

Behavior of Barhee date palm cultivar produced by using tissue culture technique and grown in different regions of upper Egypt

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Abstract

This study was conducted during 2017 and 2018 seasons on Barhee date palm cv. (*Phoenix dactylifera* L.) at the age of 18 years, grown in three regions of Upper Egypt i.e Matana, Luxor Governorate; Kom- Ombo and Toshka, Aswan Governorate to evaluate its vegetative properties as well as physical properties and determination chemical composition of fruits. The obtained results revealed that, there were significant differences between the vegetative characteristics of date palm Barhee cv. because of different weather conditions of locations conducted study. The palms grown in Matana region recorded the largest values of the palm girth, number of leaves, length of the leaf and leaflet, leaflet area, spines number and area, while the lowest values of these parameters were obtained the palms grown in Toshka region. There are significant differences between the yield components because of growing Barhee in the three regions of Upper Egypt. There were significant differences of both physical and chemical fruits properties harvested from different regions of study. Barhee in Kom-Omboregion recorded the largest values of fruit length, fruit shape index, fruit weight, specific gravity of fruit, weight and percentage of flesh in the two study seasons. The highest values of TSS percentages, total and reducing sugars, Nitrogen, Phosphorus and Potassium content and lowest tannins content. The highest values of non-reducing sugars, the highest moisture content, and the lowest acidity were obtained in the case of Barhee in Toshka region. Generally, the productivity and quality of Barhee palm could be arranged discerning as follows: Kom-Ombo, Matana and Toshka.

Keywords: Barhee date; *Phoenix dactylifera* L.; physical properties; chemical composition.

Introduction

Date palm is the most common fruit tree grown in semiarid and arid- regions it plays an important role in the protection of interplant cropping systems and the

stabilization of the ecological system (Hasnaoui *et al.* 2011).The date palm is traditional propagated by offshoots to obtain the same variety; this leads to the high price of its offshoots and the difficulty of expanding its cultivation, so the tendency to multiply by plant tissue culture method for selected and excellent varieties of date palms, where a large number of date palms can be produced in a short time compared to the

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traditional methods of propagation. Tissue culture has made it possible to rapidly produce large number of date palms from a single offshoot (Shaheen, 1990). Aswan is the second largest governorate after the New Valley in dates production in Egypt, and it is famous to produce dry dates, as it is famous New Valley Governorate for produces semi dry dates. Date palm Barhee is marketed and consumed fresh at the mature full yellow (khelal) stage as a crispy apple-like fruit due to low contents of soluble tannins in contrast to many other cultivars (Al-Qurashi and Awad, 2011; Abd-Elhaleem *et al.*, 2020).

Morphological characters for leaves and fruits could be used in identification and description of date palm cultivars. Vegetative growth parameters represented 28% of variance between date palm cultivars. However, fruit properties such as fruit weight, length, size, total sugars, TSS, tannins and fibers represented 31% from variance (Ismail *et al.*, 2008). The physical and chemical characteristics of date palm fruits depending on cultivars and environmental conditions (Mohamed *et al.* 2004). Dates are considered as an almost ideal food that provides a wide range of essential nutrients with many potential health benefits (Elleuch *et al.*, 2008). Recently, several investigators mentioned that both productivity and quality of date palm were affected by source of pollen grains (Omaima *et al.*, 2014). The chemical composition of the date fruits of palm cultivars has been studied by several workers (Iqbal *et al.*, 2004 and Al-Hamoudi *et al.*, 2006). The main objective of this work is to evaluate the vegetative characters as well as physical and chemical properties of Barhee date palm

grown under different regions in Upper Egypt i.e. Matana, Kom- Ombo and Toshka.

