

Identification of some Date palm (*Phoenix dactylifera*) cultivars by fruit characters

M.M.Sakr¹, I.M. Abu Zeid¹, A.E.Hassan², A-G.I.O.Baz² and W.M.Hassan²

¹Faculty of Education, King Abdulaziz University, Jeddah, PO: 15758 Jeddah 21454, Saudi Arabia.

²Faculty of Agriculture, Suez Canal University, Ismailia, Egypt
abuzeidm@yahoo.com

Abstract

Date palm (*Phoenix dactylifera*) was studied for the morphological, anatomical and phytochemical characters of fruit cultivars. These cultivars are Amhat, Barhy, Bint Aisha, Zaghloul, Hayany, Amry, Kuboshy and Samany. The Morphological, anatomical and chemical characters of fruit varied among the cultivars studied. Zaghloul cultivar exhibited the highest values of reducing sugar, total phenols, titrateable acidity, while Samany cultivar showed the highest value of total soluble solids. This study may be helpful for commercial utilization of date palm.

Keywords: *Phoenix dactylifera* cultivars, fruit, morphological, anatomical, chemical characters.

Introduction

The date palm *Phoenix dactylifera* L is one of the oldest fruit trees in the Arab region and it is extensively cultivated for its edible sweet fruit. Due to its long history of cultivation for fruit, its exact native distribution is unknown but probably originated somewhere in the desert oases of northern Africa and perhaps also southwest Asia (El-Shibli & Korelainen, 2009). The date palm fruit is a single, oblong, one-seeded berry with a terminal stigma, a fleshy pericarp and a membranous endocarp. The fruit morphology of date palm was studied by Mansour (2005), who indicated that the fruit length ranged from a min of 2.80 cm in Aglany cultivar to a max of 5.92 cm in Zaghloul cultivar. Moreover, the mean length of the fruit in Bent-Aisha cultivar (3.69 cm) was significantly shorter than the other studied cultivars, while the mean of the same character in Zaghloul cultivar (5.21 cm) was significantly longer than the other studied cultivars. In addition, the investigator observed 5 colours in fruits of date palm cultivars. It was bright yellow in Aglany cultivar, yellow with red spots in Samany cultivar, orange in Amry cultivar, bright red in Zaghloul and red-scarlet in both Hayany & Bent-Aisha. Furthermore, in the same study the date palm min diameters were evaluated. The min diameter of the fruit base was 0.59 cm in Bint-Aisha cultivar and the max diameter was 1.37 cm in Samany cultivar. In addition, the mean diameter of the fruit base in Bent-Aisha cultivar was 0.71 cm. The min diameter of the middle of the fruit was 0.83 cm in Aglany cultivars. However, the max diameter was 1.59 cm in Samany. The min diameter of the fruit apex was 0.40 cm in Aglany and the max was 0.82 cm in the Zaghloul cultivars. In addition, diameter of fruit apex of Zaghloul cultivar (0.70 cm) was significantly more than the other studied cultivars. Concerning the fruit anatomy, Al-Awdat & El-Deajy (1992) mentioned that the date palm fruits are simple, succulent berry. Endocarp is consisting of 1 layer of small cells which could be seen in an early stage of fruit development. Mesocarp which consist the most part

