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Lead and Other Elements in Date Palm (*Phoenix dactylifera* L.) Fruits (Dates)

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The date (fruit) of date palm (*Phoenix dactylifera* L.) has been analyzed for lead and other metal pollutants in Riyadh City, Saudi Arabia. The content of (Pb, Zn, Cu, Ni, Cr and Li) was determined for washed and unwashed dates (fruit) samples collected from five different sites with different degrees of metal pollution (three roads, area flooded with treated sewage water "Al Hayer area" and rural "control" area). The analysis of *P. dactylifera* fruit (dates) showed the date samples to be superficially polluted by lead and zinc and slightly by copper compared with the control area. However, merely washing the fruit by water can remove about 80% of the lead and reduce lead content in fresh date fruit from 1.16 to 0.35 $\mu g\ g^{-1}$ which is about three times less than the British legal limit for lead in food (1.0 $\mu g\ g^{-1}$). Therefore, it is strongly recommended to wash those date fruits growing along side the roadways before eating.

Key words: Pb, Zn, Cu, Ni, Cr, Li, Analysis, *Phoenix dactylifera* L., Saudi Arabia.

INTRODUCTION

During the last decades heavy metal pollution has considerably increased in the environment. Automobile exhaust emission is regarded as one of the major sources of heavy metal contamination in urbanised areas. This is due to the combustion of leaded gasoline and the consequent discharge of lead particles. Other metals such as Zn, Cu, Ni, Cr and Cd which are associated with vehicles are released to the environment due to wear and tear. Due to their presence in the atmosphere the metals reach the soil and the plants by precipitation[1].

In Riyadh, automobiles, power stations, oil refinery, cement plant and the industrial activities are the suspected sources of air pollution. However, among these, automobiles are considered to be the major contributors to air pollution. This is due to the very high number of vehicles which is increasing every year, *e.g.*, automobiles increased by a factor of 843% in the period 1973–1983. The average lead concentrations in two locations in Riyadh were found[2] to be 5.5 $\mu g\ m^{-3}$ and 2.5 $\mu g\ m^{-3}$. These concentrations reflects the heavy and light traffic areas respectively. Both values[3] are exceeding the WHO guideline, *i.e.*, 0.5–1.0 $\mu g\ Pb\ m^{-3}$. Copper also was reported[4] to have a high level in Riyadh environment, *i.e.*, 6.4 $\mu g\ m^{-3}$.

The date fruit is a common and highly consumed foodstuff in Saudi Arabia. Botanically the date fruit is a berry consisting of a single seed surrounded by a fibrous, parchment-like endocarp, a fleshy mesocarp and the fruit skin. The fruit is attached to the spikelet by a perianth, and takes up to 200 days from pollination to reach full maturation.[5]

In Riyadh city, date palm (*Phoenix dactylifera* L.) is a typical urban tree

occurring over large areas, even where high levels of urban pollution exist, usually growing by roadsides in industrial, rural, residential and agricultural areas. Riyadh municipality has planted date palm trees along roadsides and in central reservations of highways; for example, 1000 trees were planted in 1980, which increased to 13,700 trees in 1990. This makes it highly exposed to the heavy metal pollutants emitted by vehicles.

It has been found by Ndiokwere[6] that vegetables grown in the neighbourhood of major motorways can contain significant traces of lead and other heavy metals due to airborne metal particulates derived from motor vehicle emissions. Ademoroti[7] investigated the levels of heavy metals on fruit of trees in Nigeria. Levels of Pb and Zn were found to vary according to traffic volume. Schock and Locke[8] investigated the relationship of automotive lead particulates to certain consumer crops. Lead content of the untreated cauliflower and tomato crops was found to be decreasing exponentially with the distance away from the edge of the road. Therefore, it was the aim of this work to evaluate the metal content in date fruits from trees growing along roadsides in Riyadh city.

EXPERIMENTAL

Sampling and samples treatment

Date palm trees which grow along roadsides expose their fruits to pollutants emitted from vehicles, particularly lead. To investigate the metal levels in these fruits, date samples were collected from five locations varying in traffic density in Riyadh, including rural (control) area. Five samples were collected from each location, each sample comprising 6 dates from a single tree. Each sample was then divided into two subsamples. One was thoroughly washed with running distilled water to remove dust particles; the other remained untreated. Fresh and dry weights of each single date (fruit) were recorded. The samples were then oven-dried at 80°C, milled in a micro-hammer cutter, and fed through a 1 mm sieve. Each plant sample was stored in a clean self-sealing, plastic bag.

Extraction method

1 g samples of dry milled plant material were ashed in an electric muffle furnace at 480°C for 24 h. The weighed ash was digested in 10 ml AR concentrated HNO_3, evaporated to near dryness on a hot-plate and made up to volume with 1% HNO_3.

