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Changes of Minerals in Fruits and Leaves of Date Palm During Fruit Development

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ABSTRACT

Six nutrient elements (Ca, P, Na, K, Mn, Fe) were determined in the fruits and medium pinnae of date palm leaves of Khadhawi, Hallawi, Sayer, Zahidi (females), and Ghannani (male) during the different stages of fruit development. The percentages of P, Ca, K, Mn, and Fe gradually decreased, while Na tended to accumulate in flesh of fruits during development. The average nutrient contents of all cultivars at tamar stage were K 0.7122%, Ca 0.118%, P 0.0926%, Na 0.0179%, Fe 30 ppm, and Mn 24 ppm. Variations due to cultivars were only found in Ca, Mn, and Fe. The leaf mineral content showed, a drop in P and K, and an increase in Ca, and Fe; while Na and Mn were not significantly different as the leaf grew older. The nutritional status of pinnae was significantly influenced by the different cultivars used in this study.

INTRODUCTION

Leaf analysis is a valid guide for determining the nutritional status of plants. Moreover, the inorganic contents of the fruits is of utmost importance due to the fact, that these constituents are lost from the tree when the crop is picked. Studies carried out on the leaf mineral content of date palm are realtively few. Reuther (11) and Showky (13) studied the relation of mineral contents to the age and position of pinnae. The mineral composition of date fruits in the tamar stage was reported by several investigators (1, 2, 4, 8, 10, 14).

The purpose of this study was to determine the mineral status of pinnae and fruits of five leading Iraqi date cultivars, during the different stages of fruit development. This might be beneficial in planning any future fertilizer program, and in determining the nutritive value of Iraqi dates.

MATERIALS AND METHODS

Five cultivars of date palm (*Phoenix dactylifera* L.) with four uniform mature palm trees, were selected for the present study. These cultivars were Hallawi, Khadhrawi, Zahidi and Sayer (all being females and representing about 91% of Iraqi date pro-

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duction (7)), and Ghannami (male). Trees were grown in a silty-clay soil orchard at Tunnuma near Shattal-Arab (Basrah Province). They were about 25 years old and at 6×6 met. planting distance. The orchard, as with date orchards of Iraq, was interplanted with fruit seedlings. Fertilization and irrigation of the date palm and fruit trees were according to field requirement.

Three leaves around each palm that subtend the inflorescence were tagged. Pinnae samples were obtained by removing two medium pinnae from each side of the laminar pinna bearing portion of the leaf and the 12 pinnae per palm were composited. Samples were collected monthly during the entire period of study (from April 1975 to March 1976). Fruit samples (about 30 fruits) were collected from three different bunches around each palm at the following stages of fruit development: habobouk (May); Kimri (June); Khalaal; just turning yellow (July); Rutab (August) and Tamar (September and October).

The pinnae and fruit samples were washed with distilled water, and dried to a constant weight at 70°C. Dried pinnae and deseeded fruits were then ground, for minerals determination. One gramme from pinnae and two grammes from the fruit ground samples were digested with hydrochloric acid (dry ashing) according to Chapman and Pratt (3). Potassium, sodium, and calcium were determined by a flame photometer; while Iron, manganese and phosphorus were determined, by a spectrophotometer (3).

RESULTS AND DISCUSSION

Fruits

The average changes in phosphorus, potassium, calcium, sodium, iron and manganese contents at the different stages of fruit development are shown in Table 1 and Figure 1.

The percentages of phosphorus, calcium, potassium, iron and manganese gradually decreased during fruit development of all cultivars. Fruits in the Habobouk, Kimri and turning colour stages significantly contained greater amounts of calcium and potassium than in the rutab and Tamar stages. On the other hand, phosphorus, manganese, and iron were significantly greater in the habobouk stage than in other stages of fruit development. This decline of minerals during fruit development, could be attributed to the high rate of sugar accumulation at latter stages of fruit development (5). In regard to sodium it tended to accumulate in flesh during fruit maturity and ripening. These results were generally in agreement with those of Minessy *et al.* (10) working on Egyptian dates. On the other hand, Bliss and Haas (1) found that the amount of mineral contents, per fruit, increased at a constant rate during fruit development. The data also indicated that, the amount of potassium in the flesh was far exceeding any other mineral constituent throughout the fruit development. Similar results were obtained by other investigators during Tamar stage (1, 8, 12, 5).