of fruit size, is consisted of enlarged parenchymatous cells. The mesocarp divided into outer-mesocarp and inner-mesocarp, between them there are 3-10 layers of tanniferous cells. The exocarp consists of epidermis covered with cuticle, 3-5 layers of parenchymatous cells and last part of exocarp are occupied by stone cells in radial orientation. Shomer *et al.* (1998) examined tissues at cross-sections of the pericarp of Madjhoul date fruit deteriorated during 10 months of preservation at temperatures between 0 and 18°C by light microscope and transmission electron microscope. The ultrastructural observations of freezing at the higher temperature range resulted in the rupture of various cellular compartments whereas, in fruits frozen at the lower temperature range both intracellular membranes and cell walls were intact even after 10 months. The fruit phytochemistry of different date palm cultivars was investigated by Mousa (1981), who observed that total sugar content ranged between 75 and 85% in the fruits of 6 seedlings of date palm trees grown at Ismailia Governorate, Egypt. Moreover, El-Warraki *et al.* (1989) determined: moisture content and reducing sugars of 14 date cultivars obtained from Almadinah Al-Monawarah dates at different seasons. There were Significant differences in moisture content between seasons, the content of reducing sugars varied widely between the studied cultivars from 50.44% to 87.83%. Hussein and El-desouki (1992) reported that moisture contents were at the highest levels (66.3 and 67.4%) in Haiani dates. Abdalla *et al.* (1996) cited that commercial grading of dates is based principally on the physical characteristics and general appearance of the fruit, moisture and sugars contents. Moreover, Youssef *et al.* (1999) evaluated the chemical composition of 8 date cultivars from different areas of Upper Egypt. Total sugars contents ranged from 73.65% to 81.77% for dry cultivars and from 75.10% to 87.27% for semi-dry cultivars. Non reducing sugars (41.85%-46.52 %) were the dominant sugars of dry cultivars, while reducing sugars (71.83%-79.08%) were present in high amounts in the semi-dry

cultivars. This study therefore aimed to study the morph-anatomical and chemical characters of date palm fruits and their application in identification of 8 Egyptian date palm cultivars.

Materials and methods

Date palm samples were collected from the Experimental Station at Al-Kassassin which belongs to the Egyptian Ministry of Agriculture, Ismailia Governorate and Private Orchards beside the previous mentioned Station during Oct 2003 and 2004 seasons. The studied date palm trees were 8 female cultivars (Amhat, Barhi, Bint Aisha, Zaghloul, Hayany, Amry, Kuboshy & Samany). The obtained data were as follows:-

- Fruit samples were collected throughout the date palm fruiting seasons (2003 and 2004 crops) at Khalal maturity stage were 50 fruits for each sample. The following data were recorded: fruit weight, fruit dimensions (length, diameter and fruit length/diameter ratio L/D), fruit pulp and seed weight (g), fruit pulp percentages were calculated. Fruit colour was determined according to Hunter (1977), using a Minolta CR-10 Chromameter (Minolta Corp., Japan) measuring *L*, *a* and *b* coordinates (Francis, 1980). The colour index (CI) was calculated according to Jimenez-Cuesta *et al.* (1981) as follows:

$$CI = 1000 \times a / L \times b$$

L = Lightness, *a* = Values on a green to red scale and *b* = Values on a blue to yellow scale.

Fruit firmness (kg/cm²) was measured at 2 equatorial sites using fruit pressure tester Penetrometer ST 308 Italy Tips= 6.4 mm convex tip at 25°C.

- For studying the different tissues of fruit (pericarp), samples of the mature fruits were killed and fixed in 70% FAA solution, dehydrated with ethyl alcohol series, infiltration, then the samples were embedded in paraffin wax (M.P. 58°C). According to Willey (1971) using a rotary microtome, sections (10 μ) were obtained and stained with safranin and light green before being mounted in canada balsam. Sections were examined microscopically and the different tissues were calculated by eyepiece micrometer.
- Moisture content, dry matter, total soluble solids (TSS) and titratable acidity were determined. According to Anon (1990a) methods. Fruit samples were cleaned and seeds were removed. Date flesh were cut into pieces and dried at 60-70°C. The moisture and dry matter content percentage were calculated using the following equations:

$$\text{Moisture (\%)} = \frac{\text{weight before drying} - \text{weight after drying}}{\text{Weight before drying}} \times 100$$

$$\text{Dry matter (\%)} = \frac{\text{Average dry weight (g)}}{\text{Average fresh weight (g)}} \times 100$$

Moreover, total soluble solids (TSS) content was determined in the fruit juice using a hand refractometer. However, Fruit acidity was determined using 10 ml of fruit juice (a known fruit flesh weight blended in known

Fig.1. Showing fruit of the studied date palm genotypes: a- Amhat cv; b- Barhy cv; c - Bint-Aisha cv; d- Zaghloul cv. e- Hayany cv f-Samany cv; g- Amry cv. h- Kuboshy cv.



