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Effect of Drying Methods on Chemical Composition, Mineral and Antioxidants of Saidy Date (*Phoenix dactylifera* L.) Fruits Residue.

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ABSTRACT

Low quality fruits of Saidy date (Semi-dry variety, high quality) were analyzed for their chemical composition, total phenolic and antioxidants content. The Saidy date fruits residue (DFR) obtained after juice separation was used in this study. The effect of drying methods (Hot air oven and microwave drying) on chemical composition, minerals, phenolics content and antioxidant activity of Saidy date fruits residue (DFR) was studied. Total carbohydrates was the major component of the DFR recorded 78.31, 75.88 and 75.53 % of the fresh, hot air oven and microwave dried (DFR) samples; respectively. The DFR had high contents of total dietary fibers (62.97, 65.57 and 64.90 %; respectively of the same samples, dwb). The insoluble dietary fibers had the highest values of the total dietary fibers recorded 48.86, 49.38 and 47.93%; respectively of the same samples. While, the soluble dietary fibers varied from 14.11 to 16.97%. The microwave dried (DFR) sample had the highest values of moisture, ash, crude protein, fat and fibers (4.40, 2.57, 3.87, 1.11 and 16.92% dwb; respectively) compared to the hot oven air dried samples. The total phenolics content was 1.92, 2.12 and 2.28% of the fresh, hot air oven and microwave dried (DFR) samples; respectively. Besides, the antioxidant activity (DPPH) was 55.13, 62.62 and 60.13 of the same samples; respectively. Potassium content was the predominate value followed by phosphorous, magnesium and calcium in the dried DFR samples. With regard to the effect of drying methods on the composition of DFR samples, there are no differences among them except the drying time. Dates fruit residue (DFR) it may be a good source of dietary fibers, total phenolic contents and natural antioxidants which will ultimately result in adding value to the date fruits residue of low quality dates.

Keywords: Date fruit residue, Saidy, Microwave drying, Chemical composition, Total phenolics, Dietary fiber, Antioxidant activity.

INTRODUCTION

Date fruits (*Phoenix dactylifera* L.), a healthy and highly nutritious food, is one of the most widely distributed fruits in the world and also has played important role in people's daily lives for thousands of years (Al-Shahib and Marshall, 2003). World production of dates has increased significantly and clearly over the last 30 years. Arab countries produce about 74.5% of world history production. Egypt is the first country of the world's top ten producers of history (FAO, 2015).

Dates fruits are marketed around the world as high-value confectionery. On the other hand, too date as a fresh fruit it was remains an important subsistence crop in most of the Arabian countries. Today, the production, application and manufacture of dates in the world had been continuously increasing in Arab countries and Egypt (Assous *et al.,* 2009 and Chandrasekaran and Bahkali, 2013).

The dietary fiber of cereals is considerably used than those of fruits; while, fruit fibers are of better quality due to high total and soluble fibers content, as well as water and oil holding capacity and colonic ferment ability, In addition to lower content of phytic acid and caloric value. Thus, it was becomes necessary and important to develop different processes for the preparation of fruit fibers that decrease the losses of the associated bioactive compounds which may have exert higher health-promoting effects than dietary fiber itself. The dietary fibers concentrates can be used in different applications in the food industry while also obtaining excellent results. Fiber containing about 15% soluble dietary fibers (SDF) is fitted for to bind and retain water weight more than once (Herbafood, 2002). Dates are good source of dietary fiber (Elleuch *et al.,* 2008). The percentage of dietary fiber was content of dates ranged from 4.4 to 11.4% this ratio relying on date variety and ripening stage (Spiller, 1993 and Al-Shahib and Marshall, 2002).

The Americans Dietary Guidelines published which was jointly published by the U.S. Department of Agriculture and by the Health and Human Services recommend eating foods containing enough amounts of fiber. On the other hand, the National Cancer Institute was recommends 20 to 30 grams of fiber in the day with a maximum of (35 g). Therefore, to meet these different requirements, fibers are supplement to different food products. In addition to health benefits, fiber is added to increased cooking productivity and water retention capacity, reduce fat retention, improve structural properties and structure, or also add as a multiplication factor to reduce the content of different calories (Larrauri, 1999).

A large part of the dates in countries producing dates (e.g. 30% loss of total produce) due to many reasons its inferior quality, damage, and smaller fruits for the unattractive appearance to the consumer (Besbes *et al.,* 2009). Besides, it was also recorded that dates are also lost during various processes such as the sorting, conditioning and storage (Cheikh-Rouhou *et al.,* 2006). Non-use of lower quality dates by-product for humans food is a real economic loss because it is rich in biologically active compounds that can be extracted and can be used as value-added materials to food (Elleuch *et al.,* 2008).

