



Determination of the elemental contents of date palm (*Phoenix dactylifera* L.) from Kharj Saudi Arabia

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ABSTRACT

Date palm (*Phoenix dactylifera*) fruit are an important source of nutritional elements to people in Saudi Arabia. In this study dates fruit samples from the type Segae were collected. Washed and unwashed samples were analyzed for macro and micro-elements using flame photometry inductivity coupled plasma and atomic absorption. The study revealed that the dates have considerable contents of Fe and Mn which are important to human health. The content of trace elements that can be toxic like As, Cd, Ni and Bi was found to be less in washed samples compared to unwashed samples. The study recommends the incorporation of date fruits in the food menu.

Keywords: Palm dates, chemical analysis, estimated daily intake, *Phoenix dactylifera*

1. INTRODUCTION

The date palm (*Phoenix dactylifera*) is a common fruit tree grown in many Arab countries especially those with dry weather [1]. Before the start of oil production dates were one of most consumed food along with camel dairy products. It was a source of economic revenue as the business and trade of dates was booming by that time.

Still dates are taken with coffee as a replacement to sugar on a daily basis. Saudi Arabia is the second date producer in the world as more than 300 varieties are grown [2] and 1.07 million tons production [3]. In addition to the fruit palm tree leaves are used as animal fodder when green and as decorative material when dry. Fruits from date palm contains vitamins C, B₁ and B₂ [4]. Dates are healthy food with anticancer [5], antiviral [6] and antioxidant [7] activities.

Their antioxidant activity is due to the presence of flavonoids in date palm fruits [8]. They are recommended for pregnant women before and after delivery due to their beneficial nutrients and pleasant taste.

In a data released by the Saudi Ministry of Agriculture and Water (1997), there are 12 million palm trees that produce 590,000 tons of dates. At the industrial level, there are 22 date processing factories with a total capacity of 91.131 tons [9].

With the increase in obesity and overweight among Saudi Nationals especially young males and females [10] due to the life style and food habits, healthier balanced food may be one of the solution to this problem. Date fruits are a perfect food that can provide the necessary minerals. Moreover dates can be given to children instead of chocolates that contain various fats and additives that may subject them to health problems. Dates have longer shelf life and can be stored safely even at the high temperature of the Arabian Peninsula. Dates don't require cooking or processing. All of these advantages make dates one of the best food stuff to be consumed.

Calcium, phosphorus, sodium and potassium are considered as macro-element while iron, copper, cobalt, potassium, magnesium, iodine, zinc, manganese, molybdenum, fluoride, chromium, selenium and sulfur are categorized as micro-elements [11] (Eruvbetine, 2003). Both categories are important for human health with macro-elements need exceeding 100 mg/dl compared to less than this limit for micro-elements [12] while other are classified as trace such as arsenic, nickel, cadmium and lead.

Iron contributes to brain development and blood haemoglobin in the erythrocytes and its deficiency leads to anaemia and alterations in many metabolic processes [12]. Zinc is an essential trace element needed by living organisms as it functions as structural component of proteins and enzymes [13]. Thus zinc deficiency is the most widespread essential trace element overall the world. Aluminum is toxic at high concentration and can cause brain damage and anemia [14].

Dates contain appreciable amounts of Ca, Mg, P, K, Fe, Cu and Zn [15]. The transition metals or metalloids (arsenic, cadmium, chromium VI, beryllium, and nickel) are considered as human carcinogens at extensive exposure [16].

Cadmium is toxic with severe impact upon kidney function and bone metabolism to the extent of being carcinogenic [17]. The main source of Cd for plants in the phosphate fertilizers, sewage sludge used to improve soil properties [18]. The acceptable level of Cd in fruits is 50 ng.g⁻¹ [19]. In previous studies of Egyptian dates [20] a range of 15.5 - 24.74 ppb was reported, while the concentration in dates from Saudi Arabia was 5.65 mg·kg⁻¹ [21] and 27 ng·g⁻¹ in dates from Pakistan [22]. Regarding chromium, it is well known that hexavalent chromium Cr (VI) is toxic and even carcinogenic [17] with a tolerance limit for plants is 5.0 mg kg⁻¹. Its concentration in palm date fruits increases in the urban and Industrial area especially for unwashed samples. A range of 30.2-95 ppb was reported in dates sample from Egypt [20] while in Zilfi province Saudi Arabia the Cr concentration was found to be 4.1 – 15.5 mg·kg⁻¹ range [3].