1. Whole fruit at Rutab stage, 2. Whole fruit at Khalal stage
3. Median longitudinal section of the fruit, 4. Seed (Dorsal view)
5. Seed (Ventral view) 6. Transverse section of the fruit
8. Fruit base 7. Fruit apex

water volume) which were titrated against sodium hydroxide using phenolphthalein as an indicator according to the official methods and the titratable acidity was calculated as malic acid.

- Reducing sugars and total phenols were extracted from the fruits according to Abdel-Rahman *et al.* (1975) and estimated according to Moore (1974) methods.

All data obtained during the course of the experiment were subjected to statistical analysis according to Steel and Torrie (1982).

Results and discussion

Morphological characters

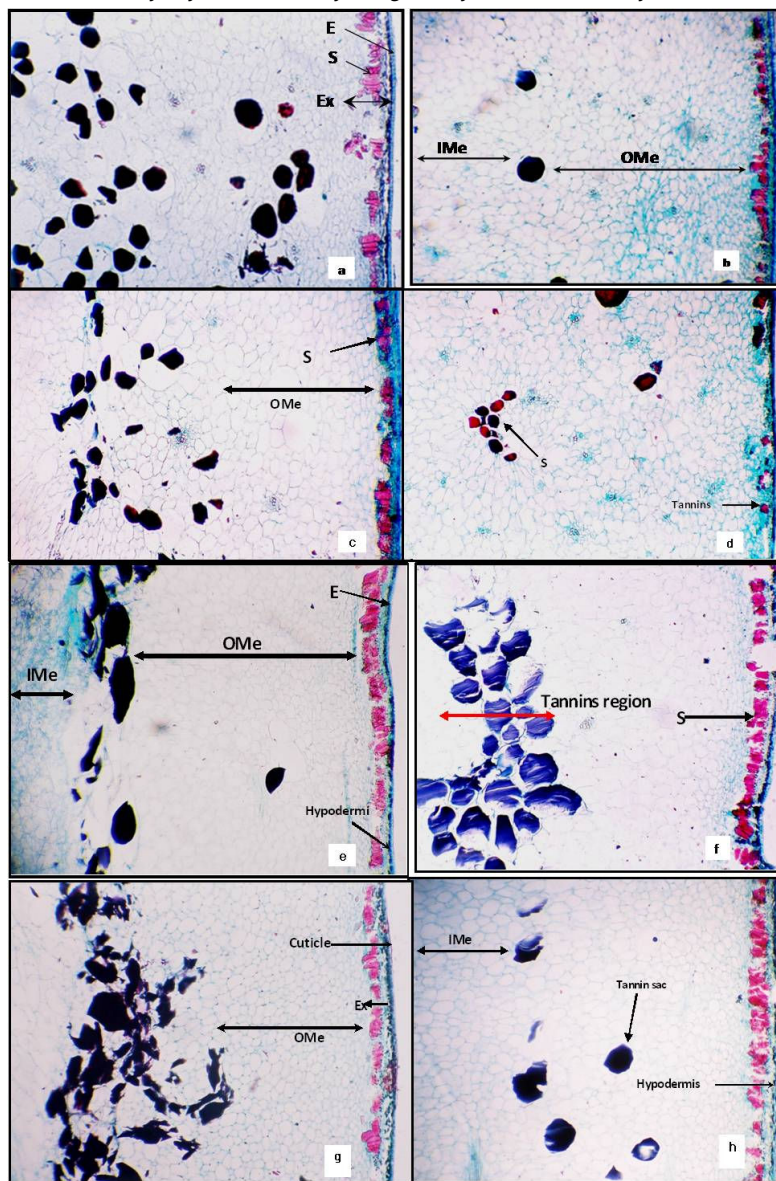
Fruit colour

The colour value 'L' which measures relative white (100) to black (0) colour is shown in Table 1 and Fig. 1. Amhat, Barhy, Samany and Kuboshy cultivars had the highest 'L' values by 62.99, 62.24, 56.06 and 44.18 respectively (Fig. 1a, b, f and h respectively) followed by Amry, Hayany, Zaghloul and Bint-Aisha cultivars by 38.8, 29.7, 29.28 and 26.08 respectively (Figs. 1g, e, d and c respectively). Moreover, 'a' value which measure relative green (-) to red (+) colour were significantly varied in different palm cultivars. Hayany (Fig. 1e) had the highest significant value (37.72) followed by Amry, Zaghloul, Bint-Aisha and Kuboshy by 36, 70, 35.88, 35, 42 and 32.16 respectively (Fig. 1g, d, c and h, respectively) while the lowest 'a' values were noticed in Barhy and Amhat by 12.78 and 13.10 (Fig. 1b and a respectively). In addition, the 'b' colour values which measure relative yellow (+) to blue (-) were significantly varied. Barhy, Amhat, Samany, Kuboshy and Amry had the highest significant 'b' values by 49.06, 47.20, 46.46, 30.78, and 23.78 respectively (Fig. 1b, a, f, h, and g respectively). The lowest 'b' values which recorded were 11.90, 11.44 and 8.810 in Zaghloul, Hayany and Bint-Aisha