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Effect of Dehydration Methods on Physicochemical Properties of Aswan Dry Dates

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Abstract

Sakkoti, Bartamuda, Gondaila, Malkabii and Shamia are excellent dry date cultivars, grown at Aswan Governorate. Physical properties {Gross fruit weight, Date flesh (pulp) weight, Date seed weight, Date flesh (pulp) percent, Average length, Average diameter, Date number per 1 kg, Date fruit volume and Date fruit density} also chemical composition {moisture, protein, Crude fiber, lipids, ash, Carbohydrates, sugars (reducing, non-reducing, Total sugar, Sucrose, Glucose and Fructose), minerals contents (Macro- and micro-elements), vitamins content (A, E and C), pH, Acidity and Total soluble solids } were determined in fresh date fruit (Tamar), after sun-drying for 25 days, solar drying for 14 days at ambient temperature 50 °C and mechanical drying at 60°C for 9 hrs. Moisture, lipids, protein, ash and pH decreased after sun-drying and mechanical drying, while total soluble solids (T.S.S), Carbohydrates, crude fiber and acidity increased in all cultivars. Total sugars, non-reducing sugar, Sucrose and Fructose were higher in content in Malkabii date fruit (Tamar) than the other date varieties while, reducing sugar and Glucose were higher in Gondaila than the other date varieties. After, drying process, all sugar fractions decreased. Potassium and Calcium contents were higher in all dates. Vitamins A and E were higher in Shamia and Bartamuda than the other date variety. Also**,** the solar drying method was the best method used for drying dates.

Keywords: *Date fruit, Sakkoti, Bartamuda, Gondaila, Malkabii.*

Introduction:

The date is a fruit, which is characterized with a middle-stone and plump outer covering. It is a very nutritious fruit that is a product of a date palm. These date palm trees are native to the dry and semi-dry climates of Northern Africa and the Middle East. This fruit is very healthy as it contains many kinds of minerals (Ca, Fe, Mg, P, K and Zn), dietary fiber (6.40-11.50%), protein (2.3-5.6%), and carbohydrates (44-88%, predominately glucose, fructose, and sucrose) (Al-Shahib and Marshall, 2003). Date is a delicious fruit with a sweet taste and a fleshy mouth feel. The major component of dates are carbohydrates (moiety the sugars; sucrose, glucose, and fructose), which may constitute about 70%. The sugars in dates are easily digested and can immediately be moved to the blood after consumption and can quickly be metabolized to release energy for various cell activities. Dates are also a good source of fiber, and contain many important vitamins and minerals, including significant amounts of calcium, iron, fluorine, and selenium (Khan *et al.,* 2008). One of the oldest forms of processing

and preserving food is drying. The main aim of drying is to extend the shelf life of certain foods, minimize packaging requirements and reduce shipping weights (Okos *et al.,* 1992). The most common method throughout history for drying dates has been sun drying. This process of sun drying has its challenges in that daytime temperature and humidity cannot controlled, the fruit is in contact with the open environment (a possible source of contamination due to dust, soil, sand particles and insects), and the fact that the process takes too much time. Due to the downsides of this processing method, sun drying does not provide an effective process for quality production (Doymaz, 2005).

Therefore, the aim of this work was to determine the chemical composition of the five date palm verities (Sakkoti, Bartamuda, Gondaila, Malkabii and Shamia) at Tamr stage of maturity and comparing the chemical composition of Aswan dry date when using sun, mechanical and solar energy drying methods.

Materials and Methods:

Materials:

This study was carried out on five date fruits which cultivated in Aswan governorate, Sakkoti, Bartamuda, Gondaila, Malkabii and Shamia are dry date varieties. 100 kg of different date fruits were collected during September 2018 and 2019 seasons, from their sources in Al-Akkab village, Aswan sector, 15 km north of Aswan city at random and transferred to laboratory for analysis. Each of these fruit types was divided into four parts.

Date samples were divided into four groups (For each variety) one group was left as control (fresh), each part was counted 25 kg for each variety, while the other three groups were treated as follows for each drying method:

- The first part (I) was used as fresh (Tamar) immediately after harvesting before the cultivars prepared to dry.
- The second part (II) was dried using electric oven at 60°C. With air circulation for 10 hrs.
- The third part (III) was dried using a solar dryer, on the roof of the Faculty of Agriculture and Natural Resources - Aswan University, from mid-September, at maximum temperature of 50 °C for 14 days.
- The fourth part (IV) was dried in open air under sun rises, from mid-September, at maximum temperature of 40 °C for 25 days.

Methods:

1. Drying methods:

1.1. Solar drying: Date samples were dried by using hot air at 50 ºC for 14 hrs, the hot air was heated in direct active solar dryer has been manufacturing in local workshop – Aswan governorate, the solar drying system is shown in Fig. (1). The solar drying process was conducted on the roof of the Faculty of Agriculture and Natural Resources, Aswan university - Aswan – Egypt.

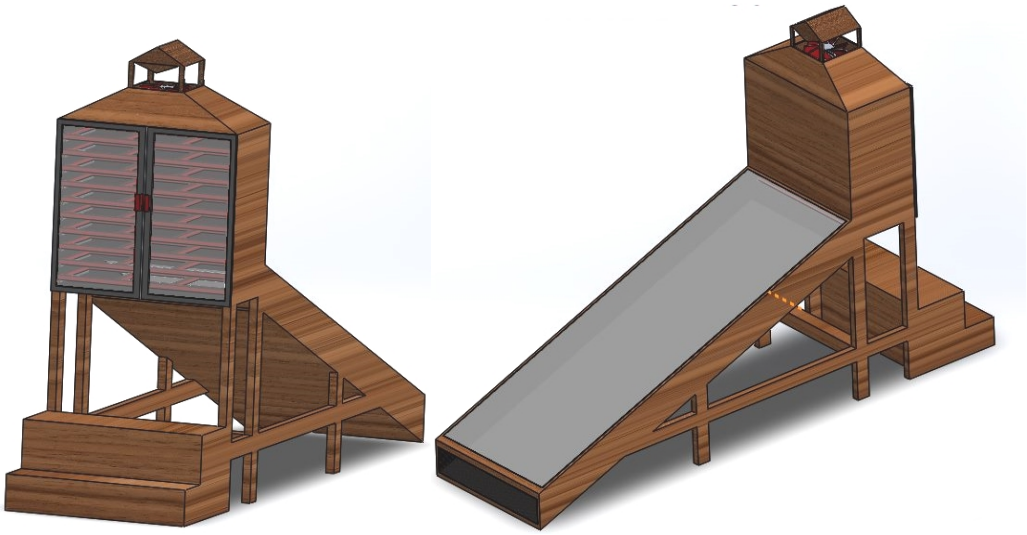

Fig. 1: Isometric view of the solar drying system.

1.2. Mechanical drying at oven: Date samples were dried by using an electrical oven at 60 ºC for 10 hrs. The drying process was carried out inside the Food Sci and Tech. Laboratory - Faculty of Agriculture and Natural Resources - Aswan university - Aswan - Egypt.

1.3. Sun drying: Date samples were dried on open air at maximum ambient temperature 40 ºC. The sun drying process started from 20 September for 25 days, on the roof of the Faculty of Agriculture and Natural Resources, Aswan university - Aswan - Egypt.

2. Physical characteristics:

Ten fruits from each variety were selected randomly, and each individual fruit, representing three replicates, was subjected to physical measurements. Fruit weight (gm), flesh weight (gm), pulp % fruit and seed weight (gm) were determined. Fruit dimension, i.e., fruit length (cm), fruit diameter (cm) and fruit shape (weight/diameter) were estimated using a micrometer caliper. Also, fruit density (gm/cm'), weight/volume, was estimated.

3. Chemical composition:

Moisture, protein, lipids, ash, crude fiber, reducing and total sugars, mineral elements, pH, acidity, and total soluble solids (T.S.S.) were determined according to official methods of analysis (AOAC, 2005). While total carbohydrates and non-reducing sugars were calculated by the difference.

Fractionation of free sugars: Several sugars were determined using a HPLC System (HP1050) with a UV detector at 210 nm. The separation was accomplished with a NH_2 (Amino) (5 µm. 4 x 250 mm) column. The mobile phase consists of (acetonitrile /water 76/24 v/v) with 0.1 ml acetic acid. The flow rate was 2 ml/min, while the injection volume was about 10 µl according to the method of (Christian, 1990).

Determination of vitamin (A): A 10 ml aliquot of date powder was mixed with 0.5 g of ascorbic acid, 40 ml of ethanol and 10 ml of 1:1 potassium hydroxide in water and heated at reflux with stirring for 30 min. The mixture was cooled in an ice bath and quantitatively transferred to a separat-

ing funnel with 50 ml water, 10 ml ethanol and 50 ml hexane containing 1.5 mg/100 ml butylated hydroxy-toluene (BHT). The separating funnel was shaken vigorously for 2 min and the phases allowed to separate. The aqueous phase was removed and extracted twice more with 20 ml portions of hexane containing 1.5 mg/100 ml BHT. The hexane extracts were combined, washed three times with 100 ml of water and then made to 100 ml with hexane. 10 ml of the hexane solution was then transferred to a glass tube and the solvent removed under a flow of nitrogen at room temperature. The residue was reconstituted with 1.0 ml of methanol and filtered through a 13 mm 0.45 µm Teflon filter disc into three separate vials for concurrent analysis by HPLC (Plozzaa *et al.,* 2012).

Determination of vitamin (E): A sample volume of 0.1 ml of hexane extract of dates containing vitamin (E) was mixed in a test tube with 1 ml of reagent solution (0.6M sulphuric acid, 28mM sodium phosphate, and 4mM ammonium molybdate) and incubated at 37°C for 90 min with vigorous shaking. Absorbance of the aqueous phase at 695 nm was measured against the appropriate blank. A typical blank contained 1 ml of reagent solution and 0.1 ml of pure hexane, and it was incubated under the same conditions as the samples (Borah *et al.,* 2012).

Determination of vitamin (C): The vitamin C extraction method was adapted from (Ross, 1994). Liquid sample (0.5 mL) and 10% meta-phosphoric acid (0.5 mL) were mixed using a vortex (5 min) (final concentration of meta-phosphoric acid was 5%), centrifuged at 8500g for 10 min, and injected onto the HPLC or UPLC column to determine ascorbic acid (AA) content.

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 1% and 5% levels of probability. Each experiment in triplicate repeated at least twice and the values presented in terms of means standard error (Steel *et al.,* 1997).

