

Changes in Physical and Chemical Characteristics of the Fruits of Four Date Palm Cultivars*

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Physical and chemical characteristics of the fruits of Seleg, Sakhi, Khudari and Nebut Seif date palm cultivars were studied during three stages of fruit development (Kimri, Khalal and Tamar). Results showed that such characteristics varied greatly from one stage to another with some variations between cultivars and seasons. Fruit weight, size, length and diameter and seed weight increased from Kimri to Khalal stages followed by a slow decline in the tamar stage. Moisture, ash, protein and tannins contents decreased sharply especially in the tamar stage. Total soluble solids (T.S.S.) and total sugars increased progressively from Kimri, Khalal and tamar stages. Pigments content (chlorophyll a + b and carotene) being high in the Kimri stage, were greatly reduced in the other two stages.

Several investigations have been published on the physical and chemical characteristics of date palm fruits together with the changes that occurs in such characteristics during different stages of fruit development (Rygg 1946, Ashmawi *et al.* 1955, Dowson and Aten 1961, Minessy *et al.* 1975 and Mougheith *et al.* 1976). They reported that different growth parameters changed gradually during their fruit development. Such parameters reached their maximum at tamar stage. Sugars accumulated during fruit development, reaching their maximum at tamar stages, with reducing sugars being dominant. Such studies on Saudi date palm cultivars are few (Hussein *et al.* 1976, Abdel Hafiz *et al.* 1980, Sawaya *et al.* 1982 a,b,c and Saad *et al.* 1986).

Therefore, the present investigation is carried out to evaluate physical and chemical changes in three stages of fruit development, namely: Kimri, Khalal and tamar of some date palm cultivars. Such studies are considered important in determining the proper harvest time.

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Materials and Methods

The study was carried out during 1985 and 1986 using four date palm cultivars (Seleg, Sakhi, Khudari and Nebut Seif) grown in the orchard of the College of Agriculture at Riyadh. The trees were grown in a clay loam soil. Management practices were the same in both years and were similar to that used in commercial orchards. Pollination was carried out during March in both years.

Ten fruit samples were taken from 10 different trees for each cultivar to study the physical and chemical characteristics of the fruits in three stages of fruit development. The samples consisted of 100 fruits each, were collected in the Kimri stage (8-9 weeks after pollination), Khalal (fruits attained full colour, red for Khudari cv. and yellow for other cultivars) and tamar stage (fruits fully ripened).

The physical characteristics determined were fruit weight, size, length (L) diameter (D), L: D ratio, seed weight and flesh percentage. The chemical characteristics determined were moisture content, acidity, ash, protein, T.S.S., reducing sugars, non-reducing sugars, total sugars, tannins, chlorophyll (a+b), carotene and anthocyanin content. Moisture, acidity (as citric acid), ash, protein ($N \times 6.25$) and T.S.S. were determined according to the A.O.A.C. methods (1980). Sugars extraction was done with 80% ethyl alcohol. Reducing and non-reducing sugars, were determined using Somogyi's method (1952). Tannins content was determined using the method of Indigo carmine indicator (A.O.A.C. 1980). Chlorophyll and carotene pigments of the fruit skin were determined according to the procedure suggested by Wenstein (1957). Anthocyanin concentration was determined with the modified colormetric method suggested by Geissman (1962).

The data obtained were statistically analyzed according to the methods described by Snedecor and Cochran (1967).

Results and Discussion

The seasonal changes that occurred in both physical and chemical characteristics in the Kimri, Khalal and Tamar stages of fruit development, in the four cultivars, in both years followed almost the same trend. Therefore, the present results are interpreted as an average of the two years and are illustrated in Tables 1 - 3 and Figs. 1 to 4.

Physical Characteristics

Fruit weight

Data indicated that fruit weight increased in the Kimri to the Khalal stage, then it decreased in the Tamar stage. The differences between stages were statis-

Table 1. Effect of fruit development stage on physical characteristics of some date palm cultivars