respectively (Fig. 1d, e and c respectively). However the colour index value was 4.19, 4.41, 8.09, 23.65, 39.78, 102.98, 111.02 and 154.16 for Barhy, Amhat, Samany, Kuboshy, Amry, Zaghloul, Hayany and Bint-Aisha respectively. These results were in accordance with Bassal (2003) who recorded that colour index was 103 in Zaghloul cultivar when treated with 500 ppm ethephon. In as similar study, Mansour (2005) observed 5 colours in fruits of date palm cultivars. It was bright yellow in Aglany cultivar, yellow with red spots in Samany cultivar, orange in Amry cultivar, bright red in Zaghloul and red-scarlet in both Hayany and Bent-Aisha.

Fruit weight and firmness

Fruit, seed and pulp weight (g) were shown in Table 1. The highest value for fruit weight was noticed in Samany cultivar by 28.71 g and for seed weight was in Hayany cultivar by 2.62 g, while the lowest values were 8.50 g for fruit weight and 1.31 g for seed weight in Amhat cultivar. The same trend was observed in this respect with pulp weight and percentage in all the studied date palm cultivars. However, Bint-Aisha, Amry, Kuboshy and Hayany cultivars had the highest values of fruit firmness

Fig. 2. Light microscope micrographs of cross sections of the pericarp of date palm cultivars fruits (16 X)
a- Amhat cv; b- Barhy cv; c - Bint-Aisha cv; d- Zaghloul cv.
e- Hayany cv f-Samany cv; g- Amry cv. h- Kuboshy cv.



Abbreviations: E, epidermis; Ex, exocarp; OMe, outer-mesocarp; IMe, inner-mesocarp S, stone cell.

by 5.34, 5.29, 4.95 and 4.92 kg/cm² respectively, while the lowest value which recorded was 3.59 kg/cm² for Amhat cultivar. These results are in comfortable with Selim *et al.* (1968), Khalifa (1973), El-Azzouni *et al.* (1975) and Kamel *et al.* (1976) for fruit weight and with Mougheith *et al.* (1976) for fruit firmness. The results of this research were also in general agreement with the findings of Mansour (2005) who recorded that the fruit weight was 23.80 g in Samany and 11.06 g in Bent-Aisha cultivars.

