3 for T1 (date paste with addition of 30% starch), 0.56g/cm3 for T2 (cooled and minced), 0.69g/cm3 for T3 (cooled, minced and addition of 20% starch), 0.64g/cm3 for control WTO (Tamr El Wadi), 0.70g/cm3 for T1 (date paste with addition of 30% starch), 0.50g/cm3 for T2 (cooled and minced), 0.59g/cm3 for (cooled and minced with addition of 20% starch). It could be seen from Table (4) that the bulk density values for date powder obtained from dried date varieties with solar drying at 60± 3 °C were about 0.71g/cm3 for control STS (El Sakkoti), 0.67g/cm3 for T1, 0.57g/cm3 for T2, 0.51g/cm3 for T3, 0.74g/cm3 for control WTS (Tamr El wadi), 0.71g/cm3 for T1, 0.53g/cm3 for T2, 0.56g/cm3 for T3.Sablani et al., (2008) found that the bulk density of date powder increased with increasing the concentration of maltodextrin and this was due to lowering characteristic dimension of particles of date powder. The addition of finer (and heavier) sized maltodextrin particles in the date paste resulted in a more dense powder mass, also this due to the content of the date powder moisture. This conclusion is in agreement with the results mentioned above.

Water absorption capacity (WAC)

The WAC data (g water /g sample) of El Sakkoti and Tamr El Wadi date powder dried by two different methods (solar and oven drying) were illustrated in Tables (3 and 4). The data showed reduction in the values for all the dates powder dried by the oven and solar drying methods compared with control. The reduction in water absorption capacity could be due to the addition of starch by 30 and 20% in T1and T3; respectively which led to a reduction of fiber content. The fibers are working to increase the water absorption.

Oil absorption capacity (OAC)

Data in Tables (3 and 4) showed the OAC (g oil/g sample) of dates powder of El Sakkoti and Tamr El wadi dried by two different methods (oven and solar drying). It cleared from the data there were no appreciable effects between the three treatments of solar drying.

As regard to the oven drying, T1 and T3 were higher than the control because of the presence of starch by 30 and 20%; respectively which led to more adsorption of oil due to the higher of molecular weight and shape size of starch. Although T1 contains 30% of starch there were small differences between the OAC values because part of starch was gelatinized by heat

Table (3): Effect of pretreatments on the physical and functional properties of dried date varieties with oven drying at 70± 3°C.

Parameters \ Treatments	El Sakkoti date powder				El Wadi date powder			
	$Control^{STO}$	$T1^{STO*}$	$T2^{STO}$	$T3^{STO}$	$Control^{WTO}$	$T1^{WTO**}$	$T2^{WTO}$	$T3^{WTO}$
Moisture content %	9.5±0.2	4.71±0.11	8.0±0.19	4.43±0.01	9.76±0.12	5.46±0.09	8.15±0.05	5.26±0.007
Total phenols mg/g	0.301±0.01	0.279±0.004	0.318±0.01	0.315±0.001	0.344±0.03	0.301±0.04	0.365±0.02	0.341±0.001
Antioxidant activity %	55.24±0.35	49.59±0.27	64.99±0.22	60.11±0.05	55.80±0.07	50.30±0.03	65.18±0.23	60.93±0.04
Non-enzymatic browning (at 420nm)	0.486±0.01	0.312±0.02	0.404±0.009	0.312±0.01	0.280±0.01	0.202±0.008	0.193±0.02	0.173±0.02
Drying ratio	1.04:1	1.09:1	1.05:1	1.08:1	1.06:1	1.08:1	1.07:1	1.09:1
Drying time(hr)	18	13	12	7	18	13	12	8
Bulk density (g/cm3)	0.71±0.03	0.78±0.01	0.56±0.02	0.69±0.02	0.64±0.01	0.70±0.009	0.50±0.02	0.59±0.05
Water absorption (gH_2O /g sample)	1.71±0.11	1.17±0.06	1.62±0.02	1.14±0.09	1.62±0.03	1.13±0.09	1.67±0.02	1.04±0.08
Oil absorption (g Oil /g sample)	0.72±0.03	0.79±0.04	0.80±0.02	0.89±0.01	0.70±0.02	0.81±0.05	0.79±0.04	0.80±0.03

Table (4): Effect of pretreatments on the physical and functional properties of dried date varieties with solar drying at 60± 3°C.