As for as the nutritive value is concerned, the results obtained showed the following averages, in the edible portion of the fruit, at the Tamar stage; potassium 0.7122%; calcium, 0.1189%; phosphorus, 0.0926%; sodium, 0.0179%, iron, 30 ppm; and Mn, 24 ppm (Fig. 1). Thus, one might conclude that the cultivars used in this study were good source of potassium, iron and manganese and fair source of calcium, but poor source of phosphorus and sodium in regard to human daily requirement (2).

Mineral contents of dates were influenced by the different cultivars used in this study. Sayer, and Khadrawi were richer in iron and calcium than the other cultivars. Fruits of Zahidi contained lesser amounts of Manganese compared to other cultivars. No significant differences were found among cultivars in phosphorus, sodium and potassium content of fruits (Table 1).

Table 1 Mineral content of some Iraqi date cultivars during development of fruit. (on dry weight basis).

	Stage of fruit development						
Cultivar	Hababouk	Kimri	Khalaal	Rutab	Tamar	Tamar	Mean
			%Phosphorus				
Hallawi	0.2968	0.1767	0.1519	0.1137	0.0909	0.0850	0.1525a
Khadhrawi	0.2783	0.1564	0.1577	0.0975	0.0778	0.0901	0.1424a
Zahidi	0.2469	0.1583	0.1432	0.1074	0.1162	0.1013	0.1455a
Sayer	0.2291	0.1525	0.1483	0.0905	0.0857	—	0.1412a
			% Calcium				
Hallawi	0.2926	0.3170	0.2255	0.1019	0.0734	0.0914	0.1836a
Khadhrawi	0.3900	0.2923	0.2896	0.2194	0.1341	0.1402	0.2442b
Zahidi	0.3107	0.1950	0.1950	0.1341	0.1097	0.1067	0.1752a
Sayer	0.3777	0.4022	0.4022	0.1585	0.1585	—	0.2786c
			% Potassium				
Hallawi	1.2375	1.350	1.419	1.0358	0.875	0.8565	1.129a
Khadhrawi	1.4805	1.163	1.2875	0.825	—	0.7065	1.093a
Zahidi	1.825	1.050	0.994	0.744	0.6875	0.725	1.004a
Sayer	1.050	1.094	1.4625	0.675	0.575	—	0.971a
			% Sodium				
Hallawi	0.01427	0.01354	0.0135	0.01740	0.01873	0.01978	0.01022a
Khadhrawi	0.01562	0.01354	0.01822	0.02369	0.01979	0.01719	0.01081a
Zahidi	0.01119	0.01249	0.01979	0.01718	0.01901	0.01848	0.00961a
Sayer	0.01978	0.0219	0.01511	0.010301	0.01408	—	0.00839a
			Iron (pmm)				
Hallawi	77.5	44	45	25.5	27	29.5	42bc
Khadhrawi	88.5	47	26	35.5	38	37	45c
Zahidi	53.5	31.5	27	22	21.5	39	33ab
Sayer	78	40	51	38.5	33.5	—	48c
			Manganese (ppm)				
Hallawi	87	51	36	29	29	24	43b
Khadhrawi	60	44	37	42	40	23	41b
Zahidi	51	28	21	26	23	25	29a
Sayer	62	30	29	38	34	—	39b

Means in a column followed by the same letter are not significantly different at P=0.05 according to Duncan's multiple range test.

Chemical analysis of the fruits of the more important date cultivars showed a wide variations in the mineral content of date fruit. The following ranges were reported; potassium 0.8–1.48%; calcium 0.05–0.184%; phosphorus 0.08–0.23; sodium, 0.08–0.39%; iron 5–103 ppm and Manganese 2–59 ppm (4, 6, 8, 10, 14). The contentration of mineral element found in this study fell in the middle of these ranges (Table 1 and Fig. 1).