Table 1. Fruit morphology of the studied date palm cultivars

Character Cultivars	Fruit colour attributes *			Colour index	Fruit weight (g)	Seed weight (g)	Pulp weight (g)	Pulp weight (%)	Fruit firmness (kg/cm ²)	Fruit				
	(a)	(b)	(L)							Length (cm)	Diameter (cm)	Length/diameter	Shape	Volume (cm ³)
a- Amhat	13.1	47.2	62.99	4.41	8.50	1.31	7.19	84.57	3.59	3.50 a	2.33 a	1.50	Oblong	8.75 a
b- Barhy	12.78	49.06	62.24	4.19	19.02	1.56	17.46	91.78	3.81	4.05 a	2.94 c	1.38	Ovate	19.14 c
c- Bint-Aisha	35.42	8.81	26.08	154.16	17.56	1.56	16.01	91.12	5.34	4.10 a	2.31 a	1.78	Oblong	13.57 b
d- Zaghloul	35.88	11.9	29.28	102.98	26.67	2.00	24.67	92.50	3.73	6.10 cd	2.76 bc	2.21	Oblong	30.40 e
e- Hayany	37.72	11.44	29.7	111.02	24.86	2.62	22.24	89.46	4.92	5.82 bcd	2.70 abc	2.16	Oblong	25.50 d
f- Samany	21.06	46.46	56.06	8.09	28.71	2.27	26.43	92.08	3.90	5.52 bc	3.31 d	1.67	Ovate	32.50 e
g- Amry	36.7	23.78	38.8	39.78	19.46	1.80	17.67	90.77	5.29	5.01 b	2.43 ab	2.06	Oblong	19.20 c
h- Kuboshy	32.16	30.78	44.18	23.65	26.42	2.18	24.24	91.73	4.95	6.65 d	2.57 abc	2.59	Oblong	26.00 d

* Color attributes: L= Lightness, 0 = black, 100 = white; + a = red, -a = green; + b = yellow, -b = blue.

Means having the same letter(s) in each column are insignificantly different at 5% level.

Fruit dimensions

It is obvious from Table 1 and Fig. 1. that fruit length per cm significantly differed among various date palm cultivars. Kuboshy and Zaghloul cultivars had the highest significant value for fruit length by 6.65 and 6.10 cm compared with other cultivars followed by Hayany, Samany, Amry, Bint-Aisha, Barhy and Amhat cultivars by 5.82, 5.52, 5.01, 4.10, 4.05 and 3.50 cm respectively. The highest recorded diameters were 3.31, 2.94, 2.76, 2.70 and 2.57 cm in Samany, Barhy, Zaghloul, Hayany and Kuboshy cultivars respectively. Opposite trend was recorded in this respect with Bint-Aisha, Amhat, and Amry cultivars which had the lowest values by 2.31, 2.33 and 2.43 respectively. The highest fruit length/fruit diameter ratio was 2.59 in Kuboshy cultivar while the lowest ratio was 1.38 in Barhy cultivar. However, fruit shape was ovate in Barhy and Samany cultivars and oblong in the other cultivars under investigation. In addition, fruit volume (cm³) was significantly higher by 32.50 and 30.40 cm³ in Samany and Zaghloul cultivars without significant difference between them, followed by 26.00 and 25.50 cm³ in Kuboshy and Hayany cultivars, there are no significant difference in fruit volume of Amry and Barhy cultivars (19.20 & 19.14 cm³). The lowest value was recorded in Amhat cultivar by 8.75 cm³ and it was significantly less than the other 8 cultivars. These results are in general agreement with Khalifa (1973), Mougheith *et al.* (1976), El-Makhtoun and Abdel-kader (1990) and Ibrahim *et al.* (2001) for fruit length and fruit diameter. Moreover, Bassal (2003) reported that fruit volume in Zaghloul ranged from 27.33- 37.66 cm³ as affected by thinning and some growth regulators treatments. These data are also in general agreement with Hussein (2005) who found that the fruit length values were 3, 3.5-4, 6, 4-5, 5-6, and 5 cm and 2-3, 2.2-2.5, 2.5-3, 2.5-3, 2.5-3.5 and 3.5 cm for fruit diameter in Amhat, Bint-Aisha, Zaghloul, Hayany, Samany and Amry respectively.