Materials and Methods

This investigation was carried out during two consecutive seasons 2017 and 2018 to evaluate of Barhee date palm cultivar produced by tissue culture technique and grown in the three different regions of upper Egypt; Al- Matana, Luxor Governorate (latitude of 25°41' 12" N, and longitude of 32°38' 23"E), Kom- Ombo, Aswan Governorate (Latitude of 24° 45' N and Longitude of 32° 56' E) and Toshka, Aswan Governorate (latitude of 22°49° N, longitude of 28°58° E). However, average temperature and average relative humidity as a mean of two seasons were shown in Table (1). The selected palm trees aged 18 years old at the beginning of study planted at 7 X 7 meters apart. All the trees were uniform in growth, free from insects damage and diseases. All the selected palms received the same horticultural practices. However, the chosen female palms were hand pollinated by using pollen grains of a selected male date palm (El-Salhy *et al.*, 2010 and Iqbal *et al.*, 2010). Physical and chemical analysis of the three experimental orchard soils were presented in Table (2). Vegetative characters of the palm trees as well as the physical properties and chemical content of the fruits were studied as follows:

Vegetative parameters:

The palm trunk girth at one meter above the soil surface and palm height was measured in meters after harvesting. Four leaves from each palm were randomly detached to calculate, leaf length and number, number of leaf lets/leaf, leaflet area length, the number

of spines/leaf, spine length and spine area length. Leaflet area = (leaflet length x maximum width x 0.84) according to Shabana and Antoun (1980) number of spines/leaf, spine area on leaf rachis and width of leaf base were calculated.

Flowering parameters

Date of spathe bursting for Barhee date palm of Matana and Kom- Ombo regions was on the last week of February, while Toshka region was in the mid of February for the two seasons. Also, the date of spathe cracking for Matana was from 1st March to 15 March and for Kom- Ombo and Toshka was on the first week of March for both seasons.

Initial and horticultural fruit set%

For determining of initial and retained fruits, 10 strands per spathe were tagged and after thirty days of hand pollination the number of setting fruit were calculated so the total number of flowers on each strand. The percentage of initial fruit set was calculated using the following equation as described by (Khalil, 1999):

Initial fruit set % = Av. number of fruit set per strand/ Av. number of flowers per strand

% of retained fruits or final fruit set:

Final or retained fruits must be calculated on the same strands you calculate the initial fruit set. so at harvest you have to count the retained fruits on the same strands tagged before and you must divide the number of retained fruits by the total number of flowers.

Yield

In the two seasons, bunches were harvested at Khelal stage on 18, 7 and 1st August for

Matana, Kom- Ombo and Toshka regions, respectively. Meanwhile, number of bunch per palm and weight of bunches (kg) were counted and recorded and the yield/palm (kg) was calculated.

Fruit quality

After harvesting, samples of 30 fruits per palm tree were randomly collected (as a replicate) for each region and sent to the laboratory to determine the physical and chemical fruit properties:

Physical characteristics

The physical properties were recorded for both seasons of study; fruit and seed length (cm), fruit diameter (cm) and shape index, fruit weight (g) and volume (cm³), specific gravity of fruit (g/cm³), flesh and seed weight (g), flesh and seed % as well as flesh thickness were measured using digital caliper.

Chemical parameters

Moisture content (%)

The fruit samples were cleaned and the perianths and seeds were removed and date flesh was cut into pieces and dried at 60-65°C for 48 hours, since the normal dehydrating temperature 105 °C might lead to burning of fructose and because the water molecules are firmly attached to the sugar molecules and will never be freed (Abd-El-Rahman, 1974 and Mawlood, 1980).

Total soluble solids (T.S.S) content (%)

The T.S.S percentages were determined using a hand refractometer (A.O.A.C., 1995).

Table 1. Average temperature and average relative humidity in Kom- Ombo, Toshka and Matana regions as average of 2017 and 2018 seasons.