The date low quality is processed to produce many products such as date syrup. Consequently, are available very large amounts of date fruit residues (DFR), which is the by-product from syrup extraction (Hashim and Khalil, 2015).

The drying method is widely way used in processing various foods which allowing the extension the shelf life of the materials (Fernandes *et al.*, 2010). Nevertheless, the processing may be cause many irreversible modifications to the polysaccharides in the cell wall, Which can affect its original structure. This may therefore promote significant modifications of these polymers in proposed physiological and pharmacological properties (Femenia, 2007).

The aim of this study is to evaluate the effect of some drying methods on chemical composition, dietary fibre, phenolics content and antioxidant capacity of date fruit residue (DFR). Thence, the information will be useful to encourage DFR as a potential source of fibre in the development of functional food products with beneficial health benefits for humans.

MATERIALS AND METHODS

Materials:

Saidy dates fruit it was obtained from the Date Paking Factory, El-Kharga oasis, The New Valley governorate, Egypt, during the 2014 season. Date fruits were cutting into small pieces, weighed and then put in hot water (75 °C) at a ratio of 1:3 w/v for 30 min with continuous stirring, The mixture obtained is filtered using a thin cloth according to Ramadan (1998 and 2000) to separation the juice from the date pulp (date fruit residue, DFR).

The date pulp residue (date cake) was divided into three parts; two of them were dried as the following ways: The first part of Saidy fruits residue (DFR) was dried by a microwave oven at 40W for 14 min. The second DFR was dried by hot-air oven at 60°C for 5 hours (Ied, 2011). The dried DFR samples were ground by pattern laboratory mill and sieved (0.125 mesh). All DFR samples were packed in laminate sacs PPA packing material (polyethylene, polyester and aluminium foils). Finally, cakes powders were preserved until analyses at 5± 2°C.

Analytical Method:

Chemical and physical analysis:

The moisture content was determined by drying the samples at 70°C. Sugars (reducing and total), crude fiber, protein, fat, ash content and the acidity as malic acid by titration were appointed according to AOAC (2005) methods. Non-reducing sugars calculated by difference. The mineral content of DFR was estimated, Sodium, potassium and calcium were determined in samples using the Flame Photometer (Gallenkamp, FGA 330, England). Iron, copper, manganese, magnesium and also were determined the zinc using Perkin Elmer Atomic Absorption Spectrophotometer (model 80, England).

Contents of soluble, insoluble and total dietary fiber were determined in the different samples of date fruit residues (DFR) powder as according to Asp *et al.* (1983).

Total phenolics compounds it was determined also, using Folin- ciocalteu reagent as described by Velioglu *et al.* (1998) as pyrogallol. Antioxidant capacity; the free radical scavenging activity of extract date fruits was determined using the 1, 1- diphenyl-2-picrylhydrazyl (DPPH) method according to (Ao *et al.,* 2008).

$$\text{(DPPH) radical scavenging \%} = \frac{\text{OD control} - \text{OD sample} \times 100}{\text{OD control}}$$

RESULTS AND DISCUSSION

Chemical composition of Saidy date fruits:

Consumer interest focused mainly on the nutritional characteristics of the product. Therefore, the development of a quality profile of history will include an assessment of the overall chemical composition, total polyphenol content and the antioxidant activity of Saidy date fruits at Tamr stage were determined and results showed in (Table 1). The moisture content of Saidy fruits was 14.28%. This result is in agreement with those obtained by Al - Abdulhadi *et al.*(2011) varied from13.96 to 15.52% of three date varieties, while, it is a lower than that reported by Ismail (2011).

The data showed that the total sugars content was 77.12 % while, the reducing and non- reducing sugars were 71.21 and 5.91%; respectively of Saidy dates. These results are in agreement with those reported by Abd-Elkarim (2016). Abd El-Majeed (2016) found that the total sugar, reducing and non- reducing sugars content of Saidy date were 77.93, 74.10 and 3.83 %; respectively. The data showed that the crude fiber content was 2.89 % which is in the same line with that reported by Abd El-Majeed (2016). However, it is lower than that reported by Abd-Elkarim (2016) in Saidy fruits (9.26 %).