Results and Discussion:

1. Physical properties:

Physical properties of the five date varieties for fresh date at Tamr stage of maturity were determined through different parameters [date weight, flesh weight, date seed weight, date flesh (pulp) %, average length, average diameter, date number per 1kg, date fruit volume, date fruit density, pH, acidity, and total soluble solids] for two seasons [2018 and 2019]. The results in Table (1) showed that (Gondaila and Sakkoti dates) gave the highest percentage of the fruit flesh (pulp) (86.17 and 83.73 % respectively) for the first season, and for the second season (Bartamuda and Gondaila dates) gave the highest percentage of the date flesh (pulp) (86.28 and 81.19 %; respectively). While the highest value of date seed weight was found for Malkabii (2.87 and 3.27 gm) for both seasons. On the other hand, we found that Gondaila and Sakkoti varieties recorded the highest value of the date Average length (4.90 and 4.87 cm; respectively) for the first season, and for the second season Gondaila gave the

highest value of the date average length (5.10 cm). Results in the same table, also indicated that (Malkabii and Gondaila) gave the highest value of the average diameter (1.97 and 1.93 cm; respectively) in comparing with the other date varieties. We also, found that Shamia variety has the highest date number per 1 kg (171) and the lowest date fruit density 0.62 cm^3, while Malkabii variety has the highest date number per 1 kg (96) and the lowest date fruit volume (10.53 cm^3), for the first season. The present results came in agree with the stated results of (Abd-Elwahid, 2007); (Kulkarni *et al.,* 2008); (Abd-Ellah, 2009) and (Elghazali *et al.,* 2010).

Analysis of variance for physical characteristics of Aswan dry date indicated that the harvesting season was significantly affected at ($p \leq 0.05$) for date seed weight and did not significantly affected at ($p \leq 0.05$) for the other physical characteristics while date cultivars were highly significant at ($p \leq 0.01$) for all physical characteristics expected average length and date fruit volume that was significantly affected at ($p \leq 0.05$). On the other hand, we found that the interaction between harvesting season and date cultivars were significant at ($P \leq 0.05$) for flesh weight and highly significant at ($p \leq 0.01$) for [date seed weight], while there were not significantly affected at ($p \leq 0.05$) for the other physical characteristics.

2. Chemical properties:

In Table (2) observed that pH value ranged from (4.97 - 6.23) for Bartamuda and Sakkoti; respectively IN first season and ranged between (4.63 - 6.34) for Gondaila and Shamia. The results indicated that all drying methods lied to decrease the pH value for all fruit date varieties. Results in the same table also indicated that total acidity (%) expressed in malic acid was higher for Sakkoti (0.29 – 0.32 %), followed by Bartamuda (0.25 – 0.27 %), Gondaila (0.23 – 0.21 %), Malkabii (0.23 - 0.22 %) and the lower value for Shamia (0.19 – 0.20 %) for fresh (Tamr) date varieties for both seasons; respectively, and we found that all drying methods led to increase the acidity value. In contrast, results of total soluble solids (T.S.S. %) were higher for Bartamuda (80.94 – 77.60%) while the lowest value for Shamia (68.33 – 71.28) in fresh (Tamr) date varieties both seasons; respectively. These results agree with those reported by (Elghazali and Hussin, 1999); (El-Sharnouby *et al.,* 2007); (Besbes *et al.,* 2009) and (Alsmairat *et al.,* 2019).

Analysis of variance for physical properties of Aswan dry date indicated that the harvesting season was significantly affected at ($p \leq 0.05$) for pH and acidity and did not significantly affected at ($p \leq 0.05$) for T.S.S. while there were highly significant at ($p \leq 0.01$) between treatments, date cultivars, the interaction between harvesting seasons and date cultivars also, the interaction between treatments and date cultivars. On the other hand, we found that the interaction between harvesting seasons and treatments did not Significant at ($p \leq 0.05$) for pH and T.S.S. but it was Significant at ($p \leq 0.05$) for acidity.

3. Chemical composition:

Chemical composition of the five date varieties for each treatment at Tamr stage of maturity were de-

termined through different parameters, [moisture, protein, crude fiber, lipids, ash, carbohydrates, total sugars, reducing sugars, non-reducing sugars, sucrose, glucose, fructose, minerals content, vitamins content] for two seasons [2018 and 2019]. In Tables (3 and 4) indicated that fresh date fruits contained high percentage of moisture content at the Tamr stage of maturity that ranged from (18.28 – 19.23 %) for Sakkoti, (19.49 – 19.47 %) for Bartamuda, (14.38 – 13.93 %) for Gondaila, (13.47 – 12.24 %) for Malkabii, (17.20 – 16.90 %) for Shamia. Also, we found that Sakkoti and Shamia dates contained the highest percentage of protein by (2.99 and 2.98 %, on dry weight basis), and the results of this study indicated that all drying systems led to decreasing the moisture and protein contents on all varieties. Also, showed that the highest crude fiber values ranged from (13.20 to 9.93 %) for Gondaila and Bartamuda, and lipids was higher for the same varieties (3.26 and 3.20 %) all drying systems lied to increase the percentage of crude fiber for all fruit date varieties while it led to decrease the lipids content. While Shamia had the higher value of ash (3.12 %), and Malkabii followed by Shamia had the lower content of carbohydrates (91.98 to 90.89 %). The former results agreed with (Al-Farsi and Lee, 2008); (Ali *et al.,* 2009); (Abd-Ellah, 2009) and (Alsmairat *et al.,* 2019).

The analysis of variance for the major chemical composition indicated that the interaction between harvesting season and treatments did not significantly affected ($p \leq 0.05$) for all chemical composition's components expected protein %, which was significantly ($p \leq 0.05$), as well as interaction between harvesting season and date cultivars did not significantly affected ($p \leq 0.05$) for all chemical composition's components expected protein %, and crude fiber %, which were significantly ($p \leq 0.05$). On other hand there were highly significantly difference ($p \leq 0.01$) among the interaction between date cultivars and treatments did for all chemical composition's components. it could also see that there were not significantly ($p \leq 0.05$) among the interaction between harvesting season, treatments and date cultivars for all chemical composition's components expected protein %.

The tabulated results in Tables (5 and 6) showed that Gondaila had the highest reducing sugars value (25.21 %) while Malkabii had highest non-reducing sugars value (60.03 %), the non-reducing sugar values were decreasing after drying while the reducing sugar values were increasing after drying. We can also conclude that Malkabii has the highest percentage of Sucrose (%) were (55.42 %) and there is little difference between Glucose (%) in all experimented date verities, and it can range between (12.04 to 14.82 %) as well as Gondaila has the highest fructose (%) followed by Sakkoti were (8.37 - 9.27 %). These results agree with those reported by (Elghazali and Hussin, 1999); (El-Sharnouby *et al.,* 2007); (Elghazali *et al.,* 2010); (Ramadan *et al.,* 2018) and (Alsmairat *et al.,* 2019).

The analysis of variance for sugars indicated that the interaction between harvesting season and treatments did not significantly affected (p

≤ 0.05) for all sugar fractions expected fructose %, which was significantly (p ≤ 0.05), as well as interaction between harvesting season and date cultivars were significantly affected (p ≤ 0.05) for all sugar fractions expected (glucose % and fructose %), which were highly significant at p (0.01). on other hand there highly significantly difference (p ≤ 0.01) among the interaction between date cultivars and treatments did for all sugar fractions. It could also see that there were not significantly (p ≤ 0.05) among the interaction between harvesting season, treatments and date cultivars for all sugar fractions expected fructose %.

The tabulated results in Tables (7, 8 and 9) showed that Gondaila contain higher level of Calcium (Ca) (65.72 mg/100g) followed by Malkabii (55.62 mg/100g), also Gondaila contain the higher level of Phosphorus (P) (19.24 mg/100g), it clear that the drying process increasing the Calcium (Ca) and Phosphorus (P) content in all drying systems. It is noticed that Potassium (K) is the most abundant element with a concentration of (903.41 mg/l00 g) for Bartamuda in the first season and Malkabii (901.11 mg/l00 g) in the second season, also dates contained moderate concentrations of Sodium (Na), where Gondaila and Shamia had the highest values (5.97 - 4.32 mg/100 g). The obtained results agreed with (Elghazali and Hussin, 1999); (Ramadan *et al.,* 2018) and (Rambabu *et al.,* 2020).

The analysis of variance for minerals content indicated that the interaction between harvesting season and treatments did not significantly affected (p ≤ 0.05) for Potassium, and Sodium also, there are significant at (p ≤ 0.05) for Calcium, Phosphorus, and Magnesium and highly significant at (p ≤ 0.01) for the other minerals. On other hand there highly significantly difference (p ≤ 0.01) among the interaction between date cultivars and treatments for all minerals. The data illustrated that the interaction between harvesting season, date cultivars and treatments did not significantly affect (p ≤ 0.05) for Potassium, also, there are significant at (p ≤ 0.05) for (Calcium, Sodium and Phosphorus), and highly significant at (p ≤ 0.01) for the other minerals.

The obtained results in Table (10) showed that Shamia contain the higher level of vitamin (A) (5.17 µg/100g) while the content of vitamin (A) was (4.87, 4.21, 2.82 and 2.71 µg/100g) for Bartamuda, Sakkoti, Gondaila and Malkabii; respectively. It also, found that the vitamin (A) content was reducing after drying process, for example vitamin content for fresh Shamia date was (5.17 µg/100g) and it was reducing after drying to (4.89, 4.33 and 4.35 µg/100g) for solar drying, sun drying and oven drying; respectively, these results come in agree with (Kendall and Sofos, 2012). The analysis of variance for vitamins content indicated that, there did not significant difference (p ≤ 0.05) variation between harvesting seasons. The results also indicated that, there were highly significant difference (p ≤ 0.01) among treatments, date cultivars, interaction between harvesting season and treatments, interaction between harvesting season and date cultivars, interaction between date cultivars and

treatments, as well as among the interaction between harvesting season, treatments, and date cultivars.

From results in Table (10) noticed that vitamin (E) content had moderate values for Shamia with a concentration of (0.81 and 0.85 mg/l00g) for first and second season; respectively followed by Gondaila (0.72 mg/l00g) in the first season while the lowest value of vitamin (E) was (0.12 and 0.20 mg/100g) for Malkabii for first and second season, respectively. It can be concluded that the concentration of vitamin (E) was decreased after drying, values of solar drying system were the highest between them followed in sequences by mechanical drying and sun drying. These results are agreed with (Kendall and Sofos, 2012). Also, it could be seen that there did not significant difference ($p \leq 0.05$) variation between harvesting seasons, interaction between harvesting season and treatments, as well as among the interaction between harvesting season, treatments, and date cultivars. while there were significant difference ($p \leq 0.05$) variation between the interaction between date cultivars and harvesting seasons. The results also indicated that, there were highly significant difference ($p \leq 0.01$) among treatments, date cultivars, the interaction between date cultivars and treatments.