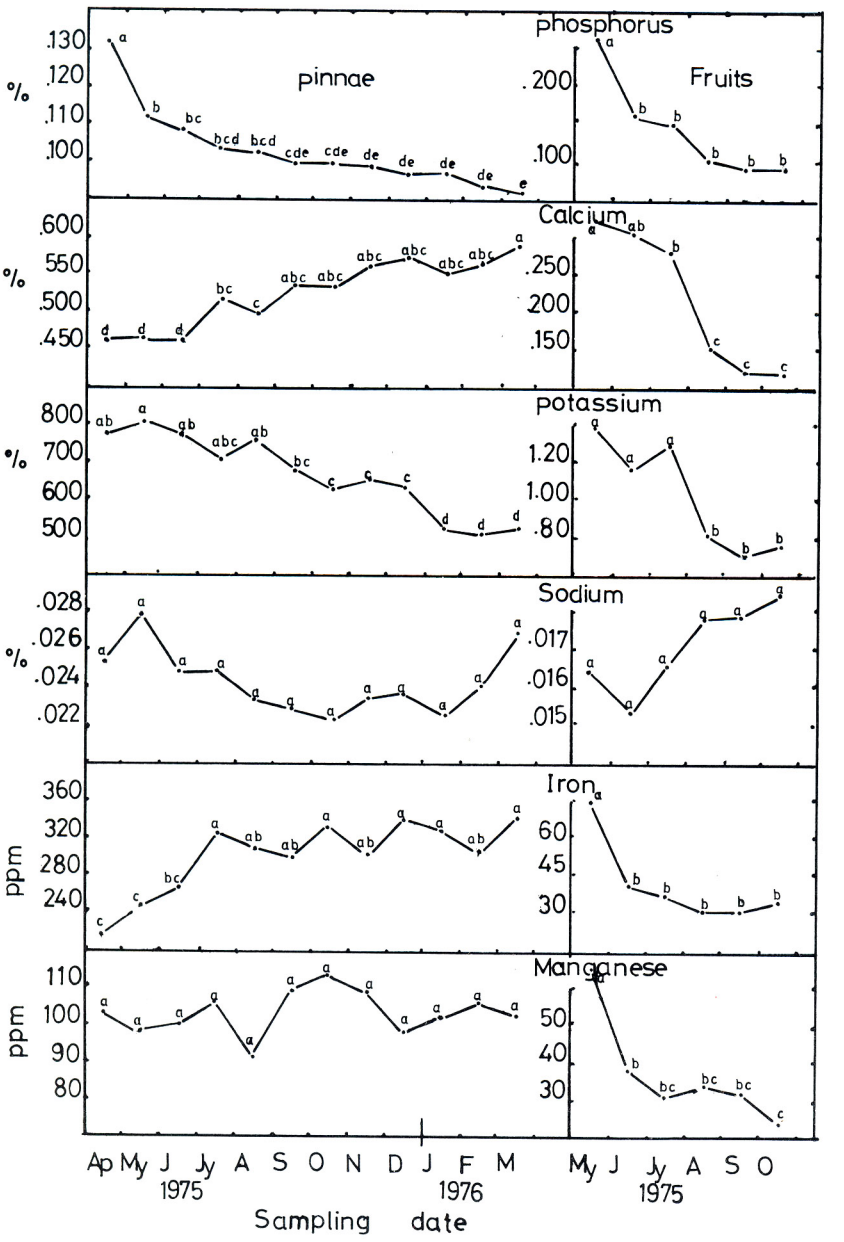

Fig. 1. Changes of Mineral content, as an average for all cultivars, in pinnae and fruits of date palm during fruit development.

Means on figure for each single element followed by the same letter are not significantly different at P = .05 according to Duncan's multiple test.

Table 2 The average mineral content (on dry weigh basis) in the median pinnae of some date cultivars.

