

Original research

Chemical Composition and Sugars Profile of Aswan's Dry Dates Species as Affected by Sun Drying, Storage and Harvesting Time

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Abstract:

This study was carried out on five varieties of dry date fruits; Sakkoti, Bartamuda, Gondaila, Malkabii and Shamia, which are the most common and popular dry date fruits cultivated in Aswan Governorate. Sun drying process was applied as a cheap and easy preservation technique. The gross chemical composition (Moisture, crude protein, crude fiber, crude fat, ash, available carbohydrates and sugars fractions [reducing, non-reducing, total sugar, sucrose, glucose and fructose]) of date fruit samples were investigated in fresh date fruits at Tamar stage, and in date fruits after sun drying for 25 days at maximum temperature about 40°C, then the dried dates were stored at ambient temperature for (12 months), during two harvesting seasons (2020 and 2021). Moisture, crude fat, crude protein and ash contents were decreased after sun drying, while available carbohydrates and crude fiber were increased in all cultivars. Glucose, fructose and sucrose were the most abundant sugars in all cultivars, that are making them a rich source of energy for the human system. At Tamar stage total sugars, non-reducing sugars, sucrose, and fructose content were higher in Malkabii date fruits than other date cultivars, while reducing sugar and glucose content were higher in Gondaila date fruits. After sun drying process, all sugar types were reduced. **Keywords:** dry date variety, sun drying, total sugars and sugar fraction

1- Introduction

Date palm (*Phoenix dactylifera* L.) is one of the maximum crucial plants of the arid barren region place of the Middle East, Southern Asia and Northern Africa for over 5000 years (**Selim et al., 2012**).

Egypt is the world's leading producer of date palm. It possesses over 15.5 million palm trees on a total area of approximately 135 thousand acres, which represents the whole area planted with palm trees in the Governorate of Egypt. Egypt's total date output is over 1.8 million tons. The governorate of Aswan supplied 2,212,148 fertile female palms, which produce about 120-155 ton/year (**Ministry of agriculture, 2022**).

Dates were the fruits with high nutritional composition besides highly perishable, so it is essential to prevent the dates from deterioration by using several drying methods available (**Saikiran et al., 2018**).

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Date fruit is of high-quality non secular and socio-financial importance and had been cultivated and fed on as a critical element of the weight reduction plan of the habitats of local human beings (Haynes and McLaughlin, 2000).

This fruit may be very wholesome because it consists of many types of dietary fiber and carbohydrates 44-88% predominately; (glucose, fructose, and sucrose). Fiber (6.40-11.50%), and protein (2.3-5.6%), sugar fractions represent about 70% (Al-Shahib and Marshall, 2003).

Elghazali and Hussin (1999) reported that the protein content of Sakkoti, Bartamuda and Gondaila were (3.41, 2.88 and 2.61 %) for fresh Aswan's dry date, (2.74, 2.45 and 2.63) for sun-drying, and (3.03, 2.23 and 2.19) for mechanical drying; respectively.

The protein content on dry weight basis of Rothana, and Nabtat Ali; respectively were (1.96 and 2.84 %) for fresh date, (1.70 and 2.12 %) for oven drying, and (1.70 and 2.15 %) for sun drying (El-Sharnouby et al. 2007). Crude protein content of El Sakkoti date was 2.13 % for fresh date (Zeinab, 2017).

Dates are a good source of dietary fiber and depending upon the variety and stage of ripening, it ranged from 6.4 to 11.5% in 14 different varieties, and some of the low-quality dates, which are used for industrial purposes, have been found to contain up to 10% of crude fiber (Al-Shahib and Marshall, 2003).

Recently; consumers are increasingly preferred and looking for foods with health benefits which eventually change the diet patterns. High-fiber diets are in great demand in the market, which are associated with the prevention and treatment of some diseases such as coronary heart-related diseases, diabetes, constipation, diverticular disease, colonic cancer etc. Furthermore, the most common form of fiber is insoluble fiber (cellulose, lignin, and some hemicelluloses), which reduces constipation and were studied for its potential to reduce the risk of colon/rectal cancer (Peressini and Sensidoni, 2009).

The sugars in dates are effortlessly digested and can straight away be moved to the blood after consumption and can quick be metabolized to release energy for various cellular sports. Dates are also terrific supply of fiber, and comprise many vital vitamins and minerals, including extensive amounts of calcium, iron, fluorine, and selenium (Al-Shahib and Marshall, 2003; Al-Farsi et al, 2005 and Khan et al, 2008).

The region of production and variety can significantly affect the glucose and total sugar contents of date fruit. Ismail et al, (2006) reported higher fructose concentrations, with a glucose-to-fructose ratio at Tamar stage, in five different date varieties (Khalas, Barhee, Fard, Boumaan, Ruzeiz) grown in the UAE.

Therefore, the aim of this work was to compare the chemical composition of five dry date palms (Sakkoti, Bartamuda, Gondaila, Malkabii and Shamia) at Tamar stage, after sun drying and after storage (12 months at room temperature).