Cultivar	Seleg				Sakhi				Khudari				Nebut Self			
	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean
Fruit Weight (g) L.S.D. (0.05) for cultivars 1.46 stages 1.42	6.69	11.37	8.66	8.91	10.87	22.27	14.24	15.79	9.31	19.32	14.39	14.34	13.14	20.83	11.75	15.24
Fruit Size (cm) L.S.D. (0.05) for cultivars 2.21 stages 1.17	6.53	11.26	7.61	8.47	10.73	22.78	13.49	15.66	9.26	19.55	13.13	13.98	12.92	20.22	11.66	14.93
Fruit Length (cm) L.S.D. (0.05) for cultivars 0.23 stages 0.22	3.16	4.04	3.58	3.59	3.31	4.54	4.12	3.99	3.27	4.47	4.28	4.00	3.03	3.60	3.21	3.28
Fruit Diameter (cm) L.S.D. (0.05) for cultivars 0.17 stages 0.14	1.89	2.13	1.50	1.84	2.30	2.77	2.15	2.41	2.13	2.47	2.10	2.23	2.72	2.78	2.32	2.61
L/D Ratio L.S.D. (0.05) for cultivars 0.12 stages 0.06	1.67	1.91	2.27	1.95	1.45	1.65	1.93	1.68	1.48	1.80	2.04	1.77	1.12	1.30	1.34	1.25
Seed Weight (g) L.S.D. (0.05) for cultivars 0.16 stages 0.10	0.73	1.40	0.97	1.03	0.92	1.34	0.96	1.07	0.80	1.34	0.98	1.04	0.80	0.96	0.72	0.83
Flesh percentage L.S.D. (0.05) for cultivars 0.47 stages NS	89.20	87.50	88.70	88.47	92.50	93.00	93.00	92.83	91.40	93.00	93.50	92.67	93.80	95.00	93.50	94.10

1-3 Stages, 1- Kimri, 2- Khalal, 3- Tamar.

* Mean of 10 samples.

NS: not significant.

Table 2. Effect of fruit development stage on sugars content of some date palm cultivars

Cultivar	Seleg				Sakhi				Khudari				Nebut Self			
	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean
Reducing sugars % L.S.D. (0.05) for cultivars 1.92 stages 2.27	5.05	15.64	54.72	25.14	5.89	16.06	41.55	21.17	6.35	14.85	53.97	25.06	5.65	13.04	52.77	23.82
Non-reducing Sugars % L.S.D. (0.05) for cultivars NS stages 1.22	0.62	2.80	4.04	2.49	0.22	1.97	3.31	1.83	0.22	4.95	5.08	3.42	0.47	3.21	1.04	1.57
Total sugars % L.S.D. (0.05) for cultivars 1.92 stages 2.27	5.67	18.44	58.76	27.62	6.11	18.03	44.86	23.00	6.57	19.80	59.05	28.47	6.12	16.25	53.81	25.39

1-3 Stages, 1- Kimri, 2- Khalal, 3- Tamar.

* Mean of 10 samples.

NS: not significant.

Table 3. Effect of fruit development stage on chemical characteristics of some date palm cultivars

Cultivar	Seleg				Sakhi				Khudari				Nebut Self			
	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean	1	2	3	Mean
Acidity % L.S.D. (0.05) for cultivars 0.06 stages 0.03	0.42	0.37	0.36	0.38	0.48	0.45	0.58	0.50	0.43	0.45	0.50	0.46	0.39	0.38	0.59	0.45
Ash % L.S.D. (0.05) for cultivars 0.18 stages 0.16	4.40	2.90	1.80	3.03	4.36	2.85	2.00	3.07	4.30	2.50	2.00	2.93	3.80	2.44	1.86	2.70
Protein % L.S.D. (0.05) for cultivars NS stages 0.38	5.95	2.90	2.20	3.68	5.50	3.40	2.90	3.93	4.80	3.00	2.50	3.43	5.00	3.10	2.80	3.63
Tannins % L.S.D. (0.05) for cultivars 0.23 stages 0.34	3.50	1.80	0.65	1.98	6.10	3.10	0.25	3.15	3.00	1.15	0.22	1.46	1.60	0.85	0.30	0.92
Chlorophyll (a+b) L.S.D. (0.05) for cultivars NS stages 1.74	22.69	1.82	1.30	8.60	18.33	2.95	1.23	7.50	19.88	1.93	1.46	7.76	14.18	1.52	1.28	5.66

1-3 Stages, 1- Kimri, 2- Khalal, 3- Tamar.

* Mean of 10 samples.

NS: not significant.