Treatments / Parameters	Date powder of El Sakkoti				Date powder of Tamr El Wadi			
	$Control^{STO}$	$T1^{STS}$	$T2^{STS}$	$T3^{STS}$	$Control^{WTO}$	$T1^{WTS}$	$T2^{WTS}$	$T3^{WTS}$
Moisture content %	10.25±0.3	7.58±0.13	8.86±0.2	6.11±0.02	11.01±0.4	7.75±0.35	9.11±0.22	6.53±0.01
Total phenols mg/g	0.276±0.01	0.264±0.005	0.300±0.02	0.304±0.002	0.321±0.01	0.287±0.006	0.341±0.02	0.322±0.001
Antioxidant activity%	51.21±0.4	48.11±0.03	59.19±0.09	56.48±0.04	50.23±0.6	50.55±0.05	59.32±0.07	58.77±0.03
Non-enzymatic browning (at 420nm)	0.503±0.001	0.330±0.004	0.421±0.01	0.331±0.04	0.301±0.02	0.231±0.03	0.211±0.009	0.193±0.02
Drying ratio	1.03:1	1.07:1	1.05:1	1.14:1	1.04:1	1.08:1	1.06:1	1.08:1
Drying time(hr)	20	17	14	11	21	17	14	10
Bulk density (g/cm3)	0.71±0.02	0.67±0.04	0.57±0.11	0.51±0.03	0.74±0.2	0.71±0.13	0.53±0.002	0.56±0.02
Water absorption (gH_2O /g sample)	1. 36±0.12	0.98±0.02	1.39±0.05	1.11±0.07	1.50±0.05	1.05±0.04	1.37±0.03	1.07±0.05
Oil absorption (g Oil /g sample)	0.75±0.01	0.78±0.02	0.76±0.02	0.77±0.06	0.68±0.04	0.79±0.009	0.74±0.02	0.79±0.04

Sensory evaluation of date powders for selecting the best treatment drying by oven and solar drying

The date treatments food formulas (date powder of El Sakkoti and Tamr El wadi) were reconstituted and sensory evaluated in terms of taste, odor, texture, color and overall acceptability. The results were statistically analyzed and recorded in Table (5).

Table (5): sensory evaluation of date powder by different levels of starch (mean10 values).