2- Material and Methods

2.1- MATERIALS:

Five varieties of dry date fruits (Sakkoti, Bartamuda, Gondaila, Malkabii and Shamia) cultivated in Aswan Governorate were obtained from Al-Akkab village, (15 km north of Aswan city). 100 kg of different date fruits were collected in September during two seasons (2020 and

2021) and transferred to laboratory of Food Science and Technology Department for analysis. Date samples were divided into two groups (For each variety).

Group 1- about (25 kg) of date fruits were left fresh as a control which known (Tamar) stage (full ripe stage or final stage in the ripening), and were used for analysis immediately after harvesting and illustrated as 0 time.

Group 2- about (75 kg) of date fruits were dried by the sun in opened place during September month for 25 days at maximum temperature about 40°C.

The dried samples were packed and stored in burlap sacks for full year at room temperature, samples of dried and stored date fruits were taken every two months (2, 4, 6, 8, 10 and 12 months, in order to estimate the chemical composition, sugars and sugars fraction content. The similar procedure was applied in the second season as well.

2.1.1- CHEMICALS

All chemicals and solvents were of analytical grade and obtained from local Chemical Companies ex, (Al-Gamhoria Company), except chemicals used in HPLC analysis were purchased from Sigma-Aldrich Chemical Company. The distilled water was used for the preparation of all solutions.

2.2- ANALYTICAL METHODS:

2. 2. 1- Determination of chemical composition:

Moisture content was determined by heating samples at 70 ± 1 °C in a hot air oven. Ash, crude protein, crude fat and crude fiber were determined according to the method which described by (A.O.A.C., 2015).

2. 2. 2- Determination of available carbohydrates (Nitrogen free extract):

The available carbohydrate (Nitrogen free extract) content of the studied samples was determined as follow:

% of available carbohydrates = $100 - [\% \text{ moisture} + \% \text{ crude protein} + \% \text{ crude lipid} + \% \text{ ash} + \% \text{ crude fibre}]$ (A.O.A.C., 2015).

2. 2. 3- Determination of sugars:

The clarified water extract of date sample was used to determind the reducing and total sugares by **Lan** and **Eynon** method according to (A.O.A.C., 2015). Non-reducing sugars were collected by deffrences. The fractionations of sugars (glucose, fructose and sucrose) were analyzed by High Performance Liquid Chromatography (HPLC) according to (A.O.A.C., 2015).

2. 3- Statistical analysis:

The statistical analysis was carried out using IBM SPSS Statistics 25, PC statistical software. LSD Multiple Range Test was applied to assess significant differences between means at 5% levels of probability. Each experiment in triplicate repeated at least twice and the values presented in terms of means standard error. Means with different letters (a, b, c, d) in the same column differed significantly at ($p \leq 0.05$), while those with similar letters are not significant differences (Steel *et al.*, 1997).

3. RESULTS AND DISCUSSION

3.1. Chemical composition:

The results of chemical composition of the studied date varieties at Tamar stage of maturity and after sun drying and storage time, during two seasons [2020 and 2021] were presented in Tables (1 and 2). Data indicated that fresh date fruits contained high percentage of moisture at Tamar stage of maturity ranged from 19.06 – 19.57 % for Sakkoti, 19.46 – 19.78 % for Bartamuda, 14.36 – 13.37 % for Gondaila, 13.61 – 12.65 % for Malkabii and 18.05 – 17.77 % for Shamia. The moisture content were decreased in all samples after sun drying and by progressing of storage times, it was between (2.16% in Gondaila and 4.27% in Shamia fruit dates). Also, during two seasons all varieties of date fruit had small amounts of crude protein, crude fat and ash content, which were slightly decreased after drying and storage periods. The crude protien, crude fat and ash contents were decreased from 3.09 to 1.78%, from 3.33 to 1.56%, and from 3.17 to 1.65%; respectively from Tamar stage up to the end of storage peroid.

Table 1: Effect of sun drying process and storage periods on chemical composition of Aswan’s dry date varieties during season 2020.