Cultivar	Sampling Date												
	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Mean
	% Phosphorus												
Hallawi	0.1360	0.1240	0.1209	0.1186	0.1167	0.1159	0.1171	0.1039	0.1004	0.0969	0.1012	0.1004	0.1127a
Khadrawi	0.1250	0.1031	0.0988	0.1003	0.0965	0.0926	0.0924	0.1100	0.1007	0.1019	0.0965	0.1023	0.1017b
Zahidi	0.1217	0.1323	0.1268	0.1065	0.1140	0.1062	0.1073	0.1038	0.1677	0.1065	0.0984	0.0991	0.1109a
Sayer	0.1120	0.0961	0.0787	0.0895	0.0814	0.0826	0.0857	0.0802	0.0806	0.0849	0.0845	0.0756	0.0858c
Gahannami	0.1205	0.1042	0.1205	0.1022	0.1039	0.1015	0.0454	0.0938	0.0945	0.0957	0.0880	0.0779	0.0998b
	% Calcium												
Hallawi	0.3780	0.4389	0.4145	0.4145	0.4145	0.4084	0.4511	0.5988	0.4145	0.4388	0.4266	0.4750	0.4311c
Khadrawi	0.4876	0.4510	0.4632	0.4755	—	0.4876	0.4998	0.5612	0.5973	0.5851	0.6461	0.5973	0.5320b
Zahidi	0.4287	0.4633	0.5059	0.5486	0.5974	0.6217	0.5851	0.6461	0.6461	0.6217	0.6887	0.7679	0.5932a
Sayer	0.5547	0.5919	0.5181	0.7241	0.5485	0.6461	0.6787	0.6095	0.6765	0.5973	0.5821	0.6095	0.6114a
Gahannami	0.4687	0.3717	0.4145	0.4144	0.4388	0.5120	0.4511	0.4998	0.5363	0.5116	0.4854	0.4997	0.4670c
	% Potassium												
Hallawi	0.8125	0.8125	0.8025	0.775	0.750	0.700	0.6875	0.700	0.650	0.550	0.5625	0.605	0.7006b
Khadrawi	0.650	0.6875	0.6375	0.445	—	0.5875	0.465	0.405	0.405	0.335	0.370	0.410	0.4907c
Zahidi	0.840	0.9125	0.7875	0.825	0.7635	0.655	0.650	0.750	0.650	0.625	0.550	0.575	0.7153b
Sayer	0.5875	0.575	0.515	0.5325	0.545	0.610	0.5825	0.605	0.5875	0.465	0.460	0.483	0.5456c
Gahannami	0.985	1.045	1.160	0.950	0.985	0.865	0.750	0.790	0.825	0.625	0.610	0.5625	0.8460a
	% Sodium												
Hallawi	0.0242	0.0242	0.0233	0.0223	0.0224	0.0233	0.0228	0.0261	0.0288	0.0242	0.0298	0.0307	0.02517a
Khadrawi	0.0201	0.0224	0.0167	0.0224	—	0.0163	0.0186	0.0237	0.0200	0.0224	0.0195	0.0224	0.02041b
Zahidi	0.0335	0.0456	0.0354	0.0354	0.0242	0.0261	0.0195	0.0200	0.0242	0.0224	0.0209	0.0307	0.02816a
Sayer	0.0168	0.0195	0.0173	0.0167	0.0177	0.0177	0.0145	0.0186	0.0186	0.0191	0.0233	0.0209	0.01881b
Gahannami	0.0317	0.0279	0.0308	0.0261	0.0288	0.0307	0.0307	0.0288	0.0270	0.0237	0.0270	0.0298	0.02858a
	Iron (ppm)												
Hallawi	247	245	282	335	290	282	323	369	356	288	339	357	309b
Khadrawi	226	197	258	312	—	301	345	275	340	314	246	350	297b
Zahidi	269	383	411	374	372	406	356	319	360	428	345	456	373a
Sayer	193	263	211	388	346	285	292	299	331	300	284	278	289b
Gahannami	154	143	175	217	224	213	237	244	310	287	258	284	228c
	Manganese (ppm)												
Hallawi	84	87	109	86	73	104	118	103	76	105	74	100	94a
Khadrawi	144	131	138	144	114	142	132	142	118	106	119	132	131b
Zahidi	90	113	83	102	95	90	116	91	100	99	116	81	98a
Sayer	87	71	70	109	87	87	113	94	86	89	108	99	92a
Gahannami	108	86	—	91	86	116	84	113	104	113	115	103	102b

Means in a column followed by the same letter are not significantly different at P=0.05 according to Duncan's Multiple Range Test.

Pinnae

The data obtained from the chemical analysis of pinnae tissue are summarized in Table 2 and Figure 1.

