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Comparison Study of *Phoenix dactylifera* L. and *Nerium oleander* L. as Biomonitors for Lead and Other Elements

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The ability of *Phoenix dactylifera* leaflets to retain heavy metal pollutants was compared with the leaves of *Nerium oleander*. Pair samples of the two species were collected from 15 sites with different degrees of metal pollution in Riyadh city. The metal content (Pb, Zn, Cu, Cr, Ni and Li) was determined for washed and unwashed samples. Both plant species seem to have a comparable ability to retain these elements on the unwashed leaves. However *N. oleander* showed higher lead, zinc and copper levels in the washed leaves than *P. dactylifera* leaflets which could be attributed to their adsorption in leaf surfaces.

Key words: ***Phoenix dactylifera* L., *Nerium oleander* L., Biomonitors, Lead, Pb, Zn, Cu, Cr, Ni, Li, Riyadh city.**

INTRODUCTION

The use of biological materials for monitoring heavy metal pollution was introduced more than 30 years ago[1]. Since then, a wide variety of botanical materials have been used for biomonitoring, including bacteria, fungi, lichens, tree bark, tree rings and leaves of higher plants.

Non-vascular plants, such as mosses and lichens, are those most frequently used to study the pattern of atmospheric metals, since they obtain their nutrients either from rainfall or by impaction and sedimentation of airborne dust. However, it has been shown in many studies that higher plant leaves can be used as accumulative monitors of many metal elements in polluted areas. Little and Martin[2] for example used elm leaves to monitor the distribution of airborne Zn, Pb and Cd in the Avonmouth area of England. In Hungary, Kovacs *et al.*[3] examined the element content of the leaves of three tree species in industrial-urban (Budapest) and rural (Vacrator) environments. Tam *et al.*[4] surveyed metal contamination of *Bauhina variegata* leaves collected at 13 urban parks near busy roads in Hong Kong. Maple leaves and pine needles were used by Tong and Farrell[5] to examine the concentration of Cu and Pb in an urban forest in Cincinnati, Ohio. The metallic content of leaves of *Prunus cerasifera*, *Malus pumila* and *Pyrus communis* have been studied by Deu and Kreeb[6] in Esslingen, Baden-Wurttemberg, Germany.

Nerium oleander is a distinctive evergreen plant. It is widely distributed

throughout the Mediterranean and Middle East countries. It has stiff, leathery, lanceolate leaves lending themselves to easy sampling for pollution monitoring investigations. Due to these features, *N. oleander* has been tested and applied as a biomonitor for the atmospheric heavy metal pollution. Fytianos[7] used *N. oleander* leaves to monitor lead, cadmium and zinc contamination in the city Thessaloniki, Greece. Zolaly[8] monitored lead, cadmium and zinc contamination in Jeddah city, Saudi Arabia, using the leaves of *N. oleander*. Seaward and Mashhour[9] evaluated *N. oleander* as a possible biomonitor of metal pollution at Yanbu industrial city, Saudi Arabia. In Riyadh city Amin[10] employed *N. oleander* leaves to monitor the atmospheric lead in three roads.

The 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. It can survive within a wide temperature range, and will grow in almost any type of soil[11]. It is an evergreen plant with leaflets lending themselves to easy sampling. It has a stiff, leathery, ensiform blade with leaflets (pinnae), folded lengthwise with prominent parallel veins, which give it the ability to accumulate deposited dust in large quantities. *Phoenix dactylifera* L. meets many of the requirements of a good biomonitor and has already been tested as a biomonitor by leaves[12] and fibres[13].

Therefore, it was decided to undertake this study to compare the ability of Phoenix dactylifera leaflets with the leaves of *N. oleander* as biomonitors.

EXPERIMENTAL

Sampling and sample treatment

In order to compare the ability of *P. dactylifera* leaflets as a biomonitor with the leaves of *N. oleander* which has been used previously in Riyadh by Amin[10], a pair of *P. dactylifera* and *N. oleander* leaves were collected from 15 sites. *P. dactylifera* leaflets were collected according to Al-Shayeb and Seawrd[14] and healthy middle age *N. oleander* leaves were collected at approximately the same height 1.5 m using stainless steel secateurs. 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 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 results was checked by duplicat-

ing 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 mean concentration of the studied elements in washed and unwashed *N. oleander* and *P. dactylifera* leaves are presented in Table-1. Fig. 1 shows the metal contents in both plant leaves for visual comparison. From the average values of the elements both plant species seem to have a comparable abilility to retain these elements on the unwashed leaves. However, *N. oleander* showed higher lead, zinc