Date varieties	Storage periods (Months)	Chemical composition (%)					
		Moisture	Crude protein	Crude fiber	Crude fat	Ash	Available carbohydrates
Sakkoti	0	19.06±1.14a	2.86±0.06a	13.52±2.17a	2.72±0.19a	2.54±0.12a	59.30±0.99a
	2	5.34±1.19b	2.35±0.06b	15.44±0.15b	1.96±0.19b	2.22±0.18b	72.69±0.55b
	4	5.32±2.30b	2.22±0.09c	15.62±0.42b	1.91±0.06b	2.15±0.15c	72.78±0.43b
	6	5.12±1.90b	2.18±0.09d	15.90±0.37c	1.86±0.12c	2.07±0.18d	72.87±0.08c
	8	4.25±0.48c	2.01±0.06e	16.02±0.18cd	1.78±0.21d	1.99±0.12e	73.95±0.15d
	10	3.68±0.82d	1.99±0.12e	16.15±0.30cd	1.67±0.09e	1.87±0.12f	74.64±0.06f
	12	3.12±0.07e	1.91±0.12f	16.25±0.18d	1.57±0.18f	1.65±0.12g	75.50±0.12g
Bartamuda	0	19.46±0.24a	2.75±0.09a	9.88±0.15a	3.32±0.16a	2.37±0.19a	62.22±0.09a
	2	5.61±2.46b	2.38±0.18b	10.57±0.48b	2.23±0.15b	2.09±0.12b	77.12±0.23b
	4	4.88±0.62c	2.31±0.09c	11.20±0.15c	2.15±0.12c	2.05±0.12c	77.41±0.08c
	6	4.66±0.24c	2.27±0.09d	11.47±0.18d	2.05±0.06d	2.03±0.15d	77.52±0.16c
	8	4.11±0.32d	2.19±0.07e	11.88±0.12e	1.97±0.12e	1.96±0.09e	77.89±0.12d
	10	3.94±0.33d	2.09±0.06f	12.07±0.12f	1.88±0.15f	1.86±0.15f	78.16±0.14g
	12	3.18±0.40e	2.06±0.09g	12.23±0.15g	1.79±0.26g	1.76±0.15g	78.98±0.15b
Gondaila	0	14.36±2.24a	2.85±0.09a	13.59±0.24a	3.33±0.15a	2.73±0.18a	63.14±0.09e
	2	4.33±0.18b	2.36±0.09b	14.20±0.32b	2.27±0.12b	2.22±0.09b	74.62±0.13d
	4	4.24±0.19b	2.30±0.06c	14.28±1.62bc	2.20±0.15c	2.15±0.12c	74.83±0.26e
	6	4.08±0.48b	2.28±0.09c	14.36±0.21bc	2.12±0.16d	2.02±0.12d	75.14±0.18f
	8	3.80±0.37c	2.13±0.04d	14.48±0.22d	2.06±0.09e	1.97±0.09e	75.56±0.21g
	10	3.46±0.29d	2.09±0.12e	14.90±0.27d	1.93±0.21f	1.87±0.18f	75.75±0.43e
	12	3.15±0.30e	2.03±0.06f	15.09±0.21d	1.84±0.21g	1.66±0.15g	76.23±0.48g
Malkabii	0	13.61±0.59a	2.76±0.06a	11.20±0.12a	2.55±0.12a	2.98±0.68a	66.90±0.24a
	2	5.06±0.26b	2.59±0.09b	13.79±0.24b	2.13±0.15b	2.50±0.06b	73.93±0.32b
	4	4.89±0.62c	2.50±0.09c	13.94±0.32bc	2.08±0.12c	2.45±0.09c	74.14±0.43c
	6	4.60±0.29d	2.47±0.06d	14.09±0.26cd	1.97±0.18d	2.38±0.12d	74.49±0.28d
	8	4.13±0.12e	2.32±0.06e	14.20±0.15d	1.86±0.18e	2.23±0.15e	75.26±0.47e
	10	3.91±0.21f	2.22±0.09f	14.61±1.36e	1.75±0.15f	2.16±0.15f	75.35±0.33f
	12	3.16±0.18g	2.16±0.12g	15.05±0.08f	1.66±0.18g	2.06±0.15g	75.91±0.15g

Date varieties	Storage periods (Months)	Chemical composition (%)					
		Moisture	Crude protein	Crude fiber	Crude fat	Ash	Available carbohydrates
Shamia	0	18.05±0.63a	2.88±0.15a	11.88±0.15a	3.05±0.78a	3.15±0.12a	60.99±0.22a
	2	6.00±0.50b	2.50±0.06b	15.47±0.18b	2.31±0.24b	2.87±0.20b	70.85±0.44b
	4	5.86±0.15c	2.48±0.09b	15.56±0.15c	2.23±0.18bc	2.77±0.09c	71.10±0.27c
	6	5.74±0.12c	2.43±0.12c	15.67±0.21d	2.14±0.16cd	2.63±0.15d	71.39±0.44d
	8	5.49±0.21d	2.34±0.04d	16.01±0.07e	2.01±0.09d	2.52±0.12e	71.63±0.24e
	10	5.04±0.82e	2.17±0.06e	16.11±0.12f	1.97±0.21e	2.41±0.12f	72.30±0.31f
	12	4.27±0.41f	2.12±0.09f	16.38±0.15g	1.87±0.18e	2.21±0.09g	73.15±0.21g

0 = Fresh dates, (2, 4, 6, 8, 10 and 12) months of storage after sun drying.

Means with different letters in the same column have significantly difference at ($p \leq 0.05$), while those with similar letters have no significant difference inbetween.

Gondaila and Malkabii date fruits contained the highest percentage of crude protein (3.09 and 2.99%; respectively). Gondaila and Bartamuda date fruits contained the highest percentage of crude fat (3.33 and 3.32%; respectively). Shamia and Malkabii date fruits contained the highest percentage of ash that was about (3.17 and 2.98%; respectively). The obtained results indicated that all date fruit samples had high content of crude fiber and available carbohydrates (Table 1 and 2). The crude fiber content ranged from 14.26 to 9.28% for Gondaila and Bartamuda date fruits; respectively at Tamar stage.

The available carbohydrates content at Tamar stage during two seasons was (66.90 and 68.84%) for Malkabii fruit which had the highest value, while the lowest values were 59.30 and 60.40% for Sakkoti fruit; respectively. The presented data revealed that drying and storage process during two seasons led to an increasing in crude fibers and available carbohydrates content.