Lead (Pb) and cadmium (Cd) are hazardous air pollutants and toxic to humans when their concentrations is high in food stuff [23]. Thus the presence of (Pb and Cd) in date fruits above the permissible limit induces severe health hazards to the consumers. Therefore the estimation of the extent of these contaminants in dates vital important to the safety and human health [24].

The objectives of this study was to determine the elemental content of Segae dates using flame photometry, inductively coupled plasma and atomic absorption. Also to study the effect of washing on the amount of elements present.

2. MATERIALS AND METHODS

2. 1. Sample collection

Samples of palm dates (*Phoenix dactylifera* L.) of the type Sugai at the tamor (dry dates) stage were collected from a farm in Kharj province (80 km from Riyadh) in November 2014. The samples were divided into two groups: one group was not washed (Group 1) while the other group was washed three times with distilled water (Group 2). The samples were left to dry in the sun, then were taken to the laboratory.

2. 2. Sample preparation

From each group ten samples were selected. Seeds were removed and then the samples were weighed then oven-dried at 105 °C for 24 hours until a constant mass. The moisture content was calculated using the formula:

$$\%Moisure = \frac{M_1 - M_2}{M_1},$$

where: M_1 and M_2 stand for the mass before and after drying respectively.

After grinding the dry sample, 1.0 g was accurately weighted into a beaker then digested according to the procedure [25]. Five milliliters of 70 % concentrated nitric acid (MERCK) and two of 30 % hydrogen (Sigma Aldrich) peroxide were added. The beaker was covered with a watch glass and left for an overnight on a 60 °C sand bath. The sample was evaporated to near dryness. The samples were then cooled and washed with distilled before filtering using a Whatman filter paper 41. The beaker was rinsed and the solution volume was 10 ml. The samples were kept for further analysis.

2. 3. Sample Analysis

The samples were analyzed for the macro-elements (Na, K and Ca) using GENWAY PFP7 flame photometer with butane as fuel and air an oxidant. The Inductively coupled plasma (iCAP Q, QTEGRA) and atomic absorption Perkin Elmer Analyst 200 was employed in determination of other elements. For all analysis a series of dilution from the standards of the elements under investigation were prepared. Following that the emission intensity was measured and a calibration curve was plotted. The curve was used to measure the concentration of the elements.

3. RESULTS AND DISCUSSION

Tables 1 & 2, show the mass and the moisture contents of dates samples from the two groups.

Table 1. Mass (g) and moisture content (%) of dates samples from Group 1.

Sample	1	2	3	4	5	6	7	8	9	10	Average	Moisture
Mass	10.05	11.21	13.04	13.67	12.13	12.80	11.40	12.50	10.52	16.16	12.35	21.86

Table 2. Mass (g) and moisture content (%) of dates samples from Group 2.

Sample	1	2	3	4	5	6	7	8	9	10	Average	Moisture
Mass	12.56	12.16	11.93	12.20	12.21	11.50	12	14.13	12.14	10.12	12.05	16.36

The mass of fruit dates is within the range reported for samples from Zilfi [3]. While the moisture contents is within the range of 10.5 - 29.5 % found by [2] in Arabia and 9.2 - 32.1 % by [26] in UAE. The reported in this study is higher that the values reported for Saudi Sukkari dates [27].

Table 3. Sodium, Potassium and Calcium contents of Group 1 and 2 ($\text{mg}\cdot\text{kg}^{-1}$) by flame photometry.