Average 2017 and 2018 seasons						
Meteorological factor	Matana					
	March	April	May	Jun	July	August
Average Temperature (C ⁰)	21.1	25.9	30.4	32.7	33.4	33.2
Average Relative Humidity (%)	24	17	16	17	19	21
Meteorological factor	Kom- Ombo					
	March	April	May	Jun	July	August
Average Temperature (C ⁰)	21.7	26.6	30.2	32.8	33.1	32.8
Average Relative Humidity (%)	28.6	23.6	21.1	20.5	23.3	25.3
Meteorological factor	Toshka					
	March	April	May	Jun	July	August
Average Temperature (C ⁰)	22.6	27.4	31.4	32.9	33.3	33.7
Average Relative Humidity (%)	26	21	20	21	24	25

According to Meteorological authority of Luxor and Aswan

Table 2. Some of the soil physical and chemical properties for the three experimental sites under study during 2017 season.

Region	Physical properties				Chemical properties				
	Sand %	Silt %	Clay %	O.M. %	H CO ₃ (meq/100 g soil)	SO ₄ ⁻ (meq/100 g soil)	Soil pH	E.C. (m mhose/cm)	CaCO ₃ %
Al-Matana	33.45	28.22	38.33	1.85	0.59	0.88	7.90	0.51	3.50
Kom- Ombo	79.0	10.0	11.0	0.33	1.36	0.34	8.5	0.24	3.89
Toshka	91.50	3.20	5.30	0.24	4.34	1.12	7.43	0.65	4.79

Sugars content (%)

Total and reducing sugar percentages were determined according to the method of Lane and Eynon volumetric method as described in the A.O.A.C. (1995). Non-reducing sugars were then calculated.

Total acidity content (%)

Acidity was determined by using 10 ml. of fruit juice which was titrated against sodium hydroxide using phenolphthalein as an indicator according to official methods (A.O.A.C., 1995) and the total acidity was calculated as malic acid (Mawlood, 1980).

Tannins content (%)

A sample of 5 fruits was taken to determine tannins content according to the official method described by Winton and Winton (1958).

N, P, K content in fruit:

Dried fruits were grinded and digested with H₂O₂ and H₂SO₄ according to Evanhuis and De Waard (1980). Suitable aliquots were taken for the determination of the mineral content. Nitrogen was determined by the Kjeldahl method as described in AOAC (1995). Phosphorus was determined by ascorbic acid method according to Murphy and Riley (1962). Potassium and sodium were determined by flame photometer.

Evaluation of the tested palms

For the final evaluation of the Barhee palm trees that were studied based on 100 units, it is divided between the yield (30 units) and the quality of the fruits (70 units); the quality units were divided as follows: Based on 10 units for fruit set%, fruit weight, pulp % and total sugars%. Meanwhile, 5 units for each fruit length and diameter, seed weight, TSS%, acidity and tannins. When a palm gives the best results in any characteristic it takes the final grade specified for this characteristic, while every other palm tree tested took less units equal to its quality (Hamed, 2012).

Statistical analysis

The Complete randomized design with three replicates was followed. Statistical analysis of the obtained data was carried according to Snedecor and Cochran (1980). L.S.D. test was used for comparing the data at the 5 % level of probability.

Results and Discussion

Vegetative characters

Data in table (2) shows the studied vegetative parameters of Barhee date palm cultivar produced by using tissue culture technique and grown in different regions of Upper Egypt during 2017 and 2018 seasons. It is evident from the previous table that there are significant differences between the vegetative traits under study, except for the spine length in the two seasons of the study of Barhee date palm grown in the three regions in southern Egypt. The largest values of palm girth, number of leaves, leaf and leaflet length, number of spines, and spines

area obtained from the growing of Barhee date palm in Matana region during the two seasons. Meanwhile, the highest values of palm length characteristic were obtained from the trees planted in Kom-Ombo region. On the other hand, the number of leaves was superior in the case of trees grown in Toshka region during the two seasons compared to the rest of the study regions. These results are in approval with those obtained by Abdalla *et al.*, 1995; Abdalla *et al.*, 1996.