These results are in agreement with (Al-Farsi and Lee, 2008; Ali *et al*, 2009; Abd-Ellah, 2009; Elghazali *et l*, 2010 and Alsmairat *et al*, 2019).

Al-Shahib and Marshall, (2003) reported that the total dietary fiber content was ranged from 6.4 to 11.5%, these differences could be depending on variety and degree of ripeness, as during the ripening process enzymes gradually break down these substances to more soluble compounds.

The analysis of variance for the chemical composition indicated that there were no significant differences at ($p \leq 0.05$) between harvesting seasons, date cultivars, and the interaction between date cultivars and storage periods also, among the interaction between date cultivars and harvesting seasons. Besides; the results indicated that the interaction between harvesting season, storage periods and date cultivars were significantly affected at ($p \leq 0.05$). On the other hand, the analysis of variance showed that there was significant difference at ($p \leq 0.05$) among storage periods. The chemical composition of dates can vary depending on the ripening stage, cultivar, soil conditions, agronomic practices growing environment, postharvest conditions, etc, (Al-Hooti *et al*, 1997 and Tang *et al*, 2013).

Table 2: Effect of sun drying process and storage periods on chemical composition of Aswan's dry date varieties during season 2021.

Date varieties	Storage periods (Months)	Chemical composition (%)					
		Moisture	Crude protein	Crude fiber	Crude fat	Ash	Available carbohydrates
Sakkoti	0	19.57±1.94a	2.72±0.23a	12.20±0.15a	2.64±0.16a	2.47±0.12a	60.4±0.77a
	2	6.22±0.19b	2.36±0.15b	15.27±0.44b	2.08±0.15b	2.26±0.09b	71.81±0.51b
	4	6.08±0.12bc	2.21±0.36c	15.55±0.47c	1.93±0.21c	2.15±0.15c	72.08±0.26c
	6	5.90±0.33c	2.10±0.12d	15.89±0.59d	1.85±0.15d	2.07±0.15d	72.19±1.12d
	8	5.36±0.48d	2.01±0.15e	16.17±0.24e	1.76±0.18e	1.97±0.12e	72.73±0.51e
	10	4.68±0.95e	1.90±0.15f	16.35±0.59f	1.64±0.23f	1.86±0.20f	73.57±0.07d
	12	4.09±0.18f	1.78±0.23g	16.77±0.64g	1.56±0.18g	1.71±0.44g	74.09±0.38d
Bartamuda	0	19.78±1.64a	2.90±0.22a	9.28±0.42a	3.02±0.09a	2.43±0.18a	62.59±0.66a
	2	5.32±0.95b	2.57±0.24b	10.38±1.24a	2.13±0.06a	2.21±0.09b	77.39±0.13c
	4	5.04±0.58bc	2.41±0.16c	10.91±0.61a	2.01±0.06a	2.11±0.09c	77.52±0.08c
	6	4.73±0.97c	2.31±0.12d	11.35±0.58a	1.97±0.12a	2.02±0.16d	77.62±0.03d
	8	4.14±0.33d	2.18±0.12e	11.84±0.99a	1.91±0.06a	1.95±0.12e	77.98±0.07a
	10	3.66±1.22d	2.01±0.18f	12.33±0.41a	1.85±0.14a	1.86±0.09f	78.29±0.20b
	12	3.17±0.87f	1.87±0.16g	12.97±0.87a	1.74±0.06a	1.71±0.09g	78.54±0.17c
Gondaila	0	13.37±2.19a	3.09±0.15a	14.26±0.24a	2.99±0.09a	2.72±0.15a	63.57±0.46d
	2	4.01±0.64b	2.58±0.15b	15.17±0.21b	2.14±0.06b	2.21±0.12b	73.89±0.12e
	4	3.64±0.74c	2.48±0.24c	15.49±0.78c	2.01±0.09c	2.11±0.06c	74.27±0.18f
	6	3.33±0.43cd	2.23±0.15d	15.77±0.82d	1.96±0.09d	1.98±0.09d	74.73±0.20d
	8	3.05±0.39d	2.16±0.18e	15.91±0.58e	1.85±0.13e	1.87±0.15e	75.16±0.33e
	10	2.50±1.28e	2.08±0.16f	16.23±0.58f	1.75±0.15f	1.72±0.09f	75.72±0.66g
	12	2.16±0.63f	1.97±0.21g	16.47±0.24g	1.65±0.15g	1.66±0.15g	76.09±0.47d
Malkabii	0	12.65±1.91a	2.99±0.15a	10.18±0.18a	2.41±0.09a	2.93±0.09a	68.84±0.06a
	2	4.68±1.1b	2.86±0.15b	11.88±0.70b	2.04±0.18b	2.50±0.12b	76.04±0.09b
	4	4.33±0.78c	2.77±0.20c	12.49±0.81c	1.97±0.15c	2.44±0.09c	76.00±0.64c
	6	4.05±0.47c	2.67±0.21d	13.01±0.18d	1.86±0.15d	2.26±0.09d	76.15±0.30d
	8	3.72±1.33d	2.56±0.18e	13.28±0.68de	1.75±0.16e	2.15±0.12e	76.54±0.44f
	10	3.25±0.45e	2.44±0.21f	13.45±0.55e	1.66±0.12f	2.03±0.15f	77.17±0.22g
	12	3.07±0.40e	2.04±0.29g	14.03±1.91f	1.56±0.15g	1.96±0.12g	77.344±0.17g
Shamia	0	17.77±0.91a	2.83±0.21a	12.95±0.61a	2.86±0.18a	3.17±0.20a	60.42±0.12a
	2	5.62±1.51b	2.43±0.18b	14.64±0.53b	2.29±0.09b	2.90±0.20b	72.12±0.43b
	4	5.24±0.44c	2.37±0.08c	14.81±1.36b	2.14±0.12c	2.76±0.20c	72.68±0.28c
	6	4.98±0.50c	2.26±0.21d	15.77±1.12c	2.02±0.12d	2.64±0.20d	72.33±0.33d
	8	4.36±0.78d	2.11±0.09e	16.31±0.84d	1.91±0.12e	2.50±0.12e	72.81±0.22e
	10	3.61±1.88e	2.02±0.21f	16.86±0.73e	1.79±0.15f	2.40±0.15f	73.32±0.27f
	12	3.11±0.61f	1.95±0.09g	17.48±1.48f	1.65±0.15g	2.20±0.18g	73.61±0.29g