The ash content (2.47%) of Saidy fruits in the line with those reported by Abd-Elwahid (2007). The crude protein content was 2.38 %, which in the same trend of those obtained by Abd Ellah (2009). The data (Table 1) also showed the fat content (1.20%) of Saidy fruits agreement with those obtained by Ramadan (1990 and 1995) and Abd-Elkarim (2016). Abd El-Majeed (2016) found that the fat content 1.49% of Saidy dates.

The total polyphenol content of Saidy date fruits was 2.60% which are higher than that reported by Ismail (2011) on Siwi date (1.16 %) at Tamr stage. Assous (1999) reported that the content of total polyphenol (expressed as pyrogallol) at Tamr stage of Siwi date was 0.78 % (dwb). Abd El-Majeed (2016) recorded that the Saidy date flesh contained 297.37 mg as gallic acid/ 100g on dry weight basis. This difference in total polyphenols from date fruits can be due to the different criteria used, the date of dates and the maturity of the dates fruits studied.

The data showed that the antioxidant activity of Saidy date fruits was 70.48%. This result is in the same line with those obtained by Abd El- galil (2017), found the antioxidant activity of El Sakkoti and Tamr El wadi was 79.61and 76.15 %; respectively.

Table 1. Chemical composition of Saidy date fruits* (% dry weight basis; dwb, except moisture):

Components	%
Moisture	14.28±0.15
Ash	2.47±0.015
Crude protein	2.38±0.025
Crude fat	1.20±0.02
Crude fiber	2.89±0.03
Nitrogen free extract	93.95±0.5
Reducing sugar	71.21±0.08
Non reducing sugar	5.91±0.014
Total sugars	77.12±0.09
Total phenolic content	2.60±0.02
Antioxidant activity(DPPH)	70.48±0. 2

***Means of three replicates ± SD**

Chemical composition of date fruit residue (DFR):

The results (Table 2) indicated that the moisture content of Saidy date fruit residue (DFR) was 20.22, 4.25 and 4.40 % for the fresh, oven hot air and microwave dried samples; respectively. The moisture content of fresh DFR was higher than that recorded by Al-Farsi *et al.* (2007) and Hashim and Khalil (2015). Hasnaoui *et al.* (2012) reported

that date fiber concentrates from Moroccan date flesh exhibited moisture content ranged from 4.43-12.29 %. Hamoda (2018) reported that moisture content of Saidy date fiber was 11.53%. The differences compositional can be related to the date varieties and the different types of techniques used in extraction.

Carbohydrate was the major component of Saidy DFR date, recorded 78.31, 75.88 and 75.53% (dry weight basis) for the fresh, oven hot air and microwave dried DFR samples; respectively. Relatively similar carbohydrate values were reported for the Tunisian date fiber concentrates (Elleuch *et al*., 2008). Hamoda (2018) found that the carbohydrate values content 84.56% of Saidy date fiber.

Moreover, ash and crude protein content of the studied samples varied from 1.91 to 2.57% and 2.87 to 3.87%; respectively. Data in (Table 2) are in agreement with that recorded by Elleuch *et al.* (2008), Hashim and Khalil (2015) and Hamoda (2018).

Data in Table 2 illustrated the crude fat and fiber ranged from 1.11 to 1.25% and 15.66 to 16.92%; respectively. The DFR reducing, non-reducing and total sugars were 12.71, 1.19 and 13.90; 11.92, 1.00 and 12.92; and 12.04, 1.11 and 13.15% for the fresh, oven hot air and microwave dried DFR; respectively. These data is consistent with that reported by Al-Farsi *et al.* (2005 and 2007), Figuerola *et al.* (2005), Elleuch *et al.* (2008), Besbes *et al.* (2009), Borchani *et al.* (2012), Hashim and Khalil (2015) and Hamoda (2018) .

The contents of soluble (SDF), insoluble (ISDF) and total dietary fiber (TDF) Table (2) of the Saidy DFR varied from 14.11 to 16.97%, 47.93 to 48.86% and 62.97 to 65.57% of the fresh, oven hot air and microwave dried DFR; respectively. These values are agreement with those recorded by Figuerola *et al.* (2005). Besides, Elleuch *et al.* (2008) founded that the TDF content for freeze-dried dietary fiber concentrates ranged from 88 to 92% for Deglet Nour and Alligh; respectively. The reason for the difference can be attributed to growth, climatic conditions, geographic origin, or an important factor, the difference in different extraction methods.

