Studies on the Sugars, Starch and Alcohol Insoluble Solids Contents in Fruits and Pinnae of Data Palm in Basrah

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ABSTRACT

The reducing and non-reducing sugars, starch and alcohol insoluble solids were determined in the fruits and the median pinnae of date palm leaves of Khadhrawi, Hallawi, Sayir, Zahidi (females) and Ghannami (male) date cultivars during the different stages of fruit development. Sugars accumulated gradually during fruit development in all varieties and were mainly reducing sugars. An opposite trend was obtained for starch and alcohol insoluble solids. Starch was present in all stages of fruit development of all cultivars. There was a general trend of decrease in sugars and starch content of the pinnae during summer followed by a slow increase during winter. Sugar found in the pinnae were mainly reducing.

Varietal differences were found in sugars, starch and alcohol insoluble solids contents of fruits and pinnae.

INTRODUCTION

Iraq is one of the major date growing countries of the world. Within Iraq, Basrah alone produces more than 31% of the total crop of date production (10). At present, the date palm trees excel any other fruit-bearing trees in Iraq in both quantity and number of varieties. Investigations covering many aspects of date palm tree are as important as any other industry of this country. Several studies were made on the chemical analysis of date palm fruit at rutab and tamar stages (3,5,6,8,15). However, very little work has been done on the chemical analysis in the fruits and leaves during fruit development. The purpose of the present study was to evaluate and ascertain compositional changes in regards to sugars (reducing and non-reducing), starch, and alcohol insoluble solids in fruits and leaves of the most important cultivars of date palm in Iraq. These cultivars include Zahidi, Sayir, Hallawi, Khadhrawi [all being females and representing up to 91% of Iraq dates production (10)] and Ghannami (male.)

MATERIALS AND METHODS

Fruits and pinnae samples were collected from a silty-clay date palm orchard at Tunnuma near Shatt-al-Arab (Basrah province). Five date varieties (4 females and 1

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male) were included viz. Zahidi (semidry-soft), Sayir, Hallawi, Khadhrawi (soft) and Ghannami (male). Four palm trees were selected from each variety.

The number of bunches per palm tree was 8 in Sayir and Khadhrawi, while 6 in Hallawi and Zahidi, the planting distance was 6 × 6 meters and the palm trees were about 25 years-old. Orchard was fertilized and irrigated according to the field requirements and fruit seedlings planted under the palm trees.

Three leaves that subtend the inflorescences were tagged for each tree. Leaves and fruits were collected at monthly intervals during the period from the 13th to the 17th of each month. Pinnae samples were obtained by removing 4 medium pinnae (2 from each side of the mid-point of the Laminar-pinna bearing portion of the rachis) and the 12 pinnae per palm were composited. Sampling extended from April, 1975 to March, 1976. A total of 30 fruit were collected from 3 different bunches at different stages of fruit development; Hababouk (May), Kimri (June), Khalaal just turning to yellow (July), Rutab (August) and Tamar (September and October).

The pinnae and fruit samples were washed with distilled water, dried to a constant weight at 68–70°C. The fruits were deseeded and the dried fruit flesh and pinnae were ground for various determinations. Two grammes were used for sugar extraction using 80% ethanol. Leading and deleading took place using lead acetate and sodium oxalate, respectively. The non-reducing sugars were determined by hydrolyzing a part of the sugar extract with 1N HCl for 10 minutes on a water bath at 67°C (12, 13). Starch was determined in the dried alcohol insoluble residue by hydrolysis with 1N HCl for 4 hours on a water bath at 90°C (8).

The reducing power of reducing sugars and non-reducing sugars and starch, after hydrolysis, was determined by Samogyi micro-copper method, 1952 reagent, as cited by Wistler *et al.* (16). The non-reducing sugars were taken as the difference between the total reducing power of soluble sugars and reducing sugars. All results were expressed in percentage, based on the dry weight.

RESULTS AND DISCUSSION

Fruits

The main changes in reducing, non-reducing and total sugars, total carbohydrates and the alcohol insoluble solids at the different stages of fruit development are shown in Figure 1.