The phosphorus and potassium concentrations tended to decrease as the leaf became older. Similar results were obtained by Reuther (11) who attributed this decline to the immigration of these elements out of the leaf, Showky *et al.* (13) reported that leaf age had a minor influence on the phosphorus content, whereas potassium content decreased greatly with age.

The pinnae of both Hallawi and Zahidi had the highest phosphorus content while Sayer contained the lowest. The potassium content was greater in Ghannami pinnae than in Khadhrawi and Sayer (Table 2). This was in agreement with Labanauskas and Nixon (9) who indicated that Kadhrawi and Sayer had low content of potassium while Sayer had low content of phosphorus. The percentages of phosphorus and potassium obtained in this study were generally within ranges reported on American dates (9, 11, 12). The Egyptian dates contained similar amounts of potassium, but were slightly higher in phosphours content (13).

Calcium in the pinnae took an opposit trend to potassium, It was consistently increasing with time. The accumulation of calcium with time was also reported by Reuther (11). The concentrations of calcium with as obtained in this study were similar to those reported by Reuther (11) and Labanauskas and Nixon (9) and higher than those reported by Reuveni (12).

Iron content, as with calcium, increased as the leaf grew older. The increment was relatively rapid at first, then became irregular at latter period. It was also noticed that, pinnae of the Zahidi had the highest iron content, while Ghannami contained the lowest. Values of iron obtained in the present study were much higher than those reported by Reuveni (12) and Labonauskas and Nixon (9) on American dates.

Manganese of the pinnae was not consistent during the entire period of sampling, ranged from 92 ppm for Sayer to 130 ppm for Khadhrawi (Table 2). These values were within ranges reported by Reuveni (12) but higher than ranges reported by Labanauskas and Nixon (9).

Sodium had decreased during summer, then slowly increased during winter. The decline in sodium content of the pinnae during summer was accompanied by a slight increase in the fruits. Sodium concentration were higher than those reported by Reuveni (12).

The concentrations of minerals were generally within ranges obtained by other investigators (9, 11, 12, 13).

Authers believed that results obtained from this study would be of great help in planning a fertility program for Iraqi dates.

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تغييرات بعض العناصر الغذائية في ثمار وأوراق نخلة التمر خلال المراحل المختلفة لنمو الثمار

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المستخلص

قدرت ستة عناصر غذائية (كالسيوم ، فوسفور ، صوديوم ، بوتاسيوم ، منجنيز ، حديد) في ثمار ووريقات خمسة أصناف رئيسية من التمور العراقية هى الخضراوى والحلاوى والساير والزهدى الغنامى (مذكر) .

تم جمع العينات على فترات شهرية وذلك ابتداء من مايو حتي أكتوبر ١٩٧٥ م بالنسبة للثمار وابتداء من أبريل ١٩٧٥ م وحتي الإزهار التالى في مارس ١٩٧٦ م ويمكن تلخيص النتائج فيما يلي :—

أ) في الثمار وجد أن النسبة المئوية للعناصر الغذائية (ما عدا الصوديوم) انخفضت تدريجيا كلما تقدمت الثمار في العمر ووصلت الحد الأدني لها في مرحلة التمر حيث وجد أن متوسط تركيز العناصر لكل الأصناف هو ٧١٢و٠٪ للبوتاسيوم ، ١١٨و٠٪ للكالسيوم ، ٠٩٢٦و٠٪ للفسفور ، ٠١٧٩و٠٪ للصوديوم ، ٣٠ جزء في المليون حديد ، ٢٤ جزء في المليون منجنيز وذلك على أساس الومن الجاف . كذلك لوحظت اختلافات معنوية بين بعض الأصناف في تركيزات الكالسيوم والمنجنيز والحديد .

ب) في الأوراق وجد أنه كلما تقدمت الأوراق في العمر ينخفض تركيز البوتاسيوم والفوسفور بينما يرتفع تركيز الكالسيوم والحديد ، أما بالنسبة للصوديوم والمنجنيز فلم يلاحظ وجود تغيرات معنوية . هذا ولقد لوحظ تغير النسبة المئوية للعناصر في الأوراق باختلاف الصنف .