From results in Table (10) noticed that the highest concentration of vitamin (C) (0.08 – 0.09 µg/l00 g) for Shamia in the first and second season respectively while Malkabii had the lowest concentration of vitamin (C) (0.06 and 0.07 mg/l00 g) in first and second season, respectively. It can be concluded that the concentrations of vitamin (C) were decreased after all drying system, where the highest values were after solar drying followed in sequences by mechanical drying and sun drying. (El-Sharnouby *et al.,* 2007) and (USDA, 2018). On the other hand, No significant difference ($p \leq 0.05$) variation between harvesting seasons. While, significant difference ($p \leq 0.05$) variation between interaction treatments and harvesting seasons. Also, the results indicated that, there were highly significant difference ($p \leq 0.01$) among treatments, date cultivars, the interaction between date cultivars and treatments.

Table 1. Physical characteristics for Aswan dry date varieties.

Physical characteristics	Harvesting season	Date cultivars				
		Sakkoti	Bartamuda	Gondaila	Malkabii	Shamia
Date weight, (g)	Season 1	7.06 ± 0.18 ^{abd}	8.70 ± 0.24 ^{abc}	9.98 ± 0.35 ^{ab}	10.39 ± 0.27 ^{a}	5.86 ± 0.26 ^{abce}
	Season 2	7.23 ± 0.21 ^{abcd}	8.22 ± 0.22 ^{abc}	9.42 ± 0.34 ^{ab}	10.69 ± 0.28 ^{a}	5.96 ± 0.37 ^{abcde}
Flesh weight, (g)	Season 1	5.91 ± 0.16 ^{abcd}	7.05 ± 0.35 ^{ac}	8.60 ± 0.37 ^{a}	7.51 ± 0.26 ^{ab}	4.61 ± 0.21 ^{abce}
	Season 2	5.44 ± 0.11 ^{ad}	7.49 ± 0.28 ^{ab}	7.65 ± 0.22 ^{a}	7.41 ± 0.20 ^{ac}	4.60 ± 0.15 ^{abde}
Date seed weight, (g)	Season 1	1.15 ± 0.04 ^{bde}	1.65 ± 0.26 ^{ab}	1.38 ± 0.07 ^{abc}	2.87 ± 0.05 ^{a}	1.25 ± 0.07 ^{abcd}
	Season 2	1.79 ± 0.30 ^{ab}	1.27 ± 0.10 ^{acde}	1.78 ± 0.02 ^{bc}	3.27 ± 0.09 ^{a}	1.36 ± 0.24 ^{abcd}
Date flesh (pulp), (%)	Season 1	83.73 ± 0.40 ^{b}	81.01 ± 2.95 ^{c}	86.17 ± 0.93 ^{a}	72.30 ± 0.75 ^{ce}	78.70 ± 0.70 ^{abcd}
	Season 2	75.33 ± 0.34 ^{bd}	86.28 ± 0.10 ^{a}	81.19 ± 0.36 ^{ab}	69.32 ± 0.34 ^{bde}	77.26 ± 2.54 ^{c}
Average length, (cm)	Season 1	4.87 ± 0.15 ^{b}	4.69 ± 0.20 ^{d}	4.90 ± 0.10 ^{a}	4.70 ± 0.32 ^{c}	4.60 ± 0.10 ^{e}
	Season 2	4.90 ± 0.21 ^{b}	4.64 ± 0.25 ^{d}	5.10 ± 0.44 ^{a}	4.89 ± 0.25 ^{bc}	4.52 ± 0.10 ^{ce}
Average diameter, (cm)	Season 1	1.80 ± 0.10 ^{e}	1.83 ± 0.16 ^{d}	1.93 ± 0.21 ^{b}	1.97 ± 0.31 ^{a}	1.90 ± 0.10 ^{c}
	Season 2	1.77 ± 0.16 ^{ce}	1.79 ± 0.10 ^{cd}	2.07 ± 0.15 ^{a}	1.80 ± 0.27 ^{abc}	1.87 ± 0.16 ^{b}
Date number per 1 kg	Season 1	141 ± 3.50 ^{ab}	115 ± 3.00 ^{abc}	100 ± 3.51 ^{abd}	96 ± 2.08 ^{abcde}	171 ± 7.55 ^{a}
	Season 2	138 ± 4.00 ^{ab}	122 ± 3.06 ^{abc}	106 ± 2.52 ^{abcd}	94 ± 3.08 ^{abcde}	165 ± 5.56 ^{a}
Date fruit volume, (cm^3)	Season 1	9.90 ± 0.20 ^{c}	9.35 ± 0.22 ^{de}	10.13 ± 0.21 ^{b}	10.53 ± 0.16 ^{a}	9.50 ± 0.30 ^{bd}
	Season 2	10.07 ± 0.42 ^{bc}	9.47 ± 0.35 ^{e}	10.38 ± 0.37 ^{a}	10.17 ± 0.41 ^{b}	9.63 ± 0.31 ^{d}
Date fruit density, (gm/cm^3)	Season 1	0.71 ± 0.03 ^{ad}	0.93 ± 0.05 ^{ac}	0.98 ± 0.04 ^{ab}	0.99 ± 0.38 ^{a}	0.62 ± 0.04 ^{abcde}
	Season 2	0.72 ± 0.06 ^{abcd}	0.87 ± 0.05 ^{ac}	0.90 ± 0.02 ^{ab}	1.05 ± 0.41 ^{a}	0.62 ± 0.02 ^{abcde}

Season 1 = 2018, Season 2 = 2019. Means with different letters (a, b, c, d, e) in the same row different significantly at p≤0.05 using one-way ANOVA test, while those with similar letters are not significant by different.

Table 2. Effect of sun, solar and mechanical drying on pH, Acidity and T.S.S. of Aswan dry date.

Date culti-vars	Treatment	Chemical properties					
		pH		Acidity (%)		Total soluble solids (T.S.S), (%)	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Sakkoti	I	6.23 ± 0.16 ^{a}	6.15 ± 0.15 ^{a}	0.29 ± 0.02 ^{abcd}	0.32 ± 0.02 ^{bcd}	72.56 ± 0.56 ^{a}	69.56 ± 1.32 ^{a}
	II	5.60 ± 0.10 ^{d}	5.57 ± 0.10 ^{c}	0.44 ± 0.03 ^{ab}	0.43 ± 0.02 ^{ab}	68.78 ± 0.74 ^{b}	65.94 ± 0.80 ^{b}
	III	6.10 ± 0.10 ^{b}	6.10 ± 0.10 ^{b}	0.52 ± 0.03 ^{a}	0.48 ± 0.02 ^{a}	66.65 ± 0.56 ^{c}	63.89 ± 0.54 ^{c}
	IV	5.63 ± 0.06 ^{c}	5.56 ± 0.07 ^{d}	0.36 ± 0.02 ^{abc}	0.37 ± 0.01 ^{ac}	62.02 ± 0.93 ^{ad}	59.45 ± 0.89 ^{ad}
Bartamuda	I	5.97 ± 2.22 ^{a}	5.87 ± 2.22 ^{a}	0.25 ± 0.02 ^{abcd}	0.27 ± 0.01 ^{ad}	80.94 ± 1.07 ^{a}	77.60 ± 1.03 ^{a}
	II	5.80 ± 0.10 ^{ab}	5.75 ± 0.11 ^{ab}	0.39 ± 0.03 ^{ab}	0.38 ± 0.02 ^{ab}	77.22 ± 1.00 ^{b}	74.03 ± 0.96 ^{b}
	III	5.30 ± 0.10 ^{ad}	5.27 ± 0.11 ^{ad}	0.45 ± 0.20 ^{a}	0.43 ± 0.02 ^{a}	75.20 ± 1.26 ^{c}	72.09 ± 1.21 ^{c}
	IV	5.73 ± 0.15 ^{c}	5.67 ± 0.15 ^{c}	0.34 ± 0.02 ^{abc}	0.34 ± 0.02 ^{abc}	59.76 ± 0.72 ^{abcd}	58.07 ± 0.69 ^{abcd}
Gondaila	I	5.40 ± 0.10 ^{a}	5.29 ± 0.10 ^{a}	0.23 ± 0.02 ^{acd}	0.21 ± 0.01 ^{acd}	75.45 ± 0.54 ^{a}	72.32 ± 0.51 ^{a}
	II	5.27 ± 0.12 ^{b}	5.20 ± 0.12 ^{b}	0.36 ± 0.03 ^{ab}	0.31 ± 0.02 ^{ab}	71.24 ± 0.96 ^{b}	68.29 ± 0.92 ^{b}
	III	5.24 ± 0.12 ^{c}	5.19 ± 0.12 ^{c}	0.42 ± 0.02 ^{a}	0.36 ± 0.02 ^{a}	67.12 ± 0.73 ^{c}	64.29 ± 0.70 ^{c}
	IV	4.70 ± 0.53 ^{d}	4.63 ± 0.54 ^{d}	0.32 ± 0.03 ^{abc}	0.29 ± 0.02 ^{abc}	63.39 ± 0.72 ^{ad}	60.77 ± 0.69 ^{ad}
Malkabii	I	6.13 ± 0.16 ^{a}	5.24 ± 0.13 ^{a}	0.23 ± 0.02 ^{abcd}	0.22 ± 0.01 ^{acd}	72.21 ± 0.87 ^{a}	74.32 ± 0.91 ^{a}
	II	5.47 ± 0.16 ^{d}	4.81 ± 0.09 ^{c}	0.34 ± 0.01 ^{ab}	0.30 ± 0.02 ^{ab}	68.58 ± 1.35 ^{b}	71.54 ± 1.40 ^{b}
	III	5.83 ± 0.06 ^{b}	5.03 ± 0.04 ^{b}	0.40 ± 0.03 ^{a}	0.34 ± 0.02 ^{a}	63.81 ± 0.81 ^{c}	66.56 ± 0.84 ^{c}
	IV	5.60 ± 0.10 ^{c}	4.80 ± 0.08 ^{d}	0.29 ± 0.02 ^{abc}	0.27 ± 0.01 ^{abc}	61.24 ± 0.98 ^{ad}	63.88 ± 1.02 ^{ad}
Shamia	I	6.00 ± 0.10 ^{a}	6.29 ± 0.11 ^{a}	0.19 ± 0.01 ^{abcd}	0.20 ± 0.01 ^{acd}	68.33 ± 0.70 ^{a}	71.28 ± 0.73 ^{a}
	II	5.99 ± 0.10 ^{b}	6.34 ± 0.11 ^{b}	0.32 ± 0.02 ^{ab}	0.30 ± 0.02 ^{ab}	65.35 ± 0.58 ^{b}	68.17 ± 0.61 ^{b}
	III	5.75 ± 0.06 ^{c}	6.07 ± 0.05 ^{c}	0.36 ± 0.03 ^{a}	0.35 ± 0.01 ^{a}	62.63 ± 0.43 ^{c}	65.34 ± 0.45 ^{c}
	IV	5.73 ± 0.16 ^{d}	6.03 ± 0.16 ^{d}	0.26 ± 0.02 ^{abc}	0.28 ± 0.02 ^{abc}	58.88 ± 0.39 ^{ad}	61.42 ± 0.41 ^{ad}

Acidity % expressed as malic acid, I = Fresh (Tamr), II = Solar Drying, III= Sun Drying, IV= Mechanical Drying (Oven). Season 1 = 2018, Season 2 = 2019. Means with different letters (a, b, c, d) in the same column different significantly at p≤0.05 using one-way ANOVA test, while those with similar letters are not significant by different.