0 = Fresh dates, (2, 4, 6, 8, 10 and 12) months of storage after sun drying. Means with different letters in the same column have significantly difference at ($p \leq 0.05$), while those with similar letters have no significant difference inbetween.

3.2- Sugar fractions Profile

Sugars are the most important constituents of dates, making them a rich source of energy for the human system. The effect of sun drying and storage periods during season 2020 and 2021

on sugar fractions (Total sugars, reducing sugars, non-reducing sugars, glucose, fructose and sucrose) contents were studied and obtained results are presented in Tables (3 and 4). The total sugars content was ranged between (82.43 and 75.77%) during the first season and between (82.09 and 76.17%) during the second season for Malkabii and Sakkoti date fruits at Tamar stage which had the highest and lowest values; respectively. The average levels of reducing sugars were ranged between (25.36 to 22.27%) during the first season for Gondaila and Sakkoti date fruits and ranged from (24.23.09 and 22.67%) during the second season for Gondaila and Malkabii date fruits at Tamar stage which had the highest and lowest values; respectively. Non-reducing sugars content was varied between (59.40 and 53.38%) and between (59.42 and 52.90%) during two seasons for Malkabii and Gondaila date fruits.

Table 3: Effect of sun drying process and storage periods on sugar and sugar fraction contents of Aswan's dry date varieties during season 2020.