Reducing and non-reducing sugars: The percentages of non-reducing sugars in the fruit were always lower than those of the reducing sugars at the different stages of fruit development in all cultivars; in other words, the reducing sugars were the dominant sugars in the fruits of the cultivars studied. These results confirm those reported by Ashmawi *et al.* (2) on Zagloul dates, Minessy *et al* (14) on four Egyptian soft date cultivars. The non-reducing sugars disappeared from all cultivars during the tamar stage. Similar results were obtained by other investigators on Hallawi, Khadhrawy and Sayir, (2,4,7). On the other hand, Postlethwait (15) on Californian Daglat Nuur (Semidry) and Cook and Furr (5) on Daglat Beidva and Kinta (dry) recorded that non-reducing sugars were the dominant sugars in the last stages of fruit ripening.

The percentages of reducing sugars in the fruit gradually increased during the different stages of fruit development in all cultivars (Fig. 1). Similar results were obtained by other workers (1, 2, 14). The fruit of Hallawi contained higher amounts of

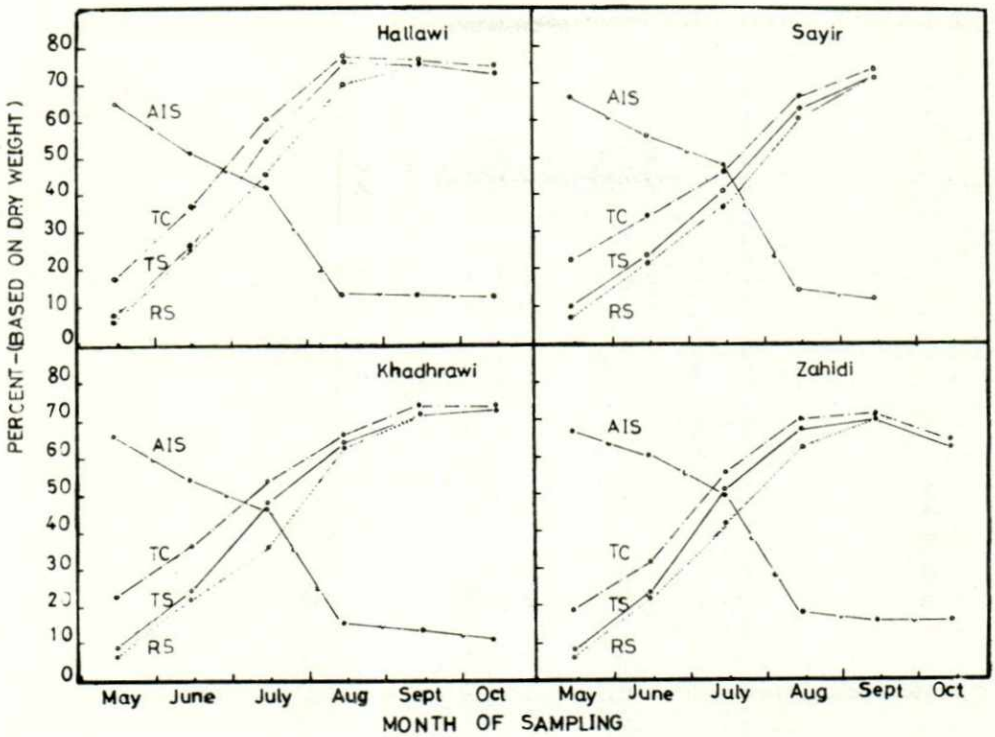

Fig. 1. Percentages of reducing sugars (RS), total sugars (TS), total carbohydrates (TC) and alcohol insoluble solids (AIS) at different stages of fruit development of four date varieties. (TC–TS = starch; TS–RS = Non-reducing sugars).

reducing sugars than in the other three varieties during the rutab an tamar stages (Table 1). These results are substantiated by the report of Carvell on Basrah dates (3).

Starch: The percentage of starch, on dry weight basis, gradually decreased during the different stages of maturity and ripening of fruits (Fig. 1). These results are in agreement with those obtained by Ashmawi *et al.* (1) who acertained starch decline in Samani date from the Kimri to rutab stage. However, Lloyd (11) detected starch in dates only at the time of pollination and non in other developmental stages.

Total sugars and carbohydrates: The percentages of total sugars and total carbohydrates in fruits showed almost the same trend as that of the reducing sugars. They gradually increased during the different stages of fruit development. The percentages of total sugars and total carbohydrates were higher in Hallawi fruits than in the fruits of the other three cultivars in both rutab and tamar stages, (Table 1).