Table 3. Effect of sun, solar and mechanical drying on Moisture, Protein, and Crude fiber of Aswan dry date.

Date culti-vars	Treatment	Chemical composition					
		Moisture, (%)		Protein, (%)		Crude fiber, (%)	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Sakkoti	I	18.28 ± 1.12^{a}	19.23 ± 0.94 ^{a}	2.99 ± 0.12 ^{a}	2.83 ± 0.08 ^{a}	13.11 ± 0.73 ^{bcd}	12.12 ± 0.68 ^{bcd}
	II	4.16 ± 0.07 ^{bc}	3.78 ± 0.31 ^{bc}	2.57 ± 0.08 ^{b}	2.76 ± 0.09 ^{b}	14.52 ± 1.51 ^{bc}	14.51 ± 1.40 ^{bc}
	III	5.24 ± 0.67 ^{b}	6.12 ± 0.34 ^{b}	2.25 ± 0.04 ^{d}	2.43 ± 0.06 ^{bd}	15.57 ± 0.74 ^{b}	15.48 ± 0.69 ^{b}
	IV	3.38 ± 0.14 ^{bd}	3.51 ± 0.29 ^{bd}	2.53 ± 0.11 ^{bc}	2.54 ± 0.05 ^{ac}	18.15 ± 0.23 ^{a}	16.81 ± 0.22 ^{a}
Bartamuda	I	19.49 ± 1.41^{a}	19.47 ± 1.09 ^{a}	2.73 ± 0.09 ^{a}	2.88 ± 0.06 ^{a}	9.93 ± 0.05 ^{d}	9.17 ± 0.50 ^{bd}
	II	3.25 ± 0.22 ^{bc}	3.21 ± 0.28 ^{bc}	2.53 ± 0.09 ^{ab}	2.69 ± 0.05 ^{b}	11.87 ± 0.56 ^{b}	10.04 ± 0.52 ^{bc}
	III	4.96 ± 0.45 ^{b}	5.20 ± 0.31 ^{b}	2.28 ± 0.08 ^{d}	2.38 ± 0.07 ^{cd}	11.53 ± 0.82 ^{bc}	10.65 ± 0.76 ^{b}
	IV	2.81 ± 0.18 ^{d}	2.73 ± 0.29 ^{bd}	2.40 ± 0.12 ^{ac}	2.68 ± 0.07 ^{c}	16.22 ± 1.28 ^{a}	15.02 ± 1.19 ^{a}
Gondaila	I	14.38 ± 1.00 ^{a}	13.93 ± 0.82 ^{a}	2.79 ± 0.05 ^{a}	3.04 ± 0.10 ^{a}	13.20 ± 0.27 ^{bd}	14.27 ± 0.30 ^{ac}
	II	3.35 ± 0.07^{ac}	3.12 ± 0.85 ^{ac}	2.59 ± 0.14 ^{b}	2.81 ± 0.09 ^{b}	16.20 ± 0.27 ^{b}	16.05 ± 0.99 ^{b}
	III	4.59 ± 0.41^{b}	4.11 ± 0.24 ^{b}	2.34 ± 0.11 ^{d}	2.45 ± 0.07 ^{bd}	14.15 ± 0.15 ^{ac}	13.30 ± 0.78 ^{bd}
	IV	2.84 ± 0.14^{bd}	2.46 ± 0.20 ^{bd}	2.38 ± 0.04 ^{ac}	2.69 ± 0.04 ^{c}	18.81 ± 0.73 ^{a}	17.18 ± 1.88 ^{a}
Malkabii	I	13.47 ± 0.72 ^{a}	12.24 ± 0.95 ^{a}	2.58 ± 0.12 ^{a}	2.95 ± 0.13 ^{a}	10.86 ± 0.92 ^{bd}	9.88 ± 0.03 ^{bd}
	II	3.48 ± 0.07 ^{c}	3.63 ± 0.09 ^{c}	2.52 ± 0.08 ^{b}	2.85 ± 0.07 ^{b}	11.01 ± 0.26 ^{c}	10.76 ± 0.28 ^{c}
	III	4.92 ± 0.37 ^{b}	4.52 ± 0.31 ^{b}	2.39 ± 0.06 ^{bd}	2.80 ± 0.07 ^{d}	13.70 ± 1.74 ^{a}	11.34 ± 0.72 ^{b}
	IV	2.34 ± 0.38 ^{bd}	2.19 ± 0.08 ^{bd}	2.50 ± 0.15 ^{c}	2.83 ± 0.09 ^{c}	13.64 ± 0.39 ^{b}	14.74 ± 0.42 ^{a}
Shamia	I	17.20 ± 1.07 ^{a}	16.90 ± 1.15 ^{a}	2.98 ± 0.20 ^{a}	2.79 ± 0.07 ^{a}	11.71 ± 0.51 ^{d}	12.67 ± 0.55 ^{d}
	II	4.93 ± 0.15 ^{ac}	5.02 ± 0.15 ^{ac}	2.68 ± 0.03 ^{ab}	2.50 ± 0.04 ^{ab}	13.67 ± 1.17 ^{ac}	15.42 ± 1.25 ^{ac}
	III	5.72 ± 0.45 ^{b}	5.18 ± 0.29 ^{b}	2.49 ± 0.12 ^{d}	2.44 ± 0.06 ^{d}	15.31 ± 0.69 ^{b}	14.77 ± 1.25 ^{b}
	IV	3.43 ± 0.08 ^{d}	3.63 ± 0.48 ^{d}	2.62 ± 0.09 ^{abc}	2.48 ± 0.04 ^{abc}	18.53 ± 0.47 ^{a}	19.99 ± 0.51 ^{a}

On dry weight basis, I = Fresh (Tamr), II = Solar Drying, III= Sun Drying, IV= Mechanical Drying (Oven). Season 1 = 2018, Season 2 = 2019. Means with different letters (a, b, c, d) in the same column different significantly at p≤0.05 using one-way ANOVA test, while those with similar letters are not significant by different.

Table 4. Effect of sun, solar and mechanical drying on Lipids, Ash, and Carbohydrates of Aswan dry date.

Date cultivars	Treatment	Chemical composition					
		Lipids, (%)		Ash, (%)		Carbohydrates, (%)	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Sakkoti	I	2.73 ± 0.08 ^{a}	2.58 ± 0.06 ^{a}	2.51 ± 0.01 ^{a}	2.55 ± 0.01 ^{a}	91.77 ± 1.03 ^{d}	92.04 ± 0.88 ^{d}
	II	2.67 ± 0.03 ^{b}	2.54 ± 0.02 ^{b}	2.39 ± 0.02 ^{b}	2.43 ± 0.03 ^{b}	92.37 ± 0.57 ^{c}	92.27 ± 0.26 ^{c}
	III	1.96 ± 0.07 ^{bd}	2.02 ± 0.05 ^{bd}	2.18 ± 0.40 ^{d}	2.23 ± 0.04 ^{d}	93.61 ± 0.27 ^{a}	93.32 ± 0.51 ^{a}
	IV	2.32 ± 0.28 ^{c}	2.28 ± 0.20 ^{c}	2.19 ± 0.04 ^{ac}	2.24 ± 0.04 ^{ac}	92.96 ± 0.13 ^{b}	92.94 ± 0.26 ^{b}
Bartamuda	I	3.20 ± 0.01 ^{a}	2.92 ± 0.01 ^{a}	2.40 ± 0.06 ^{a}	2.42 ± 0.02 ^{ab}	91.67 ± 1.38 ^{d}	91.78 ± 1.14 ^{d}
	II	3.01 ± 0.33 ^{b}	2.78 ± 0.24 ^{b}	2.27 ± 0.09 ^{ab}	2.51 ± 0.09 ^{a}	92.19 ± 0.37 ^{c}	92.02 ± 0.51 ^{c}
	III	2.09 ± 0.13 ^{bcd}	2.14 ± 0.1 ^{bcd}	2.17 ± 0.05 ^{cd}	2.19 ± 0.08 ^{cd}	93.46 ± 0.60 ^{a}	93.29 ± 0.60 ^{a}
	IV	2.87 ± 0.44 ^{bc}	2.67 ± 0.32 ^{bc}	2.23 ± 0.03 ^{c}	2.26 ± 0.03 ^{c}	92.50 ± 0.14 ^{b}	92.39 ±0.32 ^{b}
Gondaila	I	3.26 ± 0.05 ^{a}	2.96 ± 0.04 ^{a}	2.73 ± 0.02 ^{a}	2.70 ± 0.02 ^{a}	91.22 ± 0.97 ^{d}	91.30 ± 0.83 ^{d}
	II	3.10 ± 0.16 ^{b}	2.85 ± 0.11 ^{b}	2.56 ± 0.04 ^{b}	2.51 ± 0.04 ^{b}	91.75 ± 0.71 ^{c}	91.83 ± 0.26 ^{c}
	III	2.18 ± 0.2 ^{bd}	2.18 ± 0.14 ^{bd}	2.31 ± 0.05 ^{d}	2.26 ± 0.04 ^{d}	93.17 ± 0.32 ^{a}	93.11 ± 0.97 ^{a}
	IV	2.68 ± 0.16 ^{c}	2.54 ± 0.12 ^{c}	2.41 ± 0.09 ^{ac}	2.36 ± 0.09 ^{ac}	92.53 ± 0.34 ^{b}	92.41 ± 0.38 ^{b}
Malkabii	I	2.62 ± 0.04 ^{a}	2.50 ± 0.03 ^{a}	2.82 ± 0.08 ^{a}	2.80 ± 0.08 ^{a}	91.98 ± 0.68 ^{d}	91.75 ± 0.93 ^{d}
	II	2.46 ± 0.09 ^{b}	2.38 ± 0.06 ^{b}	2.61 ± 0.03 ^{b}	2.60 ± 0.02 ^{b}	92.41 ± 0.47 ^{c}	92.17 ± 0.33 ^{c}
	III	2.14 ± 0.16 ^{bd}	2.15 ± 0.16 ^{bd}	2.41 ± 0.06 ^{d}	2.44 ± 0.02 ^{d}	93.06 ± 0.13 ^{a}	92.61 ± 0.07 ^{a}
	IV	2.34 ± 0.08 ^{bc}	2.30 ± 0.08 ^{abc}	2.54 ± 0.03 ^{bc}	2.52 ± 0.03 ^{abc}	92.62 ± 0.34 ^{b}	92.35 ± 0.03 ^{b}
Shamia	I	3.03 ± 0.09 ^{a}	2.79 ± 0.06 ^{a}	3.10 ± 0.11 ^{a}	3.12 ± 0.10 ^{a}	90.89 ± 1.17 ^{d}	91.30 ± 1.10 ^{d}
	II	2.92 ± 0.14 ^{b}	2.72 ± 0.10 ^{b}	2.96 ± 0.04 ^{b}	3.00 ± 0.04 ^{b}	91.44 ± 0.66 ^{c}	91.78 ± 0.13 ^{c}
	III	2.32 ± 0.04 ^{bd}	2.29 ± 0.03 ^{bd}	2.82 ± 0.03 ^{d}	2.87 ± 0.03 ^{d}	92.37 ± 0.13 ^{a}	92.40 ± 0.20 ^{a}
	IV	2.64 ± 0.14 ^{c}	2.51 ± 0.10 ^{c}	2.86 ± 0.01 ^{abc}	2.92 ± 0.01 ^{abc}	91.88 ± 0.10 ^{b}	92.09 ± 0.46 ^{b}