Date varieties	Storage periods (Months)	Sugars content (g/100g)*			Sugar Fractions content (g/100g)*		
		Total sugars	Reducing sugars	Non-reducing sugars	Sucrose	Glucose	Fructose
Sakkoti	0	75.77±3.87 ^a	22.27±0.12 ^a	53.50±0.15 ^a	50.80±0.34 ^a	13.22±0.01 ^a	8.35±0.01 ^a
	2	69.89±4.76 ^b	17.08±0.23 ^b	52.81±2.24 ^b	49.43±0.01 ^b	10.30±0.01 ^b	6.57±0.02 ^b
	4	69.43±0.89 ^{bc}	16.98±0.12 ^c	52.45±0.06 ^c	49.36±0.02 ^b	10.23±0.01 ^c	6.43±0.01 ^{bc}
	6	68.79±1.57 ^{cd}	16.82±0.18 ^d	51.97±0.09 ^d	49.30±0.02 ^b	10.16±0.01 ^d	6.12±0.02 ^c
	8	67.12±0.15 ^{cde}	16.67±0.12 ^e	50.45±0.06 ^e	48.65±0.01 ^c	9.96±0.02 ^e	5.40±0.02 ^d
	10	65.77±0.19 ^{de}	16.43±0.20 ^f	49.34±0.07 ^f	47.97±0.01 ^d	9.31±0.01 ^f	5.02±0.01 ^d
	12	64.70±0.18 ^e	16.23±0.18 ^g	48.47±0.07 ^g	47.21±0.01 ^e	8.98±0.01 ^g	4.99±0.35 ^d
Bartamuda	0	78.50±0.18 ^a	20.84±0.18 ^a	57.66±0.04 ^a	54.79±0.32 ^a	12.03±0.01 ^a	7.74±0.03 ^a
	2	71.58±0.43 ^b	18.91±0.18 ^b	52.67±3.02 ^b	51.46±0.01 ^b	11.12±0.01 ^b	5.36±0.01 ^b
	4	71.65±0.15 ^c	18.85±0.12 ^c	52.80±1.40 ^b	51.35±0.02 ^b	10.88±0.01 ^b	5.01±0.01 ^c
	6	71.57±0.12 ^d	18.72±0.18 ^d	52.85±0.09 ^b	51.21±0.02 ^b	10.34±0.32 ^b	4.36±0.02 ^d
	8	69.63±0.18 ^e	18.56±0.09 ^e	51.07±0.12 ^c	50.65±0.01 ^c	10.11±0.02 ^c	4.12±0.01 ^e
	10	68.52±0.15 ^f	18.29±0.21 ^f	50.23±0.15 ^d	49.36±0.02 ^d	9.78±0.01 ^d	3.97±0.02 ^f
	12	67.89±0.42 ^g	18.17±0.21 ^g	49.72±0.10 ^e	48.91±0.03 ^d	9.15±0.02 ^e	3.37±0.01 ^g
Gondaila	0	78.74±0.21 ^a	25.36±0.12 ^a	53.38±3.40 ^a	50.31±0.01 ^a	14.99±0.01 ^a	8.74±0.01 ^a
	2	70.92±0.16 ^b	19.04±0.21 ^b	51.88±3.27 ^b	49.37±0.02 ^b	11.20±0.01 ^b	6.64±0.02 ^b
	4	69.64±0.09 ^c	18.88±0.18 ^c	50.76±2.32 ^b	49.30±0.02 ^c	11.13±0.02 ^c	6.58±0.02 ^c
	6	69.04±0.26 ^d	18.71±0.09 ^d	50.33±0.07 ^b	49.14±0.01 ^d	11.08±0.02 ^d	6.52±0.01 ^d
	8	68.53±0.26 ^e	18.56±0.16 ^e	49.97±0.06 ^c	48.35±0.01 ^e	10.97±0.01 ^e	6.29±0.03 ^e
	10	67.45±0.21 ^f	18.23±0.12 ^f	49.22±0.12 ^d	47.99±0.01 ^f	10.18±0.01 ^f	6.11±0.01 ^f
	12	66.65±0.21 ^g	17.88±0.12 ^g	48.77±0.09 ^d	47.26±0.01 ^g	9.70±0.02 ^g	5.96±0.02 ^g
Malkabii	0	82.43±0.09 ^a	23.03±0.12 ^a	59.40±4.27 ^a	55.86±0.34 ^a	13.40±0.07 ^a	8.66±0.01 ^a
	2	74.20±0.12 ^b	20.21±0.12 ^b	53.99±3.39 ^{bc}	50.42±0.01 ^b	12.23±0.02 ^b	7.51±0.01 ^b
	4	72.49±0.12 ^c	20.09±0.09 ^c	52.40±2.05 ^b	50.40±0.01 ^b	12.16±0.01 ^b	7.44±0.01 ^c
	6	72.12±0.12 ^d	20.03±0.12 ^d	52.09±0.12 ^{bc}	50.31±0.01 ^b	12.13±0.09 ^b	7.37±0.02 ^d
	8	71.42±0.16 ^e	19.98±0.09 ^e	51.44±0.12 ^c	49.47±0.01 ^c	11.89±0.02 ^c	7.23±0.02 ^e
	10	69.90±0.31 ^f	19.84±0.12 ^f	50.06±0.12 ^d	48.88±0.01 ^d	11.76±0.11 ^c	7.12±0.02 ^f
	12	69.13±0.67 ^g	19.76±0.16 ^g	49.37±0.10 ^e	48.11±0.02 ^e	11.03±0.01 ^d	6.98±0.01 ^g
Shamia	0	77.36±0.07 ^a	23.07±0.15 ^a	54.29±3.75 ^a	52.11±0.02 ^a	13.40±0.18 ^a	8.64±0.01 ^a
	2	64.85±0.18 ^b	18.18±0.15 ^b	46.67±0.09 ^{bc}	50.78±0.01 ^b	10.15±0.01 ^b	6.32±0.01 ^{bc}
	4	64.53±0.18 ^c	18.07±0.15 ^c	46.46±0.10 ^{bc}	50.68±0.01 ^c	10.01±0.01 ^b	6.27±0.01 ^{bcd}
	6	64.30±0.16 ^d	17.97±0.21 ^d	46.33±0.12 ^{bc}	50.62±0.01 ^d	9.97±0.02 ^b	6.14±0.24 ^b
	8	63.00±0.15 ^e	17.75±0.12 ^e	45.25±2.99 ^b	49.98±0.01 ^e	9.33±0.01 ^c	6.04±0.01 ^{cd}
	10	61.96±0.12 ^f	17.65±0.09 ^f	44.31±0.07 ^c	49.32±0.01 ^f	9.03±0.01 ^d	5.98±0.01 ^{cd}
	12	61.12±0.33 ^g	17.57±0.18 ^g	43.55±0.09 ^c	48.87±0.01 ^g	8.89±0.01 ^d	5.77±0.01 ^d

0 = Fresh dates, (2, 4, 6, 8, 10 and 12) months of storage sun drying.

Means with different letters in the same column have significantly difference at ($p \leq 0.05$), while those with similar letters are not significant difference inbetween.

*=on dry weighte

However, presented data in Tables (3 and 4) illustrated that the percentage of sucrose, glucose and fructose contents of date fruits varieties at Tamar stage during two seasons were varied. The sucrose content was ranged from 55.86 to 50.31% and from 54.85 to 49.77% during two seasons for Malkabii and Gondaila date fruits. Also the average content of glucose was ranged from (14.99 to 12.03%) and from (14.53 to 11.60%) during two seasons for Gondaila and Bartamuda date fruits. However, the average of fructose during two seasons was frequently (7-8%) in all date varieties.