Treatments		Taste (10)	Odor (10)	Texture (10)	Color (10)	Overall acceptability (40)
Oven drying						
El Tamr Sakkoti	ControlST	9.0^{ab}±0.75	8.80^{ab}±0.53	5.15^{d}±0.49	5.35^{e}±0.41	28.30^{d}±1.48
	T1^{STO*}	8.0^{d}±0.61	8.50^{bc}±0.43	8.35^{b}±0.28	9.25^{c}±0.43	34.10^{b}±1.09
	T2^{STO}	9.40^{a}±0.41	9.10^{a}±0.41	6.40^{c}±0.41	7.60^{d}±0.42	32.50^{c}±0.49
	T3^{STO}	8.50^{bcd}±0.43	8.65^{bc}±0.47	9.65^{a}±0.33	9.75^{ab}±0.38	36.55^{a}±0.70
Tamr El Wadi	Control^{WT}	9.10^{a}±0.53	8.50^{bc}±0.53	5.35^{d}±0.60	5.55^{e}±0.45	28.56^{d}±1.14
	T1^{WTO**}	8.20^{cd}±0.58	8.35^{c}±0.28	8.40^{b}±0.41	9.45^{bc}±0.36	34.40^{b}±0.98
	T2^{WTO}	9.25^{a} ±0.53	8.90^{ab}±0.37	6.55^{c}±0.38	7.70^{d}±0.87	32.40^{c}±1.57
	T3^{WTO}	8.55^{bc}±0.39	8.55^{bc}±0.28	9.70^{a}±0.35	9.95^{a}±0.10	36.75^{a}±0.64
LSD		0.5091	0.4448	0.3911	0.4453	1.0127
Solar drying						
El Tamr Sakkoti	ControlST	9.22^{a}±0.51	8.89^{bcd}±0.33	5.22^{e}±0.44	6.28^{e}±0.57	29.61^{d}±0.99
	T1^{STO*}	8.11^{c}±0.7	8.44^{ef}±0.39	8.39^{b}±0.42	9.17^{b}±0.43	34.11^{bc}±1.27
	T2^{STO}	9.44^{a}±0.46	9.22^{ab}±0.36	7.22^{d}±0.36	7.50^{c}±0.43	33.39^{c}±0.82
	T3^{STO}	8.61^{b}±0.49	8.78^{cde}±0.26	9.78^{a}±0.26	9.61^{a}±0.33	36.78^{a}±0.67
Tamr El Wadi	Control^{WT}	9.17^{a}±0.25	9.0^{bc}±0.35	4.94^{e}±0.53	7.0^{d}±0.35	30.11^{d}±0.74
	T1^{WTO**}	8.10^{c}±0.54	8.28^{f} ±0.51	8.60^{b}±0.34	9.66^{a}±0.36	34.63^{b}±0.92
	T2^{WTO}	9.25^{a}±0.35	9.40^{a}±0.31	7.65^{c}±0.37	7.70^{c}±0.29	34.0^{bc}±0.96
	T3^{WTO}	8.55^{bc}±0.47	8.65^{de}±0.37	10.0^{a}±0.0	9.83^{a}±0.25	37.03^{a}±0.73
LSD		0.4575	0.3451	0.3486	0.366	0.8527

From the results in Table(5) it could noticed that there were no significant ($P \leq 0.05$) differences between the date varieties (El Sakkoti and Tamr El wadi), also there were no significant ($P \leq 0.05$) differences between the treatments (control, T1, T2 and T3) regarding to taste and odor of date powders. We also it could notice that taste and odor scores of control and T2sto (cooled and minced) were higher than other treatments because they do not contained starch. The overall acceptability scores were the highest for reconstituted dates powder prepared with cooled, minced and with addition of 20% starch for El Sakkoti and Tamr El wadi. In the light of these results, it could be briefly concluded that the primary cooling processing followed by adding 20% starch was the best treatment in terms of texture, color and overall acceptability for production the date powder.

Chemical composition of T3 (cooled, minced and with addition starch 20%) (Sakkoti and Tamr El wadi dates powder) dried by oven and solar drying methods

Results in Table (6) indicated that the moisture content of the date powder of El Sakkoti and date powder of Tamr El Wadi (dried by oven drying) were 4.43 and 5.26% respectively, while the moisture content value for the same varieties (dried by solar dryer) were 6.11 and 6.53% respectively. Assous et al (2009) reported that the moisture content of date-skim milk powder ranged from 4.5 to 5.7%. The results in the same Table (6) showed that there were no appreciable differences between the oven and solar drying methods. As regard to the chemical composition, values of El Sakkoti and Tamr El wadi varieties there were small between them. On the other hand there were appreciable differences between the date varieties and the dates powder and these could be due to the addition of starch at 20% level.

Table (6): Chemical composition of Sakkoti and Tamr El Wadi date powders (T3)* (on dry weight basis).