Anatomical characteristics

Data pertaining to fruit anatomy obtained from cross sections are explored in Table 2 and Fig. 2. Average thickness of epidermis and cuticle layer was ranged from 15.67 μ in Zaghloul cultivar to 20.01 μ in Kuboshy cultivar (Fig. 2d and h). Number of hypodermis layers was 1 layer in Barhy, Zaghloul and Hayany or ranged from 1-2 layers in Samany and Kuboshy (Figs. 2b, d, e, f and h), 2 layers in Bint-Aisha and 3 layers in Amhat and ranged from 3-4 layers in Amry cultivar (Figs. 2c, a and g). The highest value for maximum thickness of stone cell layers was 132.00 μ in Kuboshy, while the lowest value was 8800 μ in Barhy cultivar (Figs. 2h and b), the stone cells are found in continuous layers as in all cultivars under investigation except in the Zaghloul cultivar they were found in groups (discontinuous) and this character is unique to Zaghloul cultivar. Average thickness of exocarp was ranged from 146 μ in Amry to 224 μ in Kuboshy cultivar. The highest average thickness of outer-mesocarp was recorded in Kuboshy, Amhat and Zaghloul by 1.68, 1.14 and 1.05 mm respectively (Figs. 2h, a and d). However, the lowest values were noticed in Bint-Aisha, Hayany and Barhy by 0.37, 0.49 and 0.63 mm respectively (Figs. 2c, e and b). Average thickness of tannins region ranged between 0.24 and 1.05 mm in Barhy and Samany cultivars, respectively (Fig. 2b and f), this result explain why Barhy cultivar fruit at Khalal stage has good taste and an excellent flavour with very little astringency distinguishing it from all other date varieties and this due to its low content of tannins, Fig. 2b. The aforementioned results are true to Zaghloul cultivar to where its tannins region was only 0.31 mm. In the same trend lowest average number of tannins layers between outer and inner-mesocarp was recorded in Barhy cultivar by 2 layers while, the highest average was 5 layers recorded in Amhat, Samany and Amry cultivars. Also in the same trend the tannins were very few as discontinuous layer in Barhy, few and discontinuous in Zaghloul cultivar, medium and continuous layer in Bint-Aisha and Hayany cultivars, medium but discontinuous in

Kuboshy cultivar. On the other hand, tannin was as thick continuous layer in Amhat, Samany and Amry cultivars.

The highest average thickness of inner-mesocarp was recorded in Barhy by 5.88 mm while, the lowest

1.91 and 1.81% respectively in comparison with other cultivars. The highest value of fruit titratable acidity (0.36%) was noticed in Zaghloul cultivar followed by Hayany (0.26%) and Bint-Aisha (0.24%), while the lowest

Table 2. Anatomical characters of fruits of the studied date palm cultivars

Genotypes Characters	a- Amhat	b- Barhy	c- Bint-Aisha	d-Zaghloul	e- Hayany	f-Samany	g- Amry	h-Kuboshy
Average thickness of epidermis and cuticle layer (μ)	17.79	18.46	16.68	15.67	17.34	17.79	19.35	20.01
No. of hypodermis layers	3	1	2	1	1	1-2	3-4	1-2
Maximum thickness of stone cell layers (μ)	120.56	88.00	98.56	105.60	94.16	101.20	96.80	132.00
Description of stone cell layers	Continuous	~continuous	Completely continuous	Discontinuous	Completely continuous	Continuous	Continuous	Completely continuous
Average thickness of exocarp (μ)	190	132	211	191	158	161	146	224
Average thickness of outer-mesocarp (mm)	1.14	0.63	0.37	1.05	0.49	0.99	0.84	1.68
Average thickness of tannins region between outer and inner-mesocarp (mm)	0.73	0.24	0.42	0.31	0.47	1.05	0.63	0.59
Average No. of tannins layers between outer and inner-mesocarp	5	2	3	3	3	5	5	3
Density and description of tannins layers between outer and inner-mesocarp	Thick, continuous	Very few, discontinuous	Medium, continuous	Few, discontinuous	Medium, continuous	Thick, continuous	Thick, continuous	Medium, discontinuous
Average thickness of inner-mesocarp (mm)	2.52	5.88	2.73	2.94	2.86	3.46	2.73	3.67
Average thickness of mesocarp (mm)	4.41	6.82	3.57	4.30	3.85	5.46	4.20	5.94

Abbreviations: (mm) = millimeter, (μ) = micron

average was in Bint-Aishal and Amry by 2.73 mm each.

The aforementioned anatomical description of date palm fruits is in accordance with Al-Awdat and El-Deajy (1992). Also, the results of the present study were in general agreement with Shomer *et al.* (1998) who examined tissues at cross-sections of the pericarp of date fruit, cultivar Madjhouh.