These results are in agreement with those reported by (Elghazali and Hussin, 1999; El-Sharnouby *et al*, 2007; Elghazali *et al*, 2020; Ramadan *et al*, 2018 and Alsmairat *et al*, 2019).

The two most abundant monosaccharides are fructose and glucose. Glucose is readily absorbed during digestion and leads to rapid elevation of blood sugars, while fructose, with twice the sweetness, may reduce the total calorie intake compared with other foods (Liu *et al*. 2000 and Khan *et al.*, 2008).

The data in Table (3 and 4) showed the sugars and sugar fractions content (Total, reducing, non-reducing, glucose, fructose and sucrose) after sun drying and storage for 12 months, generally; the content of this components were decreased for all date fruits samples after drying and with progressing of storage periods. Despite the changes in chemical composition, sun-dried date fruits still retain many of their essential nutrients, making them a nutritious and shelf-stable diet option.

Table 4: Effect of sun drying process and storage periods on sugar and sugar fraction contents of Aswan's dry date varieties during season 2021.

Date Varieties	Storage periods (Months)	Sugars content (g/100g)*			Sugar Fractions content (g/100g)*		
		Total sugars	Reducing sugars	Non-reducing sugars	Sucrose	Glucose	Fructose
Sakkoti	0	76.17±3.02 ^a	23.16±0.68 ^a	53.01±1.75 ^b	51.40±0.39 ^a	13.68±0.11 ^a	8.62±0.04 ^a
	2	71.57±5.18 ^b	18.63±1.10 ^b	52.94±2.62 ^b	49.51±0.24 ^b	10.62±0.13 ^b	6.57±0.05 ^b
	4	68.69±1.64 ^b	17.11±0.59 ^c	51.58±3.57 ^b	48.57±0.24 ^c	10.16±0.09 ^b	6.39±0.04 ^c
	6	67.04±0.71 ^b	16.57±1.03 ^d	50.47±2.51 ^b	48.11±0.28 ^d	9.59±0.25 ^c	6.11±0.06 ^d
	8	65.32±1.23 ^b	15.95±1.33 ^e	49.37±2.63 ^b	47.38±0.39 ^e	8.65±0.27 ^d	5.87±0.07 ^c
	10	63.95±0.51 ^b	15.25±0.92 ^f	48.70±1.67 ^b	46.60±0.27 ^f	7.56±0.27 ^e	5.89±0.05 ^f
	12	61.60±3.05 ^b	14.38±2.33 ^g	47.22±2.34 ^a	45.63±0.23 ^g	6.74±0.11 ^f	5.26±0.04 ^g
Bartamuda	0	78.36±2.52 ^a	20.05±0.43 ^a	58.31±4.04 ^a	55.92±0.25 ^a	11.60±0.23 ^a	7.58±0.04 ^a
	2	74.13±3.18 ^b	18.54±4.03 ^b	55.59±3.14 ^b	52.56±0.22 ^{ab}	9.81±0.19 ^b	5.28±0.04 ^b
	4	72.27±2.37 ^c	17.47±2.06 ^c	54.80±3.32 ^c	51.69±0.24 ^{bc}	8.86±0.23 ^c	5.06±0.04 ^c
	6	69.85±0.67 ^d	16.67±1.43 ^d	53.18±3.53 ^d	50.70±0.19 ^{bc}	7.95±0.04 ^d	4.93±0.03 ^c
	8	67.13±1.06 ^e	15.74±3.34 ^e	51.39±1.38 ^e	49.22±2.98 ^{ab}	7.54±0.21 ^d	4.71±0.04 ^d
	10	65.20±0.91 ^f	14.78±2.79 ^f	50.42±2.63 ^e	48.30±0.14 ^{bc}	6.86±0.14 ^e	4.27±0.01 ^e
	12	61.92±2.83 ^g	13.14±1.08 ^g	48.78±3.95 ^f	47.63±0.13 ^c	5.50±0.26 ^f	4.06±0.03 ^f
Gondaila	0	77.13±3.42 ^a	24.23±1.53 ^a	52.90±1.77 ^a	49.77±0.08 ^a	14.53±0.07 ^a	8.71±0.04 ^a
	2	69.17±2.93 ^b	18.88±0.36 ^b	50.29±2.19 ^b	48.29±0.32 ^b	11.03±0.06 ^b	6.39±0.04 ^b
	4	67.85±2.88 ^c	18.58±1.21 ^c	49.27±1.85 ^c	47.55±0.25 ^c	10.48±0.01 ^c	6.13±0.05 ^c
	6	66.14±2.77 ^{cd}	18.09±0.41 ^d	48.05±1.75 ^d	46.51±0.25 ^d	10.12±0.06 ^d	5.98±0.05 ^d
	8	64.06±1.72 ^{cd}	17.05±3.30 ^e	47.01±2.61 ^e	45.53±0.11 ^e	9.70±0.17 ^e	5.61±0.04 ^e
	10	63.03±1.82 ^{cd}	16.35±1.63 ^f	46.68±3.28 ^f	45.19±0.08 ^e	9.24±0.06 ^f	5.36±0.04 ^f
	12	60.44±2.26 ^d	15.18±3.31 ^g	45.26±1.46 ^g	44.74±0.31 ^f	8.95±0.40 ^g	5.28±0.04 ^f
Malkabii	0	82.09±2.60 ^a	22.67±1.69 ^a	59.42±3.27 ^a	54.85±0.23 ^a	13.28±0.10 ^a	8.45±0.03 ^a
	2	76.72±6.71 ^b	20.97±3.68 ^b	55.75±3.11 ^b	51.47±0.31 ^b	12.37±0.26 ^b	7.33±0.02 ^b
	4	74.28±0.54 ^{ab}	19.60±3.60 ^c	54.68±3.37 ^c	50.97±0.24 ^b	11.59±0.16 ^c	7.18±0.04 ^c