In Egypt, the trend is to cultivate high-quality varieties of date palm such as Barhee cv. but there are some obstacles to producing high-quality date fruits for economic reasons and competition with the international market. However, this study was carried out for the purpose of evaluating the growth, productivity and quality of Barhee date palm grown in three different regions of Upper Egypt. The differences between the vegetative growth characteristics, yield characteristics and quality of Barhee trees growing in different locations of Upper Egypt may be due to differences in the temperature and relative humidity for the three regions. Generally, climate change negatively affects plant growth and development via an increase of abiotic stresses (i.e., heat, cold, drought and wet). It has been reported that when global average temperature increases by >3.5 °C, a significant extinction of plant species is expected due to lethal heat stress (IPCC, 2007). Extensive agricultural production losses have been attributed to disturbances in growth due to climate change-associated heat stress (Kotak *et al.*, 2007).

Yield and fruit physical properties

Data in Table (3 and 4) shows the yield components and its physical characteristics of the fruits of Barhee grown in three different regions in Upper Egypt during the 2017 and 2018 seasons.

Yield and its components:

The data shows that there are significant differences between the yield and its components as a result of growing in the three regions in the two seasons, with the exception of the weight of bunch, not show significant differences in the first season. It was evident from data that Barhee date palm grown in Matanaregi on recorded the highest yield values and the number of bunches, the percentage of the initial and horticultural fruit set, the weight of bunch and the yield/ palm compared to the rest of the regions under study. While the lowest of these characteristics was recorded from Toshka region during the two seasons of the study.

Fruit physical properties:

The same tables show the physical characteristics of the fruits of Barhee date palm grown in different regions in Upper Egypt. There are significant differences between the characteristics of fruit specific gravity, flesh weight, seed weight as well as percentage of flesh and seed in the two seasons. Meanwhile, the characteristics of seed length and flesh thickness were not significantly affected in the two seasons. It was evident that the characteristics of diameter and size of the fruit as well as weight and percentage of seeds showed superiority because of Barhee in Matana region, while the characteristics of the length

of fruit, the index shape of the fruit, the fruit weight, fruit specific gravity as well as weight and percentage of flesh showed a superiority in the case of palm trees growing in Kom- Ombo during the two seasons of the study compared to the rest of the regions. On the other hand, the lowest values of length, diameter, weight and size of the fruit was recorded in the Toshka region. These results were in accordance to Abdalla *et al.*,1995; Abdalla *et al.*, 1996.

Fruit Chemical attributes:

Data in Table (5) show clearly that all the chemical characteristics of the fruit of Barhee date palm were significantly different excepted the percentage of non-reducing sugars in the two seasons of the study as a result of cultivation in different regions in Upper Egypt. The highest values of the percentage of total soluble solids, total sugars and reducing sugars as well as the percentages of nitrogen, phosphorus and potassium, were recorded in Kom-Ombo, followed by Toshka region in the two seasons. On the other hand, the highest values of acidity % and tannins% were recorded in Matana region in the two seasons compared to the rest of regions. The highest moisture content was recorded in Barhee fruits of Toshka region compared to the rest of the areas under study.

Discussion

The highest fruit weight and productivity of female Barhee date palm was recorded when using pollen grains from Aswan location. Meanwhile, the highest values of fruit quality were statistically in concomitant to Giza and

New Valley location pollen sources (Abd-Elhaleem *et al.*, 2020). Meanwhile, through our study, Barhee date palm that growing in Toshka region, where sandy soils have low fertility and increased salinity stress conditions compared to the other regions under study, and the lack of growth and productivity in this region may be due to this reason. The type of soil in which palm trees grow may have an impact on the vegetative growth, production and quality of fruits and the lack of nutrients in the soil leads to decreased productivity. Also, deficiency effects of some macro and micro elements on date palm yield, fruit qualities, fruit set and development, retention and fruit dropping and other related parameters were reported by many researchers (Melouk *et al.*, 1999; Atalla *et al.*, 1999 and Shawky *et al.*, 1999). On the other hand, extreme climatic conditions (temperature above 50 degrees in summer, relative humidity less than 20% at its best, dry hot and strong winds) in Toshka region may have an effect on the lack of growth and productivity of Barhee date palm growing in it compared to other regions.