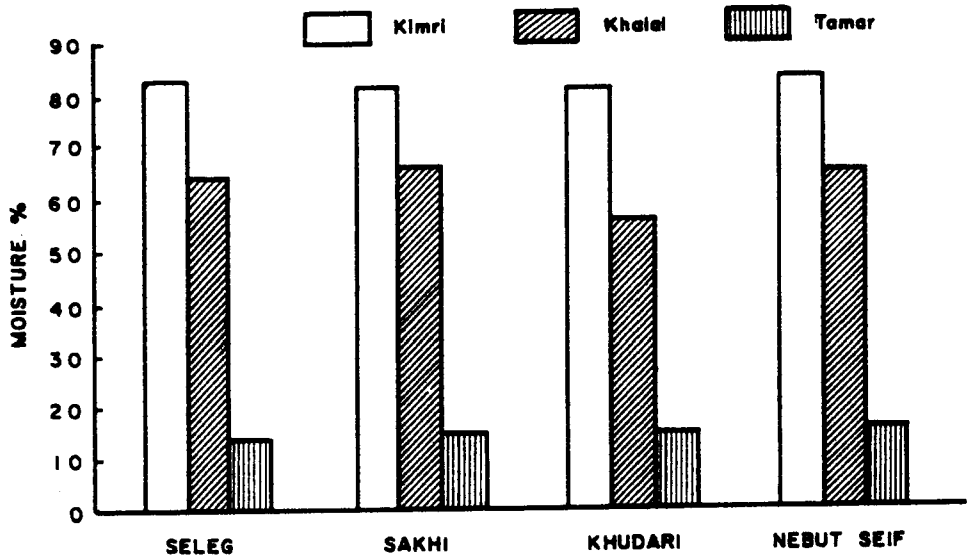


Fig. 1. Effect of fruit development stage on moisture percentage of Seleg, Sakhi, Khudari and Nebut Seif date palm cultivars.

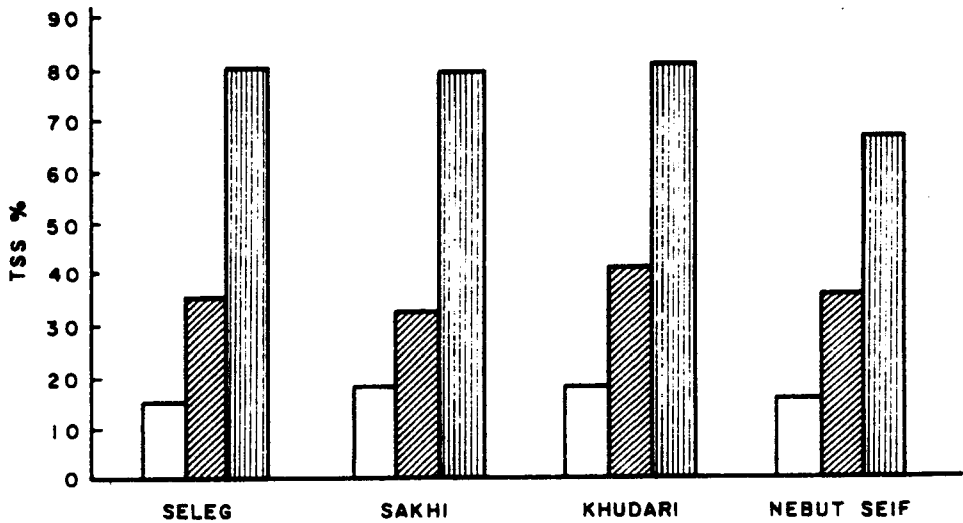


Fig. 2. Effect of fruit development stage on TSS percentage of Seleg, Sakhi, Khudari and Nebut Seif date palm cultivars.