Element concentrations were measured by an atomic absorption spectrophotometer (Perkin-Elmer model 1100, micro-computer controlled with integrated CRT screen and keyboard function). The precision of the results was checked by duplicating 20% of the samples chosen randomly. In order to ascertain the accuracy of the method employed, two reference materials were included with every batch (SRM 1547 peach leaves and CRM 281 rye grass).

RESULTS AND DISCUSSION

The concentration levels of the heavy metals in dry and fresh date fruits collected from three roads varied in traffic density, rural area with sludge amended soils (Al-Hayer) and rural (control) area presented in Tables 1 and 2 respectively. The results showed elevated concentrations of lead, zinc and copper in unwashed

TABLE-1
METAL CONCENTRATION (μg/g DRY WEIGHT ± SE) IN DATE FRUIT SAMPLES COLLECTED FROM FIVE LOCALITIES IN RIYADH CITY

Location	Pb		Zn		Cu	
	Unwashed	Washed	Unwashed	Washed	Unwashed	Washed
Almatar Road	4.97 ± 1.75	1.01 ± 0.17	9.70 ± 2.40	6.31 ± 0.29	8.37 ± 1.39	6.20 ± 0.67
Al-Jameiah Road	3.15 ± 0.37	0.84 ± 0.06	9.40 ± 0.67	8.49 ± 0.34	7.68 ± 0.74	5.88 ± 0.60
Al-Kharj Road	1.69 ± 0.23	1.15 ± 0.08	12.00 ± 0.93	11.58 ± 0.56	10.08 ± 0.70	9.32 ± 0.83
Al-Hayer area*	0.96 ± 0.15	0.61 ± 0.08	7.10 ± 0.27	6.76 ± 0.47	3.04 ± 0.06	2.66 ± 0.17
Rural area	0.98 ± 0.11	0.55 ± 0.10	5.83 ± 0.34	5.36 ± 0.46	4.50 ± 0.57	4.56 ± 0.49

Location	Cr		Ni		Li	
	Unwashed	Washed	Unwashed	Washed	Unwashed	Washed
Almatar Road	0.91 ± 0.29	0.49 ± 0.03	1.72 ± 0.39	1.52 ± 0.10	0.46 ± 0.13	0.26 ± 0.02
Al-Jameiah Road	0.72 ± 0.06	0.64 ± 0.05	1.44 ± 0.08	1.98 ± 0.15	0.30 ± 0.06	0.27 ± 0.06
Al-Kharj Road	1.21 ± 0.11	1.09 ± 0.11	2.51 ± 0.21	2.87 ± 0.50	0.36 ± 0.04	0.25 ± 0.01
Al-Hayer area*	1.18 ± 0.14	0.80 ± 0.08	2.24 ± 0.32	1.66 ± 0.23	0.23 ± 0.03	0.17 ± 0.01
Rural area	0.90 ± 0.04	0.91 ± 0.11	1.67 ± 0.25	2.08 ± 0.16	0.21 ± 0.06	0.20 ± 0.05

TABLE-2
METAL CONCENTRATION (μg/g FRESH WEIGHT ± SE) IN DATE FRUIT SAMPLES COLLECTED FROM FIVE LOCALITIES IN RIYADH CITY

Location	Pb		Zn		Cu	
	Unwashed	Washed	Unwashed	Washed	Unwashed	Washed
Almatar Road	1.16 ± 0.12	0.35 ± 0.06	2.36 ± 0.02	2.20 ± 0.09	2.13 ± 0.19	2.14 ± 0.06
Al-Jameiah Road	1.00 ± 0.08	0.29 ± 0.01	3.01 ± 0.17	2.98 ± 0.14	2.45 ± 0.16	2.05 ± 0.16
Al-Kharj Road	0.36 ± 0.04	0.28 ± 0.03	2.55 ± 0.18	2.77 ± 0.12	2.15 ± 0.17	2.21 ± 0.12
Al-Hayer area*	0.30 ± 0.04	0.24 ± 0.05	2.28 ± 0.09	2.52 ± 0.11	0.97 ± 0.02	1.00 ± 0.06
Rural area	0.36 ± 0.03	0.16 ± 0.02	2.16 ± 0.21	1.65 ± 0.25	1.65 ± 0.21	1.34 ± 0.05