By-products of dates can be considered a good source of DF. Contents of soluble DF in dates are relatively high compared to cereals and cereal derivatives which have a low soluble DF (0.4 – 4%) (Abdul-Hamid and Luan, 2000 and Prosky *et al.,* 1988). Results are in the same line with that recorded by Al-Farsi *et al.* (2007), Borchani *et al* (2011) and Hashim and Khalil (2015), but lower than that recorded by Elleuch *et al.* (2008).

Hamoda (2018) reported that date fiber concentrates (DF) from Saidy date was 64.29, 20.76 and 43.53 soluble, insoluble and total dietary fibers; respectively.

Thus, we can explain this by the presence of a part of the protein that is strongly linked to the components of the cell wall (O'Neill and Selvendran, 1985 and Redgwell and Selvendran, 1986) as well as another part of the protein that is insoluble in water.

The total phenolics content was 1.92, 2.12 and 2.28% of the fresh, oven hot air and microwave dried DFR; respectively. The results are in the same line with that recorded by Al-Farsi *et al.* (2005 and 2007). Cell wall heat treatment may disrupt and release phenolic compounds from the insoluble part of the plant (Choi *et al.*, 2006 and Jeong *et al.*, 2004). Compared to fresh fruits (Ancos *et al.,* 2000 and Moyer *et al.,* 2002) as well as dried fruits (Wu *et al.,* 2004), dates and date by-products (on the particular seeds) can be considered as rich sources of total phenols.

Table 2. Effect of drying methods on the chemical composition of Saidy date fruits residue (DFR)* (% dry weight basis except moisture):

Composition	Date fruits residues (DFR)		
	Fresh	Oven dried	Microwave dried
Moisture	20.22±0.09	4.25±0.005	4.40±0.002
Ash	1.91±0.008	2.40±0.03	2.57±0.06
Crude protein	2.87±0.04	3.78±0.05	3.87±0.04
Crude fat	1.25±0.002	1.08±0.01	1.11±0.009
Crude fiber	15.66±0.09	16.86±0.009	16.92±0.1
Total carbohydrate **	73.75±0.2	88.49±0.2	88.05±0.15
Reducing sugar	12.71±0.15	11.92±0.009	12.04±0.15
Non reducing sugar	1.19±0.009	1.00±0.01	1.11±0.02
Total sugars	13.90±0.15	12.92±0.15	13.15±0.15
Total dietary fiber (TDF)	62.97±0.2	65.57±0.2	64.90±0.2
Soluble dietary fiber(SDF)	14.11±0.2	16.19±0.10	16.97±0.15
Insoluble dietary fiber (ISDF)	48.86±0.08	49.38±0.02	47.93±0.15
Total phenolic content	1.92±0.008	2.12±0.05	2.28±0.03
Antioxidant activity(DPPH)	55.13±0.09	62.62±0.2	60.13±0.1

*** Means of triplicates ** Carbohydrate was calculated by difference**

The antioxidant activity (DPPH) was 55.13, 62.62 and 60.13% of the fresh, oven hot air and microwave dried DFR samples; respectively. These results are in the same line with that recorded by Al-Farsi *et al.* (2007) and Borchani *et al.* (2011). High antioxidant activity has been reported from dates by Vayalil (2002) and Guo *et al.* (2003). These values of antioxidant activity have also been reported much higher than those found in mango fruit fibers (16.14 mg/g), also guava fiber (26.3–58.7 mg/g) (Jiménez-Escrig *et al.,* 2001, Ubando-Rivera *et al.,* 2005, and Vergara-Valencia *et al.,* 2007). On another side, though the researchers was used extraction solvents and different methods, which make any quantitative difficult, Vayalil (2002) was reported that antmutagenic activities and potent antioxidant of dates implicate free radical scavenging activity.

Minerals content of the (DFR) powder:

The minerals content of Saidy date fruits residues powder (DFR) is shown in Table 3. Potassium was the major (501.36 and 503.60 mg) followed by phosphorous (468.24 and 470.69 mg), magnesium (370.51 and 368.04 mg), calcium (118.45 and 118.11 mg) and sodium (45.51, 43.12 mg) /100 g of the oven hot air and microwave dried samples; respectively.

The dried DFR samples contained a low level but a good source of iron, manganese, zinc and copper (Table 3). These results are in close agreement with those of many other studies (Borchani *et al.,* 2010 and Hashim and Khalil, 2015). While, these data in Table 3 Where there is a significant difference from the values reported for date fruits flesh (Elleuch *et al.,* 2008). Hamoda (2018) reported that mineral content of DF was potassium concentration was the highest (754 mg) followed with in descending order by phosphorus (501 mg), magnesium (452 mg), and

calcium (154 mg) /100g dry matter of DF. The variation of mineral content could can arise due to several reasons including originate from the same cultivar, agro-climatic and different environmental conditions (Yousif *et al.,* 1982).