Date Varieties	Storage periods (Months)	Sugars content (g/100g)*			Sugar Fractions content (g/100g)*		
		Total sugars	Reducing sugars	Non-reducing sugars	Sucrose	Glucose	Fructose
	6	71.99±0.60 ^{ab}	18.51±3.57 ^d	53.48±2.82 ^d	49.72±0.25 ^c	11.08±0.08 ^d	6.93±0.04 ^d
	8	70.17±0.62 ^{ab}	17.76±1.25 ^d	52.41±3.24 ^e	48.43±0.17 ^d	10.33±0.16 ^e	6.73±0.04 ^e
	10	67.99±0.23 ^{ab}	16.04±0.45 ^e	51.95±1.83 ^f	47.67±0.23 ^e	9.67±0.18 ^f	6.58±0.03 ^f
	12	65.07±0.66 ^{ab}	15.03±0.74 ^f	50.04±2.93 ^f	46.48±0.23 ^f	9.16±0.08 ^g	6.45±0.03 ^g
Shamia	0	77.36±0.29 ^a	23.18±1.58 ^a	54.18±2.69 ^a	51.07±0.41 ^a	13.47±0.21 ^a	8.58±0.02 ^a
	2	65.25±1.16 ^b	18.99±0.61 ^b	46.26±4.23 ^b	49.25±0.36 ^b	10.22±0.12 ^b	6.29±0.02 ^b
	4	63.86±0.41 ^{bc}	18.16±0.84 ^c	45.70±3.09 ^c	48.04±0.16 ^c	9.76±0.16 ^c	6.25±0.02 ^b
	6	61.87±1.46 ^{cd}	17.32±1.45 ^d	44.55±2.46 ^d	46.69±0.29 ^d	9.31±0.05 ^d	6.15±0.02 ^c
	8	60.55±1.03 ^d	16.88±0.81 ^e	43.67±2.24 ^{de}	45.68±0.24 ^e	9.05±0.09 ^d	6.01±0.04 ^d
	10	58.38±3.47 ^e	15.62±2.06 ^f	42.76±2.29 ^{ef}	44.99±0.30 ^f	8.59±0.11 ^e	5.95±0.04 ^e
	12	56.17±5.36 ^f	15.03±0.48 ^g	41.14±3.89 ^f	43.76±0.28 ^g	8.26±0.04 ^e	5.88±0.02 ^f

0 = Fresh dates, (2, 4, 6, 8, 10 and 12) months of storage sun drying, Season.

Means with different letters in the same column have significantly difference at ($p \leq 0.05$), while those with similar letters are no have significant difference inbetween.

*=on dry weighte.

The analysis of variance for sugars indicated that there were no significant differences existed between all varieties in the total percentage of sugars (reducing and non-reducing). The interaction between harvesting season was'nt significantly affected at ($p \leq 0.05$) for all sugar fractions expect fructose %, which was significantly ($p \leq 0.05$). As well as the interaction between harvesting season and date cultivars were significantly affected ($p \leq 0.05$) for all sugar fractions expect (glucose % and fructose %), which were highly significant at ($p \leq 0.01$). On other hand there were high significantly difference ($p \leq 0.01$) among the interaction between date cultivars and treatments for all sugar fractions. It could also see that there were no significant difference at ($p \leq 0.05$) among the interaction between harvesting season, treatments and date cultivars for all sugar fractions expect fructose percentage.

In 2006, the World Health Organization (WHO) published a report urging individuals to minimize their daily intake of free sugars to less than 10% of total calorie intake. Based on a 2000-calorie diet, this suggestion amounts to around 12 teaspoons (48 g) of additional (free) sugar per day. However, prominent American health experts want the FDA to set a maximum recommended daily intake of added (free) sugars of 10 teaspoons (40 g) in North America. A date fruit cultivars of average weight (6.75 g) contains approximately 5.28 g total sugar (average total sugar = 78.28%). Thus, 8 - 9 dates per person per day are adequate to meet the daily sugar demand (**Khan et al., 2008**).

4- CONCLUSION

Drying is one of the important processes necessary to increase the shelf life of fresh dates for use throughout the year, but it is required in the appropriate drying method that the dates reach the appropriate moisture content for storage (balanced moisture content) with the least possible loss of nutrients, which are necessary to build the body and supply it with energy.

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