Group 1				Group 2			
Sample	Na	K	Ca	Sample	Na	K	Ca
1	350	2350	120	1	370	1900	130
2	350	2150	140	2	330	2440	120
3	360	2150	170	3	340	2210	130
4	360	2500	170	4	340	2410	140
5	330	2480	170	5	310	1980	130

6	240	2050	110	6	360	2680	140
7	340	1820	140	7	330	2130	140
8	390	2450	190	8	380	2410	200
9	320	2420	170	9	350	2200	190
10	340	2070	190	10	330	1950	110
Average	338	2239	157		334	2231	143

Table 3, illustrates the concentration of the macro-elements Na, K and Ca. The sequence of concentrations is as follows: $K > Na > Ca$ for all samples. The calcium and sodium contents were less than a pervious data reported for Egyptian and Saudi dates [27]. On the other hand the potassium concentration is high indicating that dates can be a rich source for K. The elevated concentration of K may be attributed to the addition of K containing fertilizers [28].

Table 4. Elemental Contents of Group 1 dates samples ($mg \cdot kg^{-1}$) by ICP-AES.

Sample	Al	Mn	Fe	Ni	As	Rb	Ru	Cd	In	Ba	Tl	Bi
1	3.95	3.25	0	0	0.43	0	0	0	3	0.25	3.25	2.9
2	14.55	8.25	4.7	2.3	2.6	8	66.5	2.2	7.6	2.5	7.4	7.15
3	12.8	12.7	4.15	4.3	4.45	12.2	4.4	4.25	11.75	4.4	13.9	11.05
4	35.35	42.55	38.05	50.35	50.8	43.05	40.65	50.9	43.65	50.65	44.8	43.7
5	130.3	82.5	76.8	99.85	100.5	83.1	123.45	99.6	84	99.7	82.95	85.85
6	260.55	258.3	261.65	118.5	119.75	257.95	242.5	124	257.5	121	257.5	256.7
7	14.3	12.8	5.75	4.35	5.05	12.75	0	4.2	11.7	4.45	11.35	10.7
8	50.35	37.65	147.15	259.1	0	38.15	133.8	0.33	3.25	4.6	3.25	2.15
9	18.1	39.65	120.5	7.9	0	61.7	102.75	0.24	3.25	6.75	3.25	2.3
10	37.85	35.9	150.5	9.75	0	1.05	83.8	0.18	3.3	2.5	3.25	2.5

Range	3.98-260.55	3.23-258.3	4.15-261.65	2.3-259.1	0.43-119.75	1.05-257.95	4.4-242.5	0.18-99.6	3-257.5	0.25 - 99.7	3.25-257.5	2.3-256.7
Aver.	52.81	53.36	80.83	55.64	28.36	51.8	79.79	28.59	42.9	29.68	43.09	42.5

Table 5. Elemental Contents of Group 2 dates samples ($\text{mg}\cdot\text{kg}^{-1}$) by ICP-AES.

Sample	Al	Mn	Fe	Ni	As	Rb	Ru	Cd	In	Ba	Tl	Bi
1	59.4	49	215.25	9.9	0	33.15	113.1	0.06	3.25	2.6	3.2	2.9
2	70.3	63.75	328.6	10.55	0	36.9	118.25	0.12	3.1	3.3	3.2	3
3	55.9	28.95	120.35	7.85	0	47.15	139	0.04	3.25	3.3	3.0	3
4	67.95	48	161.35	10.6	0	44	107.9	0.06	3.3	3	3.4	3.8
5	32.7	56.25	167.2	10.1	0	73.5	97.55	0.13	3.2	3	3.3	2.6
6	13.6	39.1	150	9.2	0	38.4	118.3	0.06	3.2	6.7	3	3
7	60.15	57.55	135.95	9.15	0	34.55	92.4	0.13	3.3	2.7	2.8	2.6
8	14	89.25	315.5	11.75	0	46.3	144.15	0.05	3.2	3.3	3.5	2.8
9	74.85	31.18	213.25	8.85	0	39.9	201.1	0.18	3.2	3	3	2.8
10	72.55	22.58	222.45	8	0	44.55	133.8	0.12	3.3	2.7	2.7	2.6
Range	13.6-74.85	31.8-89.25	120.35-315.5	8-11.75	0	33.15-73.5	92.4-144.15	0.04-0.18	3.1-3.3	2.6-6.7	2.7-3.4	2.6-3.8
Aver.	52.14	53.94	202.99	9.6	0	40.17	126.56	0.09	3.22	3.34	3.3	2.86

Table 6. Copper, lead and zinc Contents of the dates samples ($\text{mg}\cdot\text{kg}^{-1}$) by AAS.