On dry weight basis, I = Fresh (Tamr), II = Solar Drying, III= Sun Drying, IV= Mechanical Drying (Oven). Season 1 = 2018, Season 2 = 2019. Means with different letters (a, b, c, d) in the same column different significantly at p≤0.05 using one-way ANOVA test, while those with similar letters are not significant by different.

Table 5. Effect of sun drying, solar drying and mechanical drying on sugars content of Aswan dry date.

Date cultivars	Treatment	Chemical composition (Sugar content)					
		Total sugar, (%)		Reducing Sugar, (%)		Non-Reducing Sugar, (%)	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Sakkoti	I	76.36 ± 1.64 ^{a}	76.94 ± 1.42 ^{a}	22.57 ± 0.28 ^{a}	23.21 ± 0.24 ^{a}	53.79 ± 1.51 ^{c}	53.73 ± 1.31 ^{c}
	II	75.58 ± 2.67 ^{ab}	76.26 ± 2.32 ^{ab}	20.24 ± 1.35 ^{b}	21.18 ± 1.16 ^{b}	55.34 ± 3.31 ^{a}	55.08 ± 2.88 ^{a}
	III	70.66 ± 1.86 ^{cbd}	71.98 ± 1.62 ^{cbd}	17.48 ± 1.72 ^{abcd}	18.78 ± 1.49 ^{abd}	53.18 ± 0.99 ^{d}	53.20 ± 0.86 ^{d}
	IV	73.36 ± 1.00 ^{abc}	74.33 ± 0.89 ^{abc}	18.42 ± 1.45 ^{ac}	19.60 ± 1.26 ^{ac}	54.94 ± 0.47 ^{b}	54.73 ± 0.41 ^{b}
Bartamuda	I	79.05 ± 1.73 ^{ac}	78.94 ± 1.51 ^{ab}	20.74 ± 0.27 ^{b}	19.87 ± 0.24 ^{b}	58.31 ± 1.97 ^{c}	59.07 ± 1.71 ^{a}
	II	82.32 ± 1.04 ^{a}	79.52 ± 0.90 ^{a}	21.73 ± 0.64 ^{a}	20.74 ± 0.55 ^{a}	60.59 ± 1.75 ^{a}	58.78 ± 1.53 ^{ab}
	III	75.97 ± 1.54 ^{d}	74.00 ± 1.35 ^{d}	18.84 ± 1.65 ^{cd}	18.23 ± 1.44 ^{d}	57.13 ± 1.25 ^{abcd}	55.77 ± 1.09 ^{abcd}
	IV	79.84 ± 0.26 ^{b}	77.36 ± 0.23 ^{bc}	20.52 ± 1.66 ^{bc}	19.69 ± 1.44 ^{bc}	59.32 ± 0.59 ^{ab}	57.67 ± 0.52 ^{c}
Gondaila	I	79.90 ± 1.52 ^{a}	76.54 ± 1.31 ^{a}	25.21 ± 0.62 ^{a}	23.77 ± 0.54 ^{a}	54.69 ± 1.98 ^{b}	52.77 ± 1.72 ^{b}
	II	77.28 ± 1.86 ^{ab}	74.25 ± 1.08 ^{ab}	21.25 ± 2.41 ^{b}	20.32 ± 2.10 ^{b}	56.03 ± 3.39 ^{a}	53.93 ± 2.96 ^{a}
	III	71.12 ± 1.24 ^{d}	68.91 ± 1.62 ^{cd}	18.89 ± 2.87 ^{acd}	18.27 ± 2.50 ^{abd}	52.23 ± 2.45 ^{d}	50.64 ± 2.13 ^{d}
	IV	74.00 ± 1.95 ^{bc}	71.40 ± 1.69 ^{c}	20.97 ± 1.93 ^{bc}	20.07 ± 1.67 ^{c}	53.03 ± 1.30 ^{c}	51.33 ± 1.13 ^{c}
Malkabii	I	83.02 ± 1.77 ^{a}	82.29 ± 1.54 ^{a}	22.99 ± 0.59 ^{a}	22.70 ± 0.51 ^{a}	60.03 ± 1.21 ^{a}	59.59 ± 1.05 ^{a}
	II	80.04 ± 1.37 ^{ab}	80.15 ± 1.19 ^{ab}	23.10 ± 0.54 ^{b}	21.94 ± 1.96 ^{b}	56.94 ± 3.31 ^{b}	58.21 ± 2.88 ^{b}
	III	73.50 ± 1.01 ^{cd}	75.48 ± 0.23 ^{d}	20.21 ± 2.80 ^{d}	20.29 ± 2.44 ^{d}	53.29 ± 1.43 ^{ad}	55.19 ± 1.75 ^{ad}
	IV	76.60 ± 1.43 ^{c}	78.42 ± 0.89 ^{abc}	20.99 ± 1.25 ^{c}	20.97 ± 1.09 ^{c}	55.61 ± 0.94 ^{c}	57.45 ± 0.23 ^{c}
Shamia	I	75.30 ± 1.42 ^{a}	76.02 ± 1.23 ^{a}	22.12 ± 0.71 ^{a}	22.99 ± 0.62 ^{a}	53.18 ± 2.00 ^{b}	53.03 ± 1.74 ^{b}
	II	73.23 ± 1.57 ^{b}	74.02 ± 1.51 ^{b}	19.30 ± 2.09 ^{b}	20.54 ± 1.83 ^{b}	53.93 ± 1.18 ^{a}	53.67 ± 1.03 ^{a}
	III	64.72 ± 1.74 ^{cd}	66.82 ± 2.01 ^{cd}	17.21 ± 1.66 ^{abcd}	18.72 ± 1.45 ^{abcd}	47.51 ± 3.36 ^{bd}	48.10 ± 2.91 ^{bd}
	IV	69.89 ± 2.31 ^{ac}	71.30 ± 1.37 ^{ac}	19.03 ± 0.61 ^{c}	20.30 ± 0.53 ^{c}	50.86 ± 2.39 ^{bc}	51.00 ± 2.07 ^{bc}

On dry weight basis, I = Fresh (Tamr), II = Solar Drying, III= Sun Drying, IV= Mechanical Drying (Oven). Season 1 = 2018, Season 2 = 2019. Means with different letters (a, b, c, d) in the same column different significantly at p≤0.05 using one-way ANOVA test, while those with similar letters are not significant by different.

Table 6. Effect of sun, solar and mechanical drying on sugar fractions of Aswan dry date.