Components	Oven drying		Solar drying	
	Date powder of El Sakkoti	Date powder of Tamr El wadi	Date powder of El Sakkoti	Date powder of Tamr El wadi
Moisture%	4.43±0.01	5.26±0.007	6.11±0.02	6.53±0.01
Reducing sugars %	32.60±0.04	35.31±0.02	33.01±0.02	37.08±0.01
Non- reducing sugars %	38.44±0.03	33.96±0.04	36.43±0.06	31.03±0.01
Total sugars %	70.04±0.03	69.27±0.2	69.44±0.08	68.11±0.03
Starch%	16.73±0.06	16.23±0.07	16.55±0.04	16.05±0.02
Crude fiber%	3.90±0.01	3.82±0.04	3.88±0.02	3.79±0.06
Ash%	1.40±0.004	1.35±0.05	1.40±0.02	1.39±0.01
Protein%	1.62±0.01	1.58±0.01	1.50±0.008	1.45±0.04
Crude fat%	1.46±0.02	1.38±0.01	1.35±0.02	1.22±0.009
Total acidity (as malice acid)%	0.371±0.02	0.288±0.01	0.311±0.01	0.260±0.03
pH value	5.308±0.2	5.704±0.11	5.643±0.1	5.346±0.12
Total phenols mg/g	0.315±0.001	0.341±0.001	0.304±0.002	0.322±0.001
Antioxidant activity%	60.11±0.05	60.93±0.04	56.48±0.04	58.77±0.03

Conclusion

The results showed that date powder can be produced from semi-dry or dry varieties of dates by adding starch or filling tables to prevent agglomeration and drying by solar energy or drying in ovens to remove excess moisture, then cooling and crushing before grinding to obtain date powder with high value of physical and chemical properties.

REFERENCES

A. O. A. C. (2010). Association of official analytical chemists, 18 ed.; Published by A.O.A.C. Washington, D.C. (U.S.A.).

Abd- Ellah, A. E. (2009): Chemical and Technological studies on some Sudanese Date Cultivars .PhD. thesis, Fd. Tec.Dept., Coll. Of Agric., Nil Valley.Univ., Sudanes.

Abd- Elwahid, A. A. (2007). Quality Evaluation of Some Local Date Palm Fruits Under Rubatab Area. MSc. Thesis, Fac. of Agric. Nile Valley Univ., Atbara, Sudan.

Adiba, B. D.; Salem, B.; Nabil, S. and Abdelhakim, M. (2011). Preliminary characterization of food tablets from date (Phoenix dactylifera L.) and spirulina (Spirulina sp.) powders. Powder Technology 208, 725–730.

Al-Farsi, M. A. and Lee, C. Y. (2008). Nutritional and functional properties of dates: a review. Crit. Rev., Food Sci., Nutr. 48: 877–87.

Al-Farsi, M.; Morris, A. and M Baron. (2007). Functional properties of Omani dates (Phoenix dactylifera L.). Acta Horticulturae. 736:479-487.

Ali-Mohamed, A.Y. and Khamis, A.S. (2004). Mineral ion content of the seeds of six cultivars of Bahraini date palm (Phoenix dactylifera). J. Agric. Food Chem., 52: 6522–5.

Al-Shahib, W. and Marshall, R. J. (2003a).The fruit of the date palm: it's possible use as the best food for the future. Int. J. Food Sci. Nutr. 54:247-259.

Al-Shahib, W. and Marshall, R. J. (2003b). Fatty acid content of the seeds from 14 varieties of date palm Phoenix dactylifera L. Int. J. Food Sci. Tech. 38:709-712.

Ao, C.; Li, A.; Elzaawely, A. A.; Xuan, T.D.; Tawata, S. (2008). Evaluation of antioxidant and antibacterial activities of Ficusmicrocarpa L. fil. extract. Food Control 19, 940–948.

Assous, M. T. M., Neamah. R. A. and Eman F.M.,(2009). Production and evaluation of date-skim milk powder. Bulletin of Faculty of Agriculture, Cairo University, vol.: 296-305.

Bencini, M. C. (1986). Functional properties of drum-dried chickpea (Cicerarielinum L.) flour. J. Food Sci., 51: 1518-1521, 1526.

Besbes , S.; Drira, Lobna.; Blecker, C.; Deroanne, C. and Hamadi, A.(2009). Adding value to hard date(phoenix dactyliferaL.) compositional ,Functional and sensory characteristics of date jame. J. of food chemistry, (112):406-411.