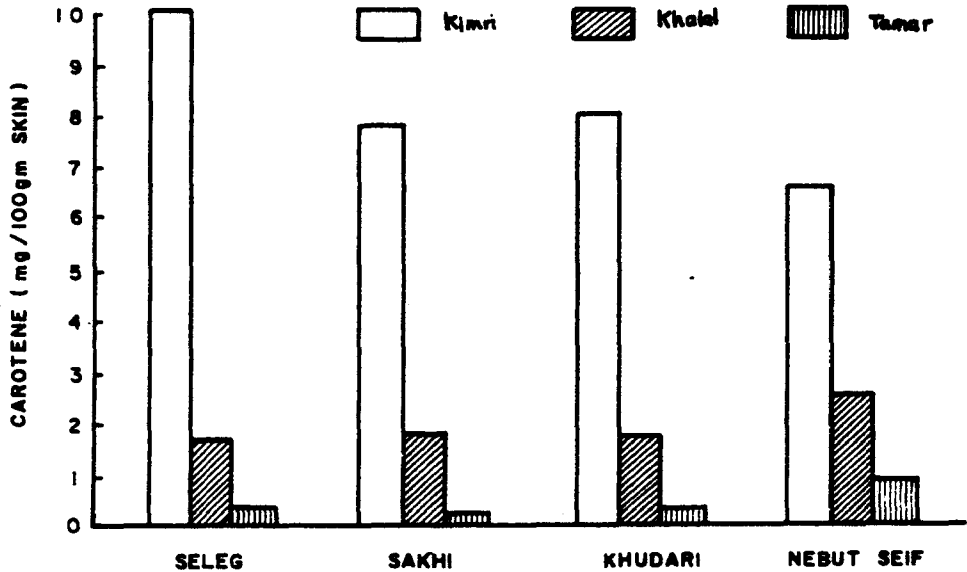


Fig. 3. Effect of fruit development stage on carotene of Seleg, Sakhi, Khudari and Nebut Seif date palm cultivars.

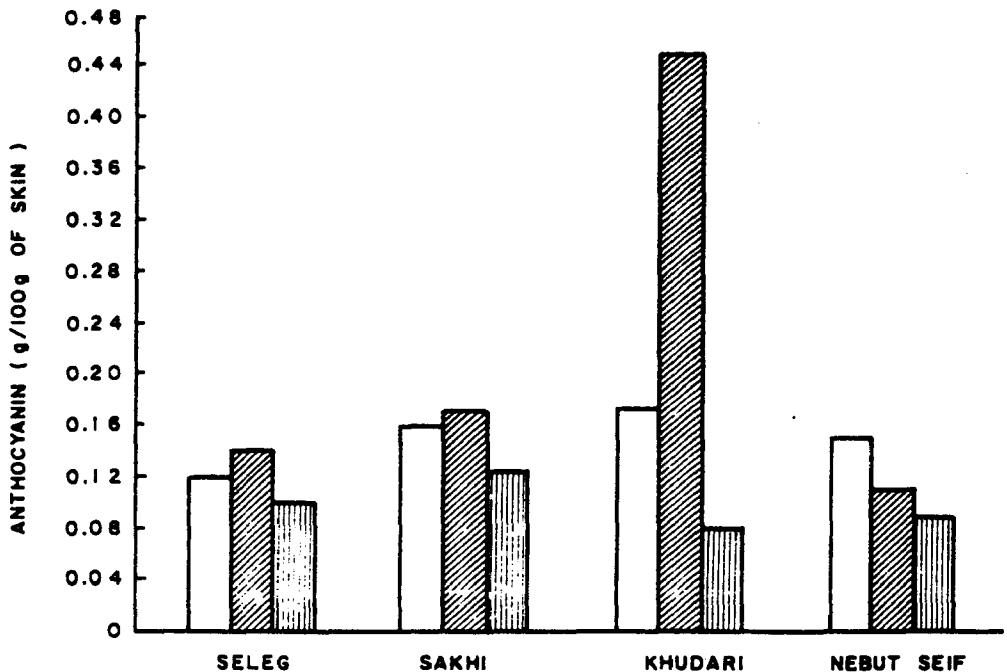


Fig. 4. Effect of fruit development stage on anthocyanin of Seleg, Sakhi, Khudari and Nebut Seif date palm cultivars.

tically significant. The trend of results was similar in the four cultivars (Table 1). With respect to fruit size, length (L), diameter (D) and L: D ratio, the changes from one stage to another were similar in trend with that of fruit weight. The differences between stages and between cultivars were significant in most cases (Table 1). Flesh percentage behaved differently, since it remained almost unchangeable in the different stages of fruit development and the differences were not significant. Whereas, flesh percentage in Seleg cultivar was significantly lower than the other three cultivars (Table 1). These results are generally in accordance with Mougheith *et al.* (1976) Sawaya *et al.* (1982) and Saad *et al.* (1986).

Chemical Characteristics

Moisture content

Data illustrated in Fig. 1 showed that moisture content of the fruits was highest in the Kimri stage, then decreased rapidly in the Khalal and Tamar stages. This result holds true in the different cultivars. The decrease in the latter stage (Tamar) was greater than in the former one. The differences were significant. These results were similar in trend with Mougheith *et al.* (1976), Sawaya *et al.* (1982a) and Saad *et al.* (1986).

T.S.S. %

The results illustrated in Fig. 2 showed that T.S.S.% increased progressively towards the Tamar stage and the increase was more intense in this stage (Tamar stage) in the four date palm cultivars. The differences between the three stages were significant. Similar results were obtained by Mougheith *et al.* (1976) and Saad *et al.* (1986).