Alcohol insoluble solids: The percentages of alcohol insoluble solids gradually decreased at the different stages of fruit development. This trend was opposite to that of reducing and total sugars and tatal carbohydrates (Fig. 1). These results, in general, are in line with those of Dowson and Aten (7). Hallawi fruits contained lower amounts of alcohol insoluble solids when compared with the other cultivars.

Table 1 Average carbohydrates (sugars and starch) and alcohol insoluble solids contents of fruits of four date varieties at rutab and tamar stages.

	Rutab stage						Tamar stage					
Variety	Reducing sugars %	Non-reducing sugars %	Total sugars %	Starch %	Total carbohyd-rates %	Alcohol insoluble solids %	Reducing sugars %	Non-reducing sugars %	Total sugars %	Starch %	Total carbohyd-rates %	Alcohol insoluble solids %
Khadhrawi	63.77 a	0.27 a	64.04 a	1.75	65.77 a	15.34 b	72.17 ab	0.00	72.17 ab	1.77	73.93 ab	14.62
Hallawi	69.95 b	6.11 c	76.05 b	1.62	77.67 b	12.74 a	75.00 b	0.00	75.00 b	1.60	76.60 b	12.74
Sayir	61.80 a	2.26 ab	64.06 a	2.33	66.36 a	17.21 ac	73.34 ab	0.00	73.39 ab	1.57	74.96 ab	12.90
Zahidi	62.88 a	4.56 bc	67.44 a	1.53	68.96 a	18.45 c	70.40 a	0.00	70.40 a	1.11	71.58 a	15.61
LSD (0.05)	3.46	3.81	4.74	N.S.	5.38	2.18	4.58		4.58	N.S.	4.38	N.S.

Average in a column followed by the same letter are not significantly different at 0.05 level of LSD.
N.S. Not Significant.

Table 2 The average carbohydrates (sugars and starch) and alcohol insoluble solids content in the median pinnae of leaves of five date varieties.

Variety	Reducing sugars %	Non-reducing sugars %	Total sugars %	Starch %	Total carbohydrates %	Alcohol insoluble Solids %
Khadhrawi	4.08 a	1.17 a	5.23 a	5.59 a	10.82 a	74.53 a
Hallawi	5.65 b	1.76 bc	7.35 c	7.48 b	14.81 c	76.19 bc
Sayir	4.25 a	1.58 b	5.87 b	6.15 a	12.01 b	74.65 ab
Zahidi	4.01 a	2.09 c	6.24 b	8.17 b	14.49 c	73.97 a
Ghannami	4.34 a	0.78 a	5.11 a	6.26 a	11.18 ab	76.41 c
LSD (0.05)	0.59	0.45	0.62	1.14	1.18	1.65

Means in a column followed by the same letter are not significantly different at 0.05 level LSD.