Date cultivars	Treatment	Chemical composition (Sugar Fractions)					
		Sucrose, (%)		Glucose, (%)		Fructose, (%)	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Sakkoti	I	51.42 ± 1.02 ^{bc}	52.81 ± 1.46 ^{b}	13.14 ± 0.37 ^{a}	13.52 ± 0.77 ^{a}	8.37 ± 0.11 ^{a}	8.74 ± 0.13 ^{a}
	II	53.19 ± 2.13 ^{a}	53.02 ± 1.37 ^{a}	12.10 ± 0.46 ^{ab}	12.42 ± 0.51 ^{ab}	7.49 ± 0.27 ^{ab}	7.87 ± 0.18 ^{b}
	III	50.36 ± 1.87 ^{cd}	50.94 ± 1.52 ^{d}	10.22 ± 0.58 ^{abcd}	10.81 ± 0.67 ^{ad}	6.54 ± 0.14 ^{cd}	6.73 ± 0.12 ^{bcd}
	IV	52.54 ± 1.64 ^{b}	52.17 ± 0.94 ^{bc}	10.85 ± 0.47 ^{abc}	11.76 ± 0.85 ^{abc}	6.99 ± 0.11 ^{ac}	7.14 ± 0.23 ^{bc}
Bartamuda	I	54.75 ± 2.03 ^{a}	55.46 ± 0.56 ^{a}	12.04 ± 0.81 ^{a}	11.92 ± 0.73 ^{b}	7.68 ± 0.17 ^{abc}	7.35 ± 0.14 ^{abc}
	II	53.64 ± 0.87 ^{b}	54.21 ± 0.87 ^{b}	11.83 ± 0.28 ^{abc}	12.34 ± 0.33 ^{a}	7.95 ± 0.18 ^{a}	7.78 ± 0.17 ^{a}
	III	51.39 ± 1.38 ^{ad}	52.34 ± 1.34 ^{ad}	11.14 ± 0.39 ^{cd}	10.93 ± 0.47 ^{bcd}	7.25 ± 0.15 ^{cd}	6.92 ± 0.20 ^{bcd}
	IV	52.48 ± 1.64 ^{ac}	53.17 ± 1.76 ^{ac}	12.01 ± 0.80 ^{b}	11.71 ± 0.52 ^{abc}	7.69 ± 0.17 ^{b}	7.38 ± 0.18 ^{ab}
Gondaila	I	50.15 ± 0.97 ^{bc}	49.80 ± 0.86 ^{bc}	14.82 ± 0.51 ^{a}	14.26 ± 0.30 ^{a}	9.27 ± 0.13 ^{ab}	9.03 ± 0.09 ^{a}
	II	53.84 ± 1.28 ^{a}	51.37 ± 1.07 ^{a}	12.75 ± 0.35 ^{ab}	12.19 ± 0.61 ^{ab}	7.76 ± 0.15 ^{abc}	7.54 ± 0.08 ^{ab}
	III	49.35 ± 1.37 ^{bcd}	48.21 ± 1.39 ^{cd}	11.13 ± 0.23 ^{acd}	10.76 ± 0.52 ^{ad}	9.87 ± 0.22 ^{a}	6.74 ± 0.17 ^{acd}
	IV	51.78 ± 2.18 ^{ab}	50.92 ± 1.14 ^{b}	12.28 ± 0.42 ^{abc}	12.04 ± 0.44 ^{abc}	7.66 ± 0.12 ^{abd}	7.52 ± 0.12 ^{abc}
Malkabii	I	55.42 ± 1.14 ^{a}	54.71 ± 0.65 ^{a}	13.29 ± 0.53 ^{b}	13.42 ± 0.71 ^{a}	8.63 ± 0.16 ^{b}	8.67 ± 0.06 ^{a}
	II	53.75 ± 1.94 ^{b}	53.67 ± 0.79 ^{b}	13.46 ± 0.61 ^{a}	13.17 ± 0.85 ^{ab}	8.77 ± 0.17 ^{a}	8.33 ± 0.13 ^{ab}
	III	50.39 ± 1.67 ^{abd}	51.34 ± 1.08 ^{ad}	12.19 ± 0.53 ^{abd}	11.94 ± 0.42 ^{cd}	7.47 ± 0.14 ^{ad}	7.61 ± 0.19 ^{abcd}
	IV	51.70 ± 1.73 ^{abc}	51.97 ± 2.17 ^{abc}	12.39 ± 0.72 ^{abc}	12.28 ± 0.32 ^{abc}	7.67 ± 0.18 ^{c}	7.96 ± 0.14 ^{abc}
Shamia	I	51.83 ± 2.34 ^{b}	50.39 ± 1.36 ^{ab}	13.14 ± 1.01 ^{a}	13.29 ± 0.23 ^{a}	8.50 ± 0.14 ^{a}	8.43 ± 0.13 ^{a}
	II	52.64 ± 1.92 ^{a}	52.01 ± 1.28 ^{a}	11.38 ± 0.64 ^{ab}	12.02 ± 0.12 ^{ab}	7.13 ± 0.25 ^{ac}	7.64 ± 0.10 ^{ab}
	III	50.43 ± 0.98 ^{d}	49.18 ± 1.94 ^{d}	10.12 ± 0.91 ^{acd}	11.03 ± 0.46 ^{acd}	6.23 ± 0.19 ^{acd}	6.85 ± 0.15 ^{cd}
	IV	51.09 ± 0.87 ^{bc}	50.37 ± 1.46 ^{bc}	11.11 ± 0.73 ^{abc}	11.67 ± 0.50 ^{abc}	7.28 ± 0.10 ^{b}	7.51 ± 0.09 ^{abc}

On dry weight basis, I = Fresh (Tamr), II = Solar Drying, III= Sun Drying, IV= Mechanical Drying (Oven). Season 1 = 2018, Season 2 = 2019. Means with different letters (a, b, c, d) in the same column different significantly at p≤0.05 using one-way ANOVA test, while those with similar letters are not significant by different.

Table 7. Effect of sun, solar and mechanical drying on minerals content Calcium, Phosphorus and Potassium of Aswan dry date.

Date cultivars	Treatment	Minerals content, (mg/100g)					
		Calcium (Ca)		Phosphorus (P)		Potassium (K)	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Sakkoti	I	47.23 ± 1.23 ^{bd}	43.84 ± 2.08 ^{d}	14.08 ± 0.65 ^{c}	13.62 ± 0.23 ^{bc}	864.81 ± 3.52^{a}	852.12 ± 2.35 ^{abc}
	II	55.61 ± 0.65^{a}	53.84 ± 1.08 ^{a}	15.46 ± 0.83 ^{a}	16.35 ± 0.13 ^{a}	861.27 ± 2.96 ^{ab}	853.46 ± 4.05 ^{ab}
	III	49.41 ± 0.97 ^{c}	52.19 ± 1.12 ^{b}	12.45 ± 0.27 ^{ad}	11.82 ± 0.09 ^{d}	842.84 ± 4.05 ^{abcd}	846.32 ± 4.26 ^{abcd}
	IV	50.13 ± 1.11^{b}	48.67 ± 0.69 ^{bc}	14.15 ± 0.67 ^{b}	15.32 ± 0.24 ^{b}	848.61 ± 5.48 ^{abc}	860.30 ± 3.15 ^{a}
Bartamuda	I	47.53 ± 1.37 ^{d}	50.02 ± 0.78 ^{c}	18.16 ± 0.29 ^{c}	17.61 ± 0.18 ^{c}	903.41 ± 4.63 ^{a}	895.81 ± 2.46 ^{a}
	II	70.25 ± 0.87 ^{a}	67.12 ± 1.45 ^{ab}	23.45 ± 0.49 ^{a}	25.62 ± 0.17 ^{a}	886.61 ± 1.08 ^{b}	875.62 ± 3.17 ^{b}
	III	50.23 ± 1.18 ^{c}	49.41 ± 3.01 ^{cd}	13.45 ± 2.06 ^{d}	15.30 ± 0.06 ^{d}	845.13 ± 3.58 ^{bcd}	850.47 ± 1.48 ^{cbd}
	IV	65.92 ± 1.58 ^{b}	67.34 ± 1.26 ^{a}	20.76 ± 0.82 ^{b}	21.23 ± 0.14 ^{b}	865.12 ± 2.15 ^{ac}	852.21 ± 2.78 ^{abc}
Gondaila	I	65.72 ± 2.01 ^{d}	63.84 ± 1.34 ^{cd}	19.24 ± 0.09 ^{c}	20.63 ± 0.06 ^{c}	765.42 ± 2.01 ^{a}	770.62 ± 1.54 ^{a}
	II	74.18 ± 1.92 ^{a}	76.37 ± 1.27 ^{a}	26.61 ± 0.46 ^{a}	24.82 ± 0.13 ^{b}	751.80 ± 1.69 ^{b}	746.30 ± 1.95 ^{b}
	III	67.81 ± 1.52 ^{c}	65.81 ± 1.38 ^{c}	15.24 ± 0.28 ^{d}	14.27 ± 0.07 ^{d}	725.15 ± 3.27 ^{bcd}	736.62 ± 2.78 ^{cd}
	IV	70.56 ± 2.07 ^{ab}	67.91 ± 1.31 ^{ab}	23.45 ± 0.08 ^{b}	25.72 ± 0.09 ^{a}	734.67 ± 1.45 ^{abc}	741.62 ± 2.10 ^{abc}
Malkabii	I	55.62 ± 0.66 ^{cd}	54.71 ± 2.06 ^{ac}	16.34 ± 0.18 ^{c}	19.31 ± 0.17 ^{c}	863.41 ± 5.04 ^{abcd}	901.11 ± 3.14 ^{bc}
	II	72.61 ± 0.25 ^{a}	57.61 ± 1.65 ^{b}	20.63 ± 0.71 ^{a}	21.52 ± 0.24 ^{ab}	880.61 ± 2.71 ^{a}	919.61 ± 2.41 ^{a}
	III	62.34 ± 0.71 ^{c}	51.34 ± 2.23 ^{cd}	14.82 ± 0.26 ^{d}	18.35 ± 0.05 ^{d}	871.63 ± 2.65 ^{abc}	889.74 ± 2.17 ^{abcd}
	IV	69.37 ± 1.36 ^{b}	58.91 ± 1.28 ^{a}	18.60 ± 0.34 ^{ab}	23.61 ± 0.30 ^{a}	872.00 ± 1.15 ^{ab}	910.21 ± 3.08 ^{b}
Shamia	I	42.35 ± 0.98 ^{d}	45.62 ± 0.94 ^{cd}	17.64 ± 0.06 ^{b}	15.64 ± 0.07 ^{d}	789.28 ± 4.68 ^{ac}	789.84 ± 3.09 ^{ab}
	II	71.34 ± 1.09 ^{a}	53.61 ± 1.92 ^{ab}	19.64 ± 0.37 ^{a}	22.64 ± 0.09 ^{a}	806.03 ± 4.56 ^{a}	797.61 ± 2.97 ^{a}
	III	48.92 ± 1.59 ^{c}	46.31 ± 0.87 ^{c}	14.63 ± 0.24 ^{ad}	16.32 ± 0.12 ^{c}	775.73 ± 3.57 ^{abcd}	776.13 ± 2.41 ^{abcd}
	IV	65.23 ± 2.38 ^{b}	54.67 ± 1.43 ^{a}	17.62 ± 0.18 ^{c}	18.62 ± 0.07 ^{ab}	795.55 ± 2.87 ^{ab}	786.09 ± 3.07 ^{abc}

On dry weight basis, I = Fresh (Tamr), II = Solar Drying, III= Sun Drying, IV= Mechanical Drying (Oven). Season 1 = 2018, Season 2 = 2019. Means with different letters (a, b, c, d) in the same column different significantly at p≤0.05 using one-way ANOVA test, while those with similar letters are not significant by different.

Table 8. Effect of sun, solar and mechanical drying on minerals content Sodium, Manganese, and Iron of Aswan dry date.