Chemical characteristics

The chemical composition tests were carried out to determine moisture content, reducing sugars, total phenols, titratable acidity, total soluble solids and TSS/Acidity ratio values of different date palm cultivars during Oct 2003 and 2004 seasons (Table 3). Amry cultivar had the lowest value of moisture content of fruit by 62.29% in comparison with other cultivars while, Kuboshy, Zaghloul, Barhy and Amhat cultivars had the highest values by 86.43, 77.00, 75.75 and 74.50%, respectively. The percentages of reducing sugars of fruits were significantly differed in different date palm cultivars. Zaghloul cultivar had the highest reducing sugars value (51%) than other cultivars followed by Bint-Aisha (40.08%), Samany (38.65%), Hayany (31.86%), Barhy (30.64%), Amhat (28.20%), Kuboshy (24.54%) and Amry (16.34%). The result of the present study also indicates that Zaghloul cultivar had the highest value of total phenols (4.38%) followed by Samany (3.16%), Amhat (2.57%), Hayany (2.50%), Kuboshy (2.28%) and Bint-Aisha (2.20%) while, Barhy and Amry had the lowest values by

values were recorded in Barhy and Amhat cultivars by 0.13 and 0.10% respectively. It is obvious from Table 3. that Samany cultivar had the highest value of total soluble solids (TSS) of fruit by 45% than other cultivars followed by Amhat (39.00%), Bint-Aisha (34.00%), Hayany (33.50%), Zaghloul (32.50%), Barhy (32.00%) and Kuboshy (28.00%) while, Amry had the lowest value by 27.50%. TSS/ acidity ratio is a very important parameter of fruit quality. It was noticed that Samany cultivar had the highest value of TSS/Acidity ratio (11.54) followed by Amhat (10.86), Zaghloul (8.71), Barhy (8.40), Hayany (6.81), Bint-Aisha (6.37) and Kuboshy (5.66) while, Amry had the lowest value by 5.20. In this respect, this might be referred to the fact that Amry is a semi-dry date. The chemical composition of different date palm cultivars has been reported by several investigators (Hussein *et al.*, 1979; Abdalla *et al.*, 1996; Youssef *et al.*, 1999; Attala *et al.*, 2001; AL-Eid, 2006; Al-Farsi *et al.*, 2007 & Alkhateeb, 2008). Abdalla *et al.* (1996) cited that commercial grading of dates is based principally on the physical characteristics and general appearance of the fruit,

Table 3. Chemical characteristics of fruits of the studied date palm cultivars

Genotypes	Moisture content (%)	Reducing sugar (%)	Total phenols (%)	Titratable Acidity (%)	TSS (%)	TSSL Acid (ratio)
a- Amhat	74.50	28.20	2.57	0.10	39.00	10.86
b- Barhy	75.75	30.46	1.91	0.13	32.00	8.40
c- Bint-Aisha	89.49	40.08	2.20	0.24	34.00	6.37
d-Zaghloul	77.00	51.00	4.38	0.36	32.50	8.71
e- Hayany	72.11	31.86	2.50	0.26	33.50	6.81
f-Samany	70.45	38.65	3.16	0.17	45.00	11.54
g- Amry	62.29	16.34	1.81	0.17	27.50	5.20
h- Kuboshy	86.43	24.54	2.28	0.17	28.00	5.66

moisture and sugars contents. Hussein *et al.* (1979) classified the dates according to their moisture contents into soft dates which usually possessed moisture content more than 30% and had low sucrose and this must be eaten fresh. Semi-dry dates which had a moisture content between 20% and 30% and had a low sucrose content and finally dry dates contained less than 20% moisture content and this type of dates require high temperature and sun level for maturation and contained approximately equal quantities of sucrose and reducing sugars. The results of the present study are in general agreement with those obtained by Abdalla (1986), Youssef *et al.* (1999) and Attala *et al.* (2001) in different date palm cultivars.

The investigation explored the morphological, anatomical and chemical characters of fruits of *Phoenix dactylifera*. Such study might add precise evidence to taxonomic identity of eight female cultivar of date palm, which include group of the most important Egyptian date palm cultivars.

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