Location	Cr		Ni		Li	
	Unwashed	Washed	Unwashed	Washed	Unwashed	Washed
Almatar Road	0.21 ± 0.02	0.17 ± 0.01	0.42 ± 0.04	0.53 ± 0.03	0.11 ± 0.01	0.09 ± 0.00
Al-Jameiah Road	0.23 ± 0.01	0.22 ± 0.02	0.46 ± 0.01	0.69 ± 0.o5	0.10 ± 0.02	0.10 ± 0.02
Al-Kharj Road	0.26 ± 0.02	0.26 ± 0.04	0.53 ± 0.04	0.70 ± 0.15	0.08 ± 0.01	0.06 ± 0.00
Al-Hayer area*	0.37 ± 0.03	0.30 ± 0.01	0.71 ± 0.07	0.61 ± 0.02	0.07 ± 0.01	0.06 ± 0.01
Rural area	0.33 ± 0.02	0.27 ± 0.02	0.60 ± 0.06	0.62 ± 0.04	0.07 ± 0.02	0.06 ± 0.01

*Rural areas with sludge amended soils.

date fruit collected from the three roads compared with their levels in the control area (Fig. 1 and 2). The differences between concentrations in washed and unwashed date fruits indicated an aerial deposition of these metals rather than translocation from the roots.

In trying to interpret our results we are faced with the problem of not having legislation in Saudi Arabia about levels of heavy metals in vegetables and fruits including dates. Because of this, it was decided to use the legal limit for lead[9] in Great Britain (2 $\mu g\ g^{-1}$ fresh weight), which is planned to be reduced to 1 $\mu g\ g^{-1}$.

The mean lead content in unwashed date fruits collected from Al-Jamiah Road was 4.97 $\mu g\ g^{-1}$ (dry weight) and 1.16 $\mu g\ g^{-1}$ (fresh weight), which is slightly

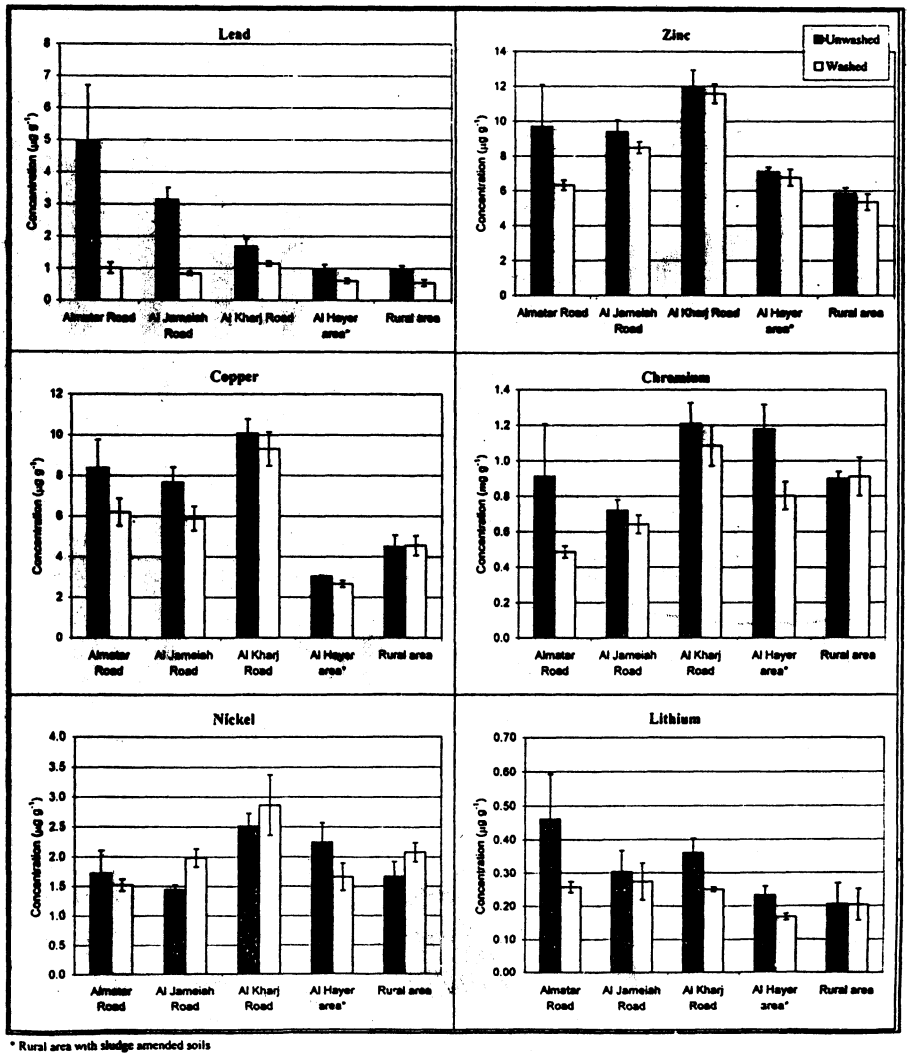

Fig. 1. Metal concentration ($\mu g/g$ dry weight ± SE) in date fruit samples collected from five localities in Riyadh city