Date cultivars	Treatment	Minerals content, (mg/100g)					
		Sodium (Na)		Manganese (Mg)		Iron (Fe)	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Sakkoti	I	3.45 ± 0.61 ^{d}	3.56 ± 0.48 ^{cd}	28.61 ± 1.02 ^{a}	27.61 ± 0.64 ^{a}	2.76 ± 0.09 ^{a}	2.54 ± 0.09 ^{a}
	II	11.91 ± 1.12 ^{a}	10.62 ± 0.14 ^{a}	25.16 ± 0.97 ^{b}	23.65 ± 0.61 ^{c}	1.80 ± 0.14 ^{b}	1.75 ± 0.07 ^{b}
	III	7.61 ± 1.03 ^{c}	7.28 ± 1.04 ^{c}	16.64 ± 1.14 ^{d}	18.28 ± 0.75 ^{cd}	1.37 ± 0.12 ^{bd}	1.42 ± 0.03 ^{cd}
	IV	9.13 ± 1.08 ^{b}	8.97 ± 0.29 ^{b}	23.54 ± 1.32 ^{c}	25.62 ± 0.82 ^{b}	1.54 ± 0.13 ^{c}	1.60 ± 0.12 ^{c}
Bartamuda	I	3.92 ± 0.54 ^{bcd}	3.87 ± 0.09 ^{d}	45.82 ± 2.17 ^{a}	44.82 ± 0.91 ^{a}	1.49 ± 0.24 ^{a}	1.37 ± 0.14 ^{a}
	II	12.43 ± 1.20 ^{a}	13.01 ± 1.01 ^{a}	40.68 ± 2.08 ^{b}	42.61 ± 0.38 ^{ab}	1.19 ± 0.04 ^{b}	1.09 ± 0.07 ^{b}
	III	7.15 ± 1.14 ^{abc}	7.23 ± 0.24 ^{c}	25.37 ± 1.87 ^{d}	23.51 ± 0.86 ^{d}	0.86 ± 0.07 ^{d}	0.91 ± 0.12 ^{bd}
	IV	10.93 ± 1.57 ^{b}	9.76 ± 0.98 ^{ab}	31.93 ± 1.54 ^{bc}	30.54 ± 1.07 ^{c}	0.97 ± 0.03 ^{c}	0.93 ± 0.09 ^{c}
Gondaila	I	5.97 ± 0.97 ^{d}	5.46 ± 0.64 ^{d}	43.90 ± 0.92 ^{a}	42.31 ± 0.76 ^{b}	1.86 ± 0.27 ^{a}	1.75 ± 0.05 ^{a}
	II	14.31 ± 1.64 ^{a}	13.62 ± 1.14 ^{a}	40.94 ± 1.11 ^{b}	42.67 ± 1.02 ^{a}	1.13 ± 0.10 ^{b}	1.17 ± 0.07 ^{b}
	III	7.31 ± 0.67 ^{bc}	8.61 ± 0.43 ^{c}	26.64 ± 0.87 ^{d}	24.63 ± 1.34 ^{d}	0.81 ± 0.07 ^{d}	0.85 ± 0.02 ^{bd}
	IV	10.53 ± 1.09 ^{b}	10.06 ± 0.56 ^{b}	36.81 ± 0.32 ^{ac}	38.70 ± 0.75 ^{ac}	0.93 ± 0.03 ^{c}	0.89 ± 0.09 ^{c}
Malkabii	I	4.02 ± 0.45 ^{d}	3.89 ± 0.28 ^{d}	47.86 ± 2.30 ^{a}	44.15 ± 1.34 ^{a}	1.52 ± 0.14 ^{a}	1.47 ± 0.08 ^{a}
	II	11.62 ± 0.74 ^{a}	10.29 ± 0.48 ^{a}	45.26 ± 1.62 ^{b}	42.35 ± 1.23 ^{b}	1.35 ± 0.09 ^{b}	1.29 ± 0.04 ^{b}
	III	6.46 ± 0.34 ^{c}	6.23 ± 0.15 ^{c}	35.16 ± 1.05 ^{d}	31.29 ± 0.64 ^{d}	0.86 ± 0.12 ^{d}	0.92 ± 0.10 ^{d}
	IV	7.64 ± 0.18 ^{b}	8.12 ± 0.67 ^{ab}	38.45 ± 0.47 ^{ac}	39.26 ± 1.45 ^{ac}	1.11 ± 0.04 ^{c}	1.14 ± 0.05 ^{bc}
Shamia	I	4.76 ± 0.17 ^{d}	4.32 ± 0.34 ^{d}	29.35 ± 1.30 ^{a}	32.45 ± 0.67 ^{a}	2.34 ± 0.15 ^{a}	2.43 ± 0.07 ^{a}
	II	9.23 ± 0.19 ^{a}	9.78 ± 0.64 ^{a}	27.61 ± 1.85 ^{b}	30.45 ± 0.94 ^{b}	2.22 ± 0.06 ^{ab}	2.17 ± 0.04 ^{b}
	III	6.12 ± 0.82 ^{c}	6.01 ± 0.27 ^{c}	19.24 ± 2.14 ^{d}	21.54 ± 2.01 ^{d}	1.45 ± 0.08 ^{d}	1.62 ± 0.08 ^{bd}
	IV	7.85 ± 0.27 ^{ab}	7.23 ± 0.87 ^{b}	25.36 ± 1.64 ^{ac}	26.37 ± 0.46 ^{ac}	1.97 ± 0.12 ^{ac}	1.85 ± 0.06 ^{c}

On dry weight basis, I = Fresh (Tamr), II = Solar Drying, III= Sun Drying, IV= Mechanical Drying (Oven). Season 1 = 2018, Season 2 = 2019. Means with different letters (a, b, c, d) in the same column different significantly at p≤0.05 using one-way ANOVA test, while those with similar letters are not significant by different.

Table 9. Effect of sun, solar and mechanical drying on minerals content Magnesium, Copper, and Zinc of Aswan dry date.

Date cultivars	Treatment	Minerals content, (mg/100g)					
		Magnesium (Mn)		Copper (Cu)		Zinc (Zn)	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Sakkoti	I	0.69 ± 0.02 ^{a}	0.61 ± 0.02 ^{a}	0.76 ± 0.01 ^{a}	0.72 ± 0.01 ^{a}	0.87 ± 0.10 ^{c}	0.91 ± 0.02 ^{c}
	II	0.29 ± 0.03 ^{cd}	0.39 ± 0.04 ^{b}	0.61 ± 0.02 ^{b}	0.65 ± 0.01 ^{b}	1.13 ± 0.09 ^{a}	1.09 ± 0.03 ^{a}
	III	0.42 ± 0.04 ^{b}	0.27 ± 0.02 ^{d}	0.53 ± 0.04 ^{d}	0.57 ± 0.04 ^{d}	0.80 ± 0.04 ^{cd}	0.86 ± 0.04 ^{cd}
	IV	0.31 ± 0.01 ^{c}	0.33 ± 0.03 ^{c}	0.57 ± 0.05 ^{c}	0.62 ± 0.02 ^{bc}	1.09 ± 0.05 ^{ab}	1.02 ± 0.05 ^{ab}
Bartamuda	I	0.65 ± 0.02 ^{a}	0.72 ± 0.05 ^{a}	0.88 ± 0.01 ^{a}	0.92 ± 0.09 ^{a}	0.72 ± 0.04 ^{c}	0.69 ± 0.08 ^{c}
	II	0.51 ± 0.05 ^{b}	0.52 ± 0.04 ^{b}	0.74 ± 0.04 ^{b}	0.83 ± 0.03 ^{ab}	0.94 ± 0.08 ^{a}	0.91 ± 0.03 ^{a}
	III	0.32 ± 0.01 ^{cbd}	0.37 ± 0.01 ^{bc}	0.69 ± 0.01 ^{bcd}	0.64 ± 0.02 ^{cd}	0.61 ± 0.03 ^{d}	0.67 ± 0.04 ^{cd}
	IV	0.35 ± 0.02 ^{c}	0.31 ± 0.03 ^{d}	0.81 ± 0.03 ^{c}	0.70 ± 0.04 ^{c}	0.83 ± 0.01 ^{b}	0.90 ± 0.04 ^{ab}
Gondaila	I	0.54 ± 0.03 ^{a}	0.59 ± 0.04 ^{a}	1.67 ± 0.11 ^{a}	1.52 ± 0.04 ^{a}	0.72 ± 0.02 ^{c}	0.80 ± 0.01 ^{b}
	II	0.36 ± 0.01 ^{b}	0.39 ± 0.01 ^{b}	1.12 ± 0.08 ^{b}	1.15 ± 0.02 ^{b}	0.97 ± 0.04 ^{a}	1.03 ± 0.04 ^{a}
	III	0.34 ± 0.01 ^{bc}	0.26 ± 0.03 ^{d}	0.83 ± 0.03 ^{d}	0.75 ± 0.01 ^{d}	0.64 ± 0.01 ^{d}	0.61 ± 0.08 ^{ad}
	IV	0.28 ± 0.02 ^{d}	0.33 ± 0.01 ^{c}	0.97 ± 0.04 ^{c}	1.06 ± 0.09 ^{bc}	0.86 ± 0.05 ^{b}	0.79 ± 0.04 ^{c}
Malkabii	I	0.68 ± 0.01 ^{a}	0.63 ± 0.05 ^{a}	0.91 ± 0.06 ^{a}	0.87 ± 0.07 ^{a}	0.81 ± 0.04 ^{c}	0.78 ± 0.03 ^{c}
	II	0.59 ± 0.03 ^{b}	0.55 ± 0.04 ^{b}	0.67 ± 0.01 ^{d}	0.81 ± 0.03 ^{b}	0.93 ± 0.01 ^{a}	0.87 ± 0.04 ^{a}
	III	0.37 ± 0.04 ^{d}	0.37 ± 0.01 ^{cd}	0.87 ± 0.02 ^{b}	0.56 ± 0.05 ^{cd}	0.76 ± 0.01 ^{d}	0.72 ± 0.01 ^{acd}
	IV	0.45 ± 0.02 ^{c}	0.39 ± 0.03 ^{c}	0.76 ± 0.03 ^{ac}	0.77 ± 0.01 ^{c}	0.89 ± 0.03 ^{ab}	0.83 ± 0.01 ^{b}
Shamia	I	0.65 ± 0.04 ^{a}	0.59 ± 0.02 ^{a}	0.87 ± 0.07 ^{a}	0.79 ± 0.04 ^{a}	0.88 ± 0.06 ^{c}	0.80 ± 0.08 ^{ac}
	II	0.53 ± 0.02 ^{b}	0.52 ± 0.02 ^{b}	0.62 ± 0.02 ^{b}	0.62 ± 0.02 ^{ac}	0.93 ± 0.01 ^{a}	0.87 ± 0.01 ^{a}
	III	0.45 ± 0.01 ^{cd}	0.41 ± 0.05 ^{d}	0.59 ± 0.01 ^{c}	0.73 ± 0.05 ^{b}	0.75 ± 0.08 ^{acd}	0.71 ± 0.06 ^{acd}
	IV	0.48 ± 0.03 ^{c}	0.46 ± 0.04 ^{c}	0.54 ± 0.02 ^{cd}	0.69 ± 0.04 ^{cd}	0.91 ± 0.02 ^{b}	0.85 ± 0.01 ^{b}

On dry weight basis, I = Fresh (Tamr), II = Solar Drying, III= Sun Drying, IV= Mechanical Drying (Oven). Season 1 = 2018, Season 2 = 2019. Means with different letters (a, b, c, d) in the same column different significantly at p≤0.05 using one-way ANOVA test, while those with similar letters are not significant by different.