Biglari, F.; AlKarkhi, A. F. M. and Easa, A. M. (2008). Antioxidant activity and phenolic content of various date palm (Phoenix dactylifera) fruits from Iran. Food Chemistry. 107: 1636-1641.

Chouicha, S.; Boubekri, A.; Mennouche, D; Bouguetaia, H.; Berrbeuh, M. H.; Bouhafs, S. and Rezzoug, W. (2014). Valorization Study of Treated Deglet-Nour Dates By Solar Drying

Using Three Different Solar Driers. Energy Procedia 50 : 907 - 916.

Duncan, D. B. (1952). Multiple Range and Multiple F-Test. Biometrics, Vol. 11, p. 42.

El- Sohaimy, S .A. and Hafez, E.E. (2010): Biochemical and nutritional characterization of date palm fruits (phoenix dactylifera L.).J of Applied Scie., Rese., 6(8):1060-1067.

Elias, Y. M. (2008). Date - A Wonder Fruit of Arabia. Retrieved April 1,2009, from http://ezinearticles.com/?Date-A-Wonder-Fruit-of-Arabia&id=1527461.

Elleuch, M.; Besbes, S.; Roiseux,O.; Blecker, C.; Deroanne, C.; Drira, N and Attia, H (2008). chemical composition and characteristics of the dietary fiber. J. of food chem., (111):676-682.

Falade, K. O. and Abbo, E. S. (2007). Air-drying and rehydration characteristics of date palm (Phoenix dactylifera L.) fruits. Journal of Food Engineering 79, 724-730.

FAO [Food and Agriculture Organization]. (2014). Crop production and trade data. Available at http://faostat.fao.org/site/291/default.aspx (accessed November 17, 2017).

Gadalla, E. G.; Abd-El Kareim, A. H. I. and Ahmed, E. F. S. (2014). Behavior of some Egyptian dry cultivars and Barhee cv. date palm produced from tissue culture under Shark Al-Oinat condition El-Wadi El-Gadid governorate.

Hossain, M. A.; Woods, J. L. and Bala, B. K. (2005). Optimization of solar tunnel dryer for drying of chilli without color loss. Renewable Energy, 30: 729-742.

Hulse, J. H.; Rachie. K. O. and Billingsley, L. W. (1977).Nutritional standards and methods of evaluation for food legume breeders. International Development Research Center, Postal Address : box 8500, Ottawa, Canda, Head Office: 60 Queen street, Ottawa.

Jain, D. and Tiwari, G. (2003). Thermal aspects of open sun drying of
various crops. Energy, 28: 37-54.

Janjai, S. and Tung, P. (2005). Performance of a solar dryer using hot air from roof-integrated solar collectors for drying herbs and spices. Renewable Energy, 30: 2085-2095.

Khattab, A.G., A.H. Eltinay and A.A.M. Nour. (1982). Chemical composition of some date palm cultivars grown in Sudan. In: Proceedings of 13th Symposium on Date Pam, Al-Hassa, Kingdom of Saudia Arabia.

Koca, N.; Burdurlu, H.S. and Karadeniz, F. (2007). Kinetics of color changes in dehydrated carrots. J. Food Eng., 78: 449-455.

Kulkarni, S. G.; Vijayanand, P.; Aksha, M.; Reena, P. and Ramana, K. V. R. (2008). Effect of dehydration on the quality and storage stability of immature dates (Phoenix dactylifera). Food Science and Technology. LWT 41:278–283.

Leminel, F. M. M.; Samb, A.; Bounal, Z. A. O. Ahmed, M. V. O. M.; Djehl T. O. and

Boukhary, A. O. M. S. O. (2014). Assessment of physicochemical diversity in fruit of Mauritanian date palm (Phoenix dactylifera L.) cultivars. African journal of agricultural research.9: 2167-2176.

Lin, M. J. Y.; Humbert, E. S. and Sosulski, F. W. (1974). Certain functional properties of sunflower meal products. J. Food Sci., 39: 368 - 370.