Total score for Barhee yield and quality (100 Units):

Data in Table (6) show that growing Barhee date palm in Kom- Ombo area was superior in terms of productivity and quality as it attained the uppermost score units (94.64) compared to its growing in the rest of regions as an average of both seasons. The superiority was in the units of fruit weight, percentage of flesh, length of fruit, seed weight, total sugars, total soluble solids and tannins. On the other hand, growing of Barhee in Toshka resulted in the lowest evaluation units (87.48) of productivity and quality characteristics in the average of the two seasons of the study.

Conclusion

From the obtained data of such study, it could be concluded that, although of different weather conditions of different regions of Upper Egypt and different soil fertility in these regions, Barhee soft date palm cultivar could be grown successfully in such regions. Regarding the growth vigour, palm productivity, fruit quality and to get high economic income, we recommend to spread cultivation of Barhee date palm cultivar in studied regions and they could arranged descendigly as follows Matana, Kom-Ombo and Toshka.

Table 2. Vegetative characteristics of Barhee date palm cultivar produced through tissue culture technique and grown in different regions of Upper Egypt during 2017 and 2018 seasons.

Locations	Palm height (m)	Trunk girth (m)	Leaf number	Leaf length (m)	Leaflet length (cm)	Leaflets number	Spines number	Leaflets area length (m)	Spines area length(m)	Spine length (cm)
First season (2017)										
Al-Matana	8.30	1.68	146.4	5.25	61.4	227.1	23.2	4.01	1.23	11.1
Kom-Ombo	8.55	1.66	126.4	4.68	55.0	231.8	20.2	3.60	1.07	10.4
Toshka	8.01	1.60	104.2	4.66	52.8	233.0	19.8	3.61	1.05	10.1
LSD 5%	0.19	0.06	8.3	0.16	3.14	7.93	2.2	0.17	0.12	n.s
Second season (2018)										
Al-Matana	8.30	1.68	153.5	5.33	60.1	226.8	22.8	4.11	1.21	10.7
Kom-Ombo	8.55	1.66	131.8	4.73	53.0	233.1	21.0	3.64	1.11	10.8
Toshka	8.01	1.60	112.8	4.62	51.4	235.0	20.0	3.59	1.02	9.8
LSD 5%	0.19	0.06	7.0	0.14	3.4	7.8	2.1	0.16	0.14	n.s

Table 3. Yield components and some physical characteristics of fruit of Barhee date palm cultivar produced through tissue culture technique and grown in different regions of Upper Egypt during 2017 and 2018 seasons.

Locations	Number of bunches	Initial Fruit Set %	Horticultural Fruit set %	Average weight of bunch(Kg)	Yield/palm (kg)	Fruit length (cm)	Fruit diameter (cm)	Fruit shape index	Fruit weight (g)	Fruit volume(cm ³)
First season (2017)										
Al-Matana	15.14	47.76	34.67	13.36	202.85	3.57	2.80	1.26	15.57	16.69
Kom-Ombo	11.42	38.40	28.21	12.86	146.42	3.68	2.74	1.34	17.12	15.33
Toshka	10.00	37.55	24.38	12.63	125.71	3.43	2.68	1.28	15.20	14.44
LSD 5%	0.99	0.43	2.42	n.s	6.60	0.14	0.08	0.05	0.73	1.18
Second season (2018)										
Al-Matana	15.42	48.19	34.78	13.36	206.00	3.59	2.77	1.30	15.69	16.86
Kom-Ombo	12.14	39.35	28.42	12.24	148.14	3.70	2.71	1.36	16.83	15.43
Toshka	10.14	37.87	24.72	12.56	126.85	3.49	2.68	1.30	15.14	14.46
LSD 5%	0.97	0.56	2.34	0.84	6.74	0.14	0.08	0.05	1.16	1.15

Table 4. Some physical characteristics of fruit of Barhee date palm cultivar produced through tissue culture technique and grown in different regions of Upper Egypt during 2017 and 2018 seasons.