Group 1				Group 2			
Sample	Cu	Pb	Zn	Sample	Cu	Pb	Zn
1	1.09	3.80	0.59	1	0.98	2.17	0.51

2	1.53	5.83	0.48	2	1.26	1.16	0.20
3	0.92	5.72	0.51	3	1.12	3.52	0.05
4	1.35	3.25	0.36	4	1.13	4.16	0.38
5	1.49	0.78	0.33	5	1.29	3.50	0.62
6	1.10	4.80	0.30	6	0.96	3.03	0.84
7	1.16	4.85	0.23	7	1.17	2.30	0.23
8	1.28	3.05	0.18	8	1.26	1.73	0.20
9	1.61	3.33	0.95	9	1.17	0.45	0.06
10	0.92	2.67	0.77	10	1.11	3.82	0.26
Average	1.26	3.81	0.45		1.15	2.58	0.34

Tables 4-6, displays the elemental contents of dates before and after considerable washing as determined by ICP-AES. The amount of Fe present in both groups is the highest among elements. This values recorded in this study is higher than the results reached by [27] for dates from both Saudi Arabia and Egypt and United Arab Emirates [26]. The Mn content is in the range of Fe and in accordance with previous findings [26]. This indicates that the samples contain a considerable amount of Fe and Mn which have great nutritional value. The Al concentration is comparable with previous findings for dates from Zilfi [3]. It can be noticed that the concentration of trace elements Ni, As, Cd, In, Tl and Bi has significantly decreased as a result of extensive washing. Particularly As has been completely washed out giving a zero concentration in Group 2. The concentrations of copper, lead and zinc are shown in Table 6, where their averages were higher in the unwashed samples also. This may indicate an external source of these elements that may be the dust or pollution due to the industry of heavy traffic. Similar results were obtained by many researchers who indicated the correlation between unwashed dates and high level of toxic elements [3, 27].

The farm is located next to high way road that may be the source trace elements. In their study Aldjain *et al.* [29] reported high Pb and Cd contents in dates grown in proximity of roads in Riyadh. The ranges given for the elemental content of Iraqi dates [30] were: Na (50 - 160), Ca (1330 - 2070), K (8330 - 8940), Fe (32.1 - 103.7), Mn (51.4 - 58.6), Cu (25.4 - 28.9), Zn (7.4 - 18.2) and Co (7.6 - 9.6) mg/kg are almost in agreement with the result obtained in this study. The estimated daily intake per meal size of palm dates fruits (ED_{ml}) for each element was calculated according to this equation [31, 32].

$$ED_{ml} = MsxC$$

where: Ms is the meal size (g) and C is the metal concentration ($\mu\text{g/g}$).

Some studies showed that the Kingdom occupies the first rank in the world in terms of average per capita consumption of dates per year, which reached 34.8 kg/year in 2003 (Food Agriculture Organization of the United Nations, the site of base consumption data, 2003). Table 7, illustrates the values of ED_{ml}, which was calculated on the concentration of washed sample, indicates that these dates have considerable nutritional values and they do not induce any harm to consumers health.

Table 7. Estimated daily intake per meal size of palm date fruit (ED_{ml}) compared with tolerable intake (μg /person/day) suggested by (JECFA) [33].

Element	TI	ED _{ml}
Cd	58.3*	1.81
Cu	700	23.1
Fe	800	4078
Mn	1800-2300	1064
Ni	300	193
Zn	8000-11000	6.8
Al	nd.	1048
Pb	105*	51.8
As	21-560*	0.0

* Toxological limit ($\mu\text{g}\cdot\text{day}^{-1}$) IOM [34]

5. CONCLUSIONS

Dates from the Segae type were collected at the ripened (tamr) stage from a farm in Kharj province Saudi Arabia. The sample were analyzed for their moisture contents and elemental analysis. Flame photometry was utilized to determine Na, K and Ca. The other elements were determined via ICP-AES and atomic absorption. The results showed that some elements especially those having considerable toxicity were accumulated in unwashed dates. The estimated daily intake per meal size of palm dates fruits (ED_{ml}) for the different elements revealed consumers are not prone to any harm due to these dates intake.

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