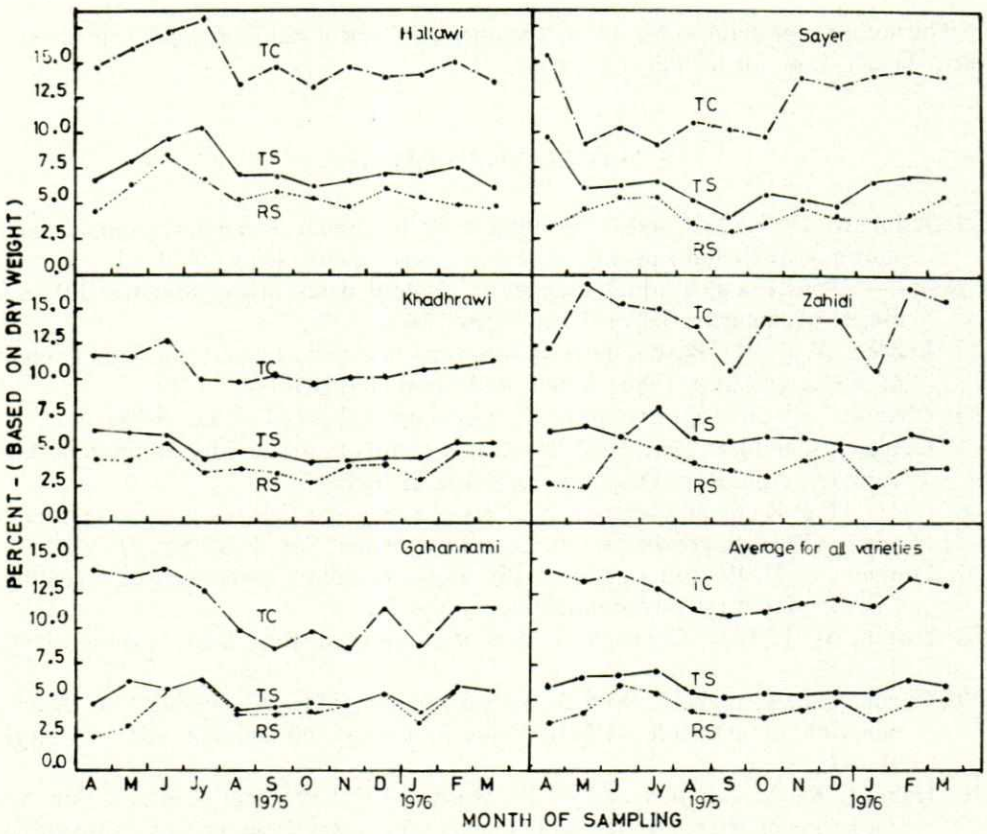

Fig. 2. Percentages of reducing sugars (RS), total sugars (TS) and total carbohydrates (TS) in the median primae of data palm leaves of five date varieties. (TC–TS = starch; TS–RS = non-reducing sugars).

Pinnae

The results obtained for the five cultivars showed that there was a general trend of decrease in carbohydrate contents during summer and autumn, especially in the time of sugar accumulation in fruits, followed by slow increase during winter (Fig. 2). This result confirms that reported by Chandler (4). This decrease might be due to the translocation of sugars to fruits and/or to the high rate of respiration during summer. As in fruits, the percentages of non-reducing sugars in the pinnae of the five cultivars were always lower than those of the reducing sugars (Fig. 2).

The average of the 12 months sampling dates indicated that, the percentages of reducing and total sugars in Hallawi pinnae were significantly higher than in the other four cultivars. The percentage of total carbohydrates and starch were significantly higher in Hallawi and Zahidi pinnae than in the other three cultivars. The percentage of alcohol insoluble solids in Ghannami pinnae was higher than those of the other four varieties and the differences were significant except in the case of Hallawi (Table 2).

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دراسات على المحتويات السكرية والنشا والمواد الصلبة الغير قابلة للذوبان فى الكحول فى ثمار وريقات نخلة التمر

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مستخلـــــص

قدرت السكريات المختزلة والغير مختزلة والنشا والمواد الصلبة الغير قابلة للذوبان فى الكحول فى ثمار وريقات (الخوصات) خمسة أصناف تمر هى الخضراوى والساير والحلاوى والزهدى والغنامى (مذكر) نامية فى منطقة شط العرب بالبصرة (العراق) وذلك خلال المراحل المختلفة لنمو الثمار ٠

وقد أوضحت النتائج ما يلى : ـ

أ) تراكمت السكريات تدريجيا خلال نمو ونضج الثمار فى كل الاصناف وكان أغلبها سكريات مختزلة وقد تراوحت النسبة المئوية للسكريات الكلية (على أســـاس الوزن الجاف) من ٤٠ و ٧٠ ٪ الى ٠٠ر٧٥ ٪ وذلك خلال مرحلة التمر من الأربعـــة أصنـــاف ٠

ب) انخفضت النسبة المئوية للنشا والمواد الصلبة الغير قابلة للذوبان فـــى الكحول تدريجيا حتى وصلت لأقل نسبة فى مرحلة التمر ٠

جـ) لوحظ انخفاض عام فى محتوى الوريقات من السكريات والنشا خلال الصيف (أثناء تراكم السكر فى الثمار) تلاه زيادة بسيطة فى الشتاء وقد تراوحت النسبـــة المئوية للكربوهيدرات الكلية فى الوريقات من ٨٢و١٠ ٪ الى ٨١و١٤ ٪ كمتوسط لاثنى

عشر شهرا فى الخمسة أصناف وكذلك وجد أن أغلب السكريات فى الوريقات كان على صورة سكريات مختزلة ٠

د) وجدت اختلافات بين الأصناف من حيث محتوى الثمار والوريقات من السكريات والنشا والمواد الصلبة الغير قابلة للذوبان فى الكحول وقد احتوت ثمار الصنف حـلاوى على أعلى نسبة من السكريات الكلية وأقل من المواد الصلبة الغير قابلة للذوبـان فـى الكحـول ٠