Locations	Specific gravity of fruit (g/cm ³)	Flesh weight (g)	Seed weight (g)	Flesh %	Seed %	Seed length (cm)	Flesh thickness (cm)
First season (2017)							
Al-Matana	0.93	14.26	1.29	91.67	8.33	2.07	0.85
Kom-Ombo	1.12	16.40	0.76	95.54	4.46	2.09	0.85
Toshka	1.05	14.39	0.81	94.68	5.32	2.01	0.83
LSD 5%	0.06	0.62	0.18	1.17	1.17	n.s	n.s
Second season (2018)							
Al-Matana	0.93	14.29	1.32	91.54	8.46	2.11	0.87
Kom-Ombo	1.09	16.03	0.80	95.23	4.77	2.07	0.87
Toshka	1.05	14.37	0.85	94.42	5.58	2.04	0.84
LSD 5%	0.06	0.72	0.27	1.81	2.21	n.s	n.s

Table 5. Chemical characteristics of fruit of Barhee date palm cultivar produced through tissue culture technique and grown in different regions of Upper Egypt during 2017 and 2018 seasons.

Locations	TSS%	Total sugars (%)	Reducing sugars (%)	Nonreducing sugars (%)	Moisture content (%)	Acidity (%)	Tannins (%)	N (mg/100gm dry wt.)	P (mg/100gm dry wt.)	K (mg/100gm dry wt.)
First season (2017)										
Al-Matana	36.29	32.93	22.17	10.76	58.68	0.49	0.234	253.9	182.5	527.5
Kom-Ombo	41.44	38.24	27.32	10.91	53.01	0.41	0.227	271.1	188.3	569.1
Toshka	39.43	34.16	23.01	11.44	60.21	0.23	0.231	262.1	186.3	566.1
LSD 5%	1.52	1.23	1.15	n.s	1.90	0.003	0.003	1.79	2.38	4.16
Second season (2018)										
Al-Matana	36.55	33.27	22.30	10.97	58.12	0.51	0.237	255.6	184.1	529.9
Kom-Ombo	41.70	38.54	27.48	11.06	52.21	0.42	0.230	272.3	189.2	570.8
Toshka	39.70	34.38	22.82	11.57	59.67	0.24	0.234	263.5	187.8	567.9
LSD 5%	1.50	1.39	0.99	n.s	1.72	0.003	0.003	2.59	1.30	4.23

Table 6. General score evaluation of fruit of Barhee date palm cultivar produced through tissue culture technique and grown in different regions of Upper Egypt in the mean of 2017&2018 seasons.

Index	Average of 2017 &2018 seasons			
	Units specified	Al-Matana	Kom-Ombo	Toshka
Yield (Kg)	30	30.00	26.13	24.22
Fruit set (%)	10	10.00	9.11	8.78
Fruit weight (gm)	10	9.11	10.00	8.80
Pulp (%)	10	8.77	10.00	9.13
Fruit length (cm)	5	4.52	5.00	4.20
Fruit diameter(cm)	5	5.00	4.62	4.15
Seed weight (gm)	5	4.22	5.00	4.65
Total sugars (%)	10	9.00	10.00	9.44
TSS (%)	5	4.00	5.00	4.55
Acidity (%)	5	4.11	4.60	5.00
Tannins (%)	5	4.32	5.00	4.56
Total scour fruit quality	70	63.05	68.33	63.26
Total unit yield/palm	100	93.05	94.64	87.48

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