Reducing and non-reducing sugars

The results indicated that reducing sugars increased progressively towards the Tamar stage, and this increase was more obvious in this stage in the four cultivars (Table 2). This percentage increased from about 15% in the Khalal stage to more than 50% in the Tamar stage in the four cultivars. The non-reducing sugars were much lower in the fruits and were found not to exceed 5% in any of the cultivars used and in any of the stages under study (Table 2). Total sugars followed the same pattern as the reducing sugars in the different cultivars and in the relevant stages of fruit development. The results also clearly show that reducing sugars are the dominant sugars in the fruits of the four cultivars studied (Table 2). These results confirm those reported by Ashmawi *et al.* (1955), Minessy *et al.* (1975), Sawaya *et al.* (1982b) and Saad *et al.* (1986) working on different date palm cultivars.

It is worthnoting that total sugars in the Tamar stage differed between cultivars and could be arranged between cultivars in a descending order as follows: Khudari, Seleg, Nebut Seif and Sakhi. The percentages of total sugars were 59.05, 58.76, 53.81 and 44.86, respectively in the above cultivars (Table 2).

Acidity

It was shown that acid contents of the fruits were slightly changed in the Kimri, and Khalal, stages. Whereas in Tamar stage, it increased significantly in the Sakhi, Khudari and Nebut Seif cultivars (Table 3). In Seleg cultivar, acid percentage was found to decrease significantly from the Kimri to the Khalal stages, whereas in the Tamar stage, it was slightly changed (Table 3). These results fall in line with Mougheith *et al.* (1976).

Ash

Ash fruit content was continually decreasing in the three stages of development in the four cultivars and the differences were significant. Its decrease in the Khalal stage was more profound than in the Tamar stage (Table 3). These results were in agreement with those of Sawaya *et al.* (1982 a,c).

Protein

Data showed that protein content of the fruits was high in the Kimri stage in the four cultivars. then it was decreased greatly in the Khalal stage. Although in the Tamar stage, protein content decreased, but the decrease was relatively less in the Khalal stage in the four cultivars (Table 3).

Tannins

The results obtained in the four cultivars showed that tannins contents were significantly higher in the Kimri stage, decreased sharply especially in the Tamar stage. Its contents in this latter stage (Tamar) were almost diminished in the fruits of the four cultivars (Table 3). This is in general agreement with Mougheith *et al.* (1976) and Sawaya *et al.* (1982b).

Pigments

Pigments content including chlorophyll a+b being dominant in the Kimri stage, were greatly reduced in the following stages of fruit development and almost were diminished in the Tamar stage (Table 3). Carotene pigment followed the same trend as chlorophylls but its values were much less than chlorophylls (Fig. 3). Anthocyanin was present in minute amounts in the various stages of fruit development in the different cultivars except in the Khudari cultivar where its contents of anthocyanin were noticeably increased in the Khalal stage. This is true since the colour of the skin characterizing the Khalal stage of

this cultivar, Khudari, is red (Fig. 4). These results are in agreement with those reported by Dowson and Aten (1962) and El-Sabroun (1979) on different date palm cultivars.

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التغيرات الموسمية للصفات الطبيعية والكيميائية في ثمار أربعة أصناف من التمور.

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درست التغيرات الموسمية للصفات الطبيعية والكيميائية في ثمار أربعة أصناف من التمور خلال ثلاث
مراحل من النمو وهي: الكمرى، الخلال، التمر. وقد أوضحت النتائج أن هذه الصفات تتغير
بدرجة كبيرة من مرحلة إلى أخرى مع وجود بعض الاختلافات بين الأصناف والسنوات.

وقد وجد أن حجم، طول وقطر الثمرة ووزن البذرة تزداد زيادة ملموسة من مرحلة الكمرى
إلى مرحلة الخلال، يلي ذلك نقص بسيط في مرحلة التمر.

لوحظ أن محتوى الثمار من الرطوبة، الرماد، البروتين، التانين ينخفض بدرجة كبيرة وخاصة
في مرحلة التمر، وقد ازدادت المواد الصلبة الذائبة الكلية والسكريات الكلية زيادة كبيرة من مرحلة
إلى أخرى وخاصة في مرحلة التمر. وبالنسبة للصبغات (الكلوروفيل أ، ب، +ب والكاروتين)
فكانت سائدة في مرحلة الكمرى في حين نقصت بدرجة كبيرة في المرحلتين التاليتين.