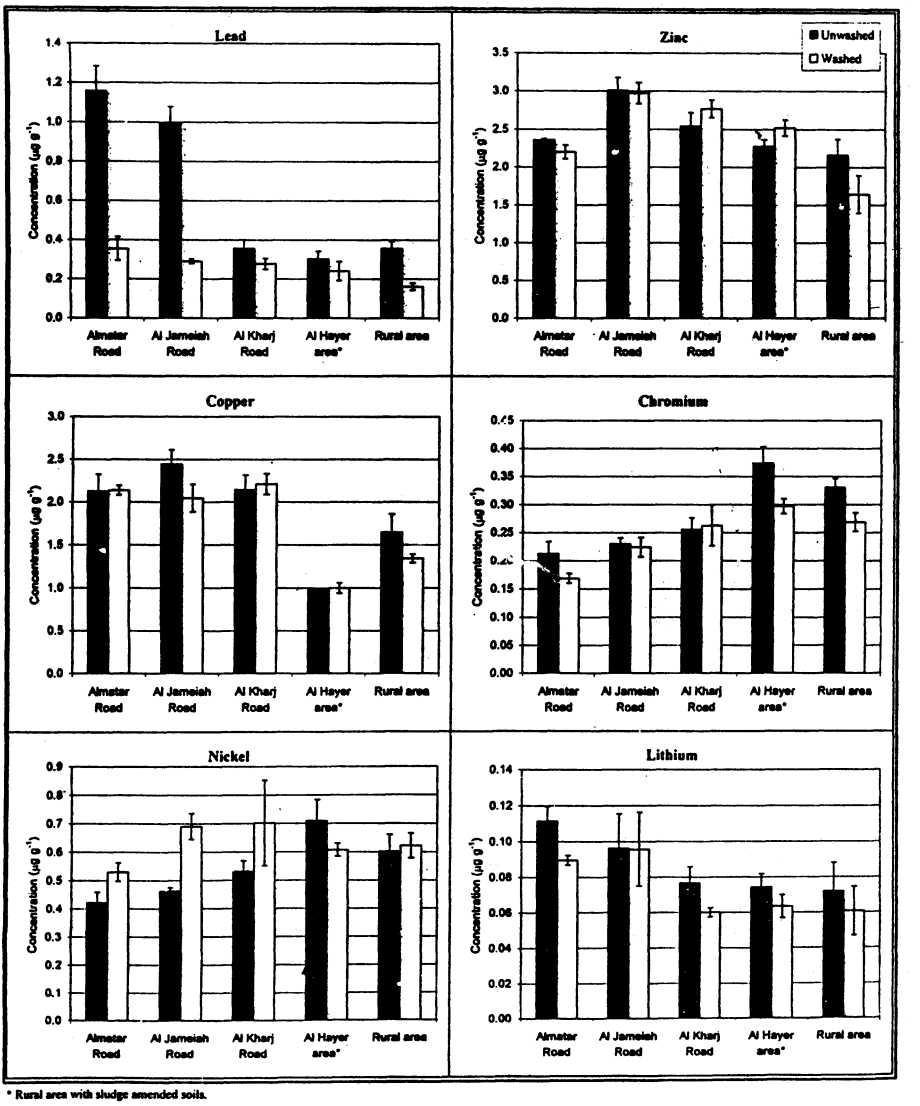

Fig. 2. Metal concentration (µg/g fresh weight ± SE) in date fruit samples collected from five localities in Riyadh city

above the British legal limit for lead in food. On the other hand, lead content in washed dates from the same road was 1.01 µg g^{-1} (dry weight) which is about four times less than that in the unwashed ones. This emphasised the atmospheric deposition as the main route by which this metal can reach the date fruit. Also, it can be shown that merely washing the fruit by water can remove about 80% of the lead and reduce lead content in fresh date fruit to 0.35 µg g^{-1} which is about three times less than the British legal limit for lead in food.

The effect of automobile emissions in rising lead levels can be noticed by comparing lead levels in unwashed date fruits from the three roads (4.97, 3.15

and 1.69 μg g^{-1} dry weight) with its level in the (control) rural area 0.98 μg g^{-1} dry weight). Also, the effect of automobile tyres and oil as a source of zinc in roadside environment can be shown from the differences between its levels in unwashed date fruit from the three roads (9.70, 9.40 and 12.0 μg g^{-1} dry weight) and in date fruit from the control area (5.83 μg g^{-1} dry weight). Copper level in unwashed date fruits from the three roads showed to be about double its content in unwashed fruits from the control area. The levels of nickel in washed and unwashed samples did not appear to be related to airborne contamination. It appeared to be mainly related to the soil content, and not attributed to pollution by automobiles. Chromium showed slight enrichment in unwashed fruit samples compared with the washed fruits, particularly in the samples derived from Almatar road.

Finally, in the light of this work it is strongly recommended to wash the date fruits growing alongside the roadways before eating.

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