Table 10. Effect of sun, solar and mechanical drying on vitamin A, B, and C contents of Aswan dry date.

Date cultivars	Treatment	Vitamin (A), (µg/100g)		Vitamin (E), (mg/100g)		Vitamin (C), (µg/100g)	
		Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
Sakkoti	I	4.21 ± 0.025 ^{a}	4.10 ± 0.095 ^{a}	0.29 ± 0.025 ^{a}	0.25 ± 0.035 ^{a}	0.07 ± 0.015 ^{a}	0.08 ± 0.010 ^{a}
	II	4.09 ± 0.020 ^{b}	3.96 ± 0.200 ^{b}	0.24 ± 0.021 ^{ab}	0.23 ± 0.025 ^{b}	0.06 ± 0.020 ^{b}	0.08 ± 0.021 ^{a}
	III	3.51 ± 0.095 ^{abcd}	3.63 ± 0.104 ^{ad}	0.19 ± 0.010 ^{ad}	0.15 ± 0.010 ^{ad}	0.05 ± 0.010 ^{c}	0.04 ± 0.011 ^{cd}
	IV	3.83 ± 0.085 ^{abc}	3.77 ± 0.125 ^{abc}	0.21 ± 0.017 ^{abc}	0.20 ± 0.015 ^{abc}	0.05 ± 0.020 ^{c}	0.07 ± 0.015 ^{ac}
Bartamuda	I	4.87 ± 0.158 ^{a}	4.94 ± 0.075 ^{a}	0.55 ± 0.050 ^{a}	0.59 ± 0.050 ^{a}	0.09 ± 0.015 ^{a}	0.10 ± 0.014 ^{a}
	II	4.69 ± 0.115 ^{b}	4.71 ± 0.336 ^{b}	0.49 ± 0.035 ^{b}	0.50 ± 0.036 ^{ab}	0.08 ± 0.011 ^{b}	0.09 ± 0.020 ^{b}
	III	3.90 ± 0.106 ^{abc}	3.68 ± 0.070 ^{abc}	0.35 ± 0.041 ^{abd}	0.38 ± 0.045 ^{abc}	0.05 ± 0.019 ^{d}	0.07 ± 0.015 ^{ac}
	IV	3.79 ± 0.115 ^{abcd}	3.14 ± 0.574 ^{abd}	0.39 ± 0.036 ^{abc}	0.37 ± 0.040 ^{abd}	0.06 ± 0.018 ^{ac}	0.06 ± 0.010 ^{acd}
Gondaila	I	2.82 ± 0.075 ^{a}	2.86 ± 0.060 ^{a}	0.72 ± 0.025 ^{a}	0.69 ± 0.041 ^{a}	0.10 ± 0.010 ^{a}	0.08 ± 0.009 ^{a}
	II	2.52 ± 0.027 ^{ab}	2.63 ± 0.076 ^{ab}	0.68 ± 0.024 ^{b}	0.65 ± 0.045 ^{b}	0.09 ± 0.019 ^{b}	0.06 ± 0.015 ^{b}
	III	2.12 ± 0.061 ^{acd}	2.19 ± 0.045 ^{acd}	0.61 ± 0.020 ^{ad}	0.60 ± 0.050 ^{ac}	0.04 ± 0.036 ^{d}	0.04 ± 0.020 ^{d}
	IV	2.45 ± 0.050 ^{abc}	2.56 ± 0.070 ^{abc}	0.64 ± 0.023 ^{abc}	0.59 ± 0.031 ^{ad}	0.08 ± 0.011 ^{abc}	0.05 ± 0.006 ^{ac}
Malkabii	I	2.71 ± 0.085 ^{a}	2.74 ± 0.065 ^{a}	0.22 ± 0.015 ^{a}	0.21 ± 0.015 ^{a}	0.06 ± 0.020 ^{a}	0.07 ± 0.014 ^{a}
	II	2.64 ± 0.065 ^{b}	2.48 ± 0.036 ^{ab}	0.19 ± 0.020 ^{b}	0.20 ± 0.021 ^{b}	0.06 ± 0.010 ^{a}	0.07 ± 0.010 ^{a}
	III	2.18 ± 0.031 ^{abd}	2.22 ± 0.040 ^{abcd}	0.14 ± 0.055 ^{ad}	0.12 ± 0.010 ^{abd}	0.03 ± 0.021 ^{c}	0.03 ± 0.020 ^{c}
	IV	2.50 ± 0.050 ^{abc}	2.37 ± 0.075 ^{abc}	0.16 ± 0.041 ^{abc}	0.14 ± 0.011 ^{abc}	0.04 ± 0.011 ^{b}	0.05 ± 0.025 ^{ab}
Shamia	I	5.17 ± 0.061 ^{a}	5.11 ± 0.040 ^{a}	0.81 ± 0.042 ^{a}	0.85 ± 0.050 ^{a}	0.08 ± 0.090 ^{a}	0.09 ± 0.010 ^{a}
	II	4.89 ± 0.085 ^{b}	4.73 ± 0.086 ^{ab}	0.76 ± 0.060 ^{b}	0.77 ± 0.040 ^{b}	0.06 ± 0.011 ^{b}	0.08 ± 0.011 ^{b}
	III	4.33 ± 0.319 ^{abd}	4.21 ± 0.035 ^{abc}	0.65 ± 0.040 ^{ad}	0.63 ± 0.055 ^{ad}	0.03 ± 0.015 ^{ad}	0.04 ± 0.022 ^{abd}
	IV	4.35 ± 0.056 ^{abc}	4.47 ± 0.070 ^{abcd}	0.69 ± 0.025 ^{abc}	0.69 ± 0.036 ^{ac}	0.04 ± 0.024 ^{abc}	0.05 ± 0.009 ^{abc}

On dry weight basis, I = Fresh (Tamr), II = Solar Drying, III= Sun Drying, IV= Mechanical Drying (Oven). Season 1 = 2018, Season 2 = 2019. Means with different letters (a, b, c, d) in the same column different significantly at p≤0.05 using one-way ANOVA test, while those with similar letters are not significant by different.

Conclusion:

Drying is one of the important processes necessary to increase the shelf life of fresh dates for use throughout the year, but it requires the appropriate drying method that the dates reach the appropriate moisture content for storage (balanced moisture content) with the least possible loss of nutrients and vitamins, which are necessary to build the body and supply it with energy. So, the solar drying system led to drying of dates and reaching suitable moisture content for storage with less losses in chemical composition, mineral elements, sugars, and vitamins compared to the rest of the other drying systems.

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تأثير طرق التجفيف علي الخواص الفيزوكيميائيه لبلح اسوان الجاف

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الملخص

اجريت هذه الدراسة على خمسة أصناف من البلح الجاف الذي يزرع في محافظة اسوان - جمهورية مصر العربية - وهي أصناف السكوتى والبرتمودا والجنديلا والملكابي والشامية وهي من أحسن انواع نخيل البلح - وقد تم تقدير كل من الخصائص الفيزيائية (وزن الثمرة الكلي و وزن اللحم و وزن البذرة و نسبة وزن اللحم ومتوسط الطول ومتوسط القطر وعدد الثمار لكل ١ كجم و حجم الثمرة و وكثافة الثمرة ودرجة تركيز أيون الهيدروجين والحموضة والمواد الصلبة الذائبة) والخصائص الكيميائية (الرطوبة والبروتين والألياف والدهون والرماد و الكربوهيدرات والسكريات (الكلية والمختزلة والغير مختزلة والسكروز والجلوكوز والفركتوز) والعناصر المعدنية (الكبري والصغري) والفيتامينات (أ ، هـ ، ج) في هذه الأصناف مجتمعة بعد الحصاد مباشرة في مرحلة التمر ثم بعد التجفيف الشمسى لمدة ٢٥ يوم والتجفيف بالطاقة الشمسية لمدة ١٤ يوم علي درجة حرارة متوسطة ٥٠ درجة مئوية والتجفيف الصناعي على درجة ٦٠ درجة مئوية لمدة ٩ ساعات وتم المقارنة بين طرق التجفيف المختلفة. وقد وجد من النتائج أن الرطوبة و اللييبدات والبروتين و الرماد وتركيز أيون الايدروجين تقل بعد كل من عمليات التجفيف الشمسي والتجفيف الصناعي، بينما المواد الصلبة الكلية والكربوهيدرات والألياف والحموضة تزيد في كل الأصناف. وجد أيضاً أن كل من عنصرى البوتاسيوم والكالسيوم سجلا أعلى نسبة في مكوناتهم في كل الأصناف عن العناصر المعدنية الأخرى. وان عنصر البوتاسيوم كان مرتفعا في بلح البرتمودا بينما كان عنصر الكالسيوم مرتفع في صنف الجنديلا عن الأصناف الأخرى. وجد أن كل من أن السكريات الكلية و السكريات الغير مختزلة والسكروز والفركتوز في البلح من صنف الملكابي كانت مرتفعة عن الأصناف في مرحلة التمر بينما كانت نسبة السكريات المختزلة والجلوكوز مرتفعة في البلح الجونديلا عن باقي الأصناف، ووجد أن السكريات بصورة عامة إنخفضت بعد عملية التجفيف. وجد أيضاً أن فيتامينات (أ ، هـ) كانت مرتفعة في أصناف الشامية والبرتموا عن باقي الأصناف الأخري محل الدراسة في حين وجد أن فيتامين (ج) يوجد بكميات قليله في معظم الاصناف وان كان يرتفع قليلا في الجونديلا و الشاميه عن باقي الاصناف. وقد أوجدت الدراسة أن طريقة التجفيف بالطاقة الشمسية كانت أفضل الطرق المستخدمة في تجفيف البلح.