Mahdy, H. A. (2015). Effect of some growth regulators on fruit quality of Tamr date cultivar. J. Hort. 42: 665-673.

Maier V. P. and Metzler D. M. (1965).Quantitative Changes in Date Polyphenols and Their Relation to Browning. Journal of Food Science. 30: 80–84.

Nour, G.M.; Khalifa, A.S.; Hussein, A.A.M. and Moustafa, A.A. (1986). Studies on the evaluation of fruit characteristics on nine dry date palm cultivars grown at Aswan. Proc. 2nd Symp. on Date Palm, 3-6 March, King Faisal Univ., Al-Hassa, Saudi Arabia, pp. 163-171.

Ranganna, S. (1977). Hand book of manual of analysis of fruit and
vegetable products. New Delhi: Tata Mc Graw-Hill.

Rapusas, R. S.; Driscoll, R. H. and Srzednicki, G. S. (1995). Bulk density and resistance to airflow of sliced onions. J. Food Eng., 26: 67-80.

Roos, Y.H. (1995). Glass transition-related physicochemical changes in foods. Food Technol. 10: 97–102.

Roos, Y.H. and Karel, M. (1991a). Phase transition of amorphous sucrose and sucrose solution. J. Food Sci., 56: 38–49.

Roos, Y.H. and Karel, M. (1991b). Applying state diagrams to food processing and development. Food Technol. 45: 66–71.

Saafi, E. B.; El Arem, A.; Issaoui, M.; Hammamil, M. and Achour, L. (2009). Phenolic content and antioxidant activity of four date palm (Phoenix dactylifera L.) fruit varieties grown in Tunisia. International Journal of Food Science and Technology, 44, 2314-2319.

Sablani, S. S.; Shrestha, A. K. and Bhandari, B. R. (2008). A new method of producing date powder granules: physicochemical characteristics of powder. Journal of Food Engineering 87 (3), 416-421.

Salem, S.A.and Hegazi, S.M. (1971). Chemical composition of the Egyptian dry dates. J. Food Agric. 22: 632-633.

SAS Program, (1998). SAS/ STAT User's Guide Release 8.2 edition. Cary, NC, SAS Inst. Inc. USA.Sulieman, A. M. E.; Masaad, M. K. and Ali O. A.

Sawaya, W. N.; Safi, W. M.; Khalil, J. K. and Mashadi, A. S. (1983). Physical measurements, proximate analysis, and nutrient elements content of twenty five date cultivars grown in

Saudi Arabia at the Khalal (mature color) and Tamer (ripe) stages. Proceedings of the 1ST symp. On date palm, Saudi Arabia: 454-466.

Steel, R.; Torrie, J. and Dickey, D. (1996). Principles and Procedures of Statistics. A Biometrical Approach (3rd Edition). McGraw Hill Book Co., New York.

Sulieman, A. E.; Masaad, M. K. and Ali O. A. (2011). Effect of partial substitution of wheat flour with date powder on biscuit quality. Journals of University of Gezira. Vol. 9 No. 2 9-16.

Sulieman, A. M. E.; Azza M. S. E. and Mohamed E. E. (2009). Quality and evaluation of syrup from local date (Phoenix dactylifera L.) cultivars. Gezira Journal of Agricultural Science, Vol. 7 No2.

Sulieman, E. A. Abd Elhafise, A. I. Abdelrahim, M. A. (2012). Comparative Study on Five Sudanese Date (Phoenix dactylifera L.) Fruit Cultivars. Food and Nutrition Sciences, 3, 1245-1251.

Swain, T. and Hillis, W.E. (1959). The phenolic constituents of Primus donwstica 1.-The quantitative analysis of phenolic constituents. J. Sci. Food Agric. 10:63-68.

Yousif, A.K.; Abdelmasseh, M.; Yousif, M.E. and Saeed, B.T. (1987). Use of date paste in the processing of nutritious candy bars. Date Palm J. 5 (1): 107-116.