The high amount of potassium coupled with low amount of sodium serves acts as a systematic strategy to prevent or control high blood pressure, decrease cardiovascular morbidity and mortality, kidney disease, stroke, and cardiovascular disease (Aaron and Sanders, 2013).

Table 3. Effects of the drying methods on the minerals contents (mg/100g dwb) of Saidy date fruits residue (DFR):

Element	Date fruits residues (DFR)	
	Oven dried	Microwave dried
Sodium (Na)	45.51	43.12
Potassium (K)	501.36	503.60
Calcium (Ca)	118.45	118.11
Phosphorous (P)	468.24	470.69
Magnesium (Mg)	370.15	368.04
Zinc (Zn)	10.119	10.133
Iron (Fe)	14.00	14.31
Copper (Cu)	5.129	5.132
Manganese (Mn)	0.210	0.223

CONCLUSIONS

The results indicated that the date fruit residues (DFR), appears as a good and suitable source for dietary fiber, total phenolics and antioxidant capacity. Therefore, could be considered the DFR as substitution dietary fiber with health benefits and source for different food products. Therefore, this will provide a solution for disposal processing by-products of dates and benefits to the date industry.

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تأثير طرق التجفيف على التركيب الكيميائي، المعدني ومضادات الأكسدة لعجينه ألياف ثمار البلح الصعيدي

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في هذه الدراسة تم تقدير التركيب الكيميائي، محتوي الفينولات الكلية ومضادات الأكسدة فى الثمار المنخفضة الجودة من البلح الصعيدي (صنف نصف جاف، عالي الجودة). وقد أستخدم اللب (عجينه الثمار DFR) الناتج بعد فصل العصير من الثمار لدراسة تأثير طرق التجفيف (فرن الهواء الساخن والميكروويف) على التركيب الكيميائي، المحتوي المعدني والفينولات الكلية والنشاط المضاد للأكسدة لهذه العجينة (DFR). أظهرت النتائج (علي أساس الوزن الجاف) أن الكربوهيدرات الكليه كانت المكون الرئيسي في (DFR) حيث سجلت ٧٨.٣١، ٧٥.٨٨ و ٧٥.٥٣٪ في العينات الطازجة، فرن التجفيف بالهواء الساخن والميكروويف، على التوالي. وكانت نسبة الألياف الغذائية الكلية ٦٢.٩٧، ٦٥.٥٧ و ٦٤.٩٠% لنفس العينات على التوالى. وكانت الألياف الغذائية غير الذائبة أعلى القيم من الألياف الكلية حيث سجلت ٤٨.٨٦، ٤٩.٣٨ و ٤٧.٩٣٪، بينما تراوحت نسبة الألياف الغذائية الذائبة بين ١٤.١١ و ١٦.٩٧%. وكانت العينات المجففه بالميكروويف هى الأعلى فى محتواها من الرطوبة، الرماد، البروتين الخام، الدهن الخام و الألياف الخام (٤.٤٠، ٢.٥٧، ٣.٨٧، ١.١١ و ١٦.٩٢% لنفس العينات على التوالى مقارنة بالعينات المجففة بالفرن. وقد وجد أن محتوى العينه الطازجة، المجففة بالفرن و المجففة بالميكروويف من الفينولات الكلية هو ١.٩٢، ٢.١٢ و ٢.٢٨% على التوالى. إضافة إلى النشاط المضاد للأكسدة (DPPH) الذى سجل ٥٥.١٣، ٦٢.٦٢ و ٦٠.١٣ لنفس العينات على التوالى. كما تشير النتائج إلى أن البوتاسيوم هو السائد بين العناصر المعدنية يليه الفسفور، المغنيسيوم و الكالسيوم فى العينات المجففة. بالنظر إلى النتائج المتحصل عليها تبين أنه لا توجد فروق واضحة بين طريقتى التجفيف فى التأثير على تركيب عينات عجينه الثمار فيما عدا الوقت اللازم للتجفيف. ومن النتائج المتحصل عليها يمكن إعتبار عجينه الثمار مصدراً جيداً للألياف الغذائية، الفينولات الكلية و مضادات الأكسدة الطبيعية، والتى تمثل قيمة إضافية لثمار البلح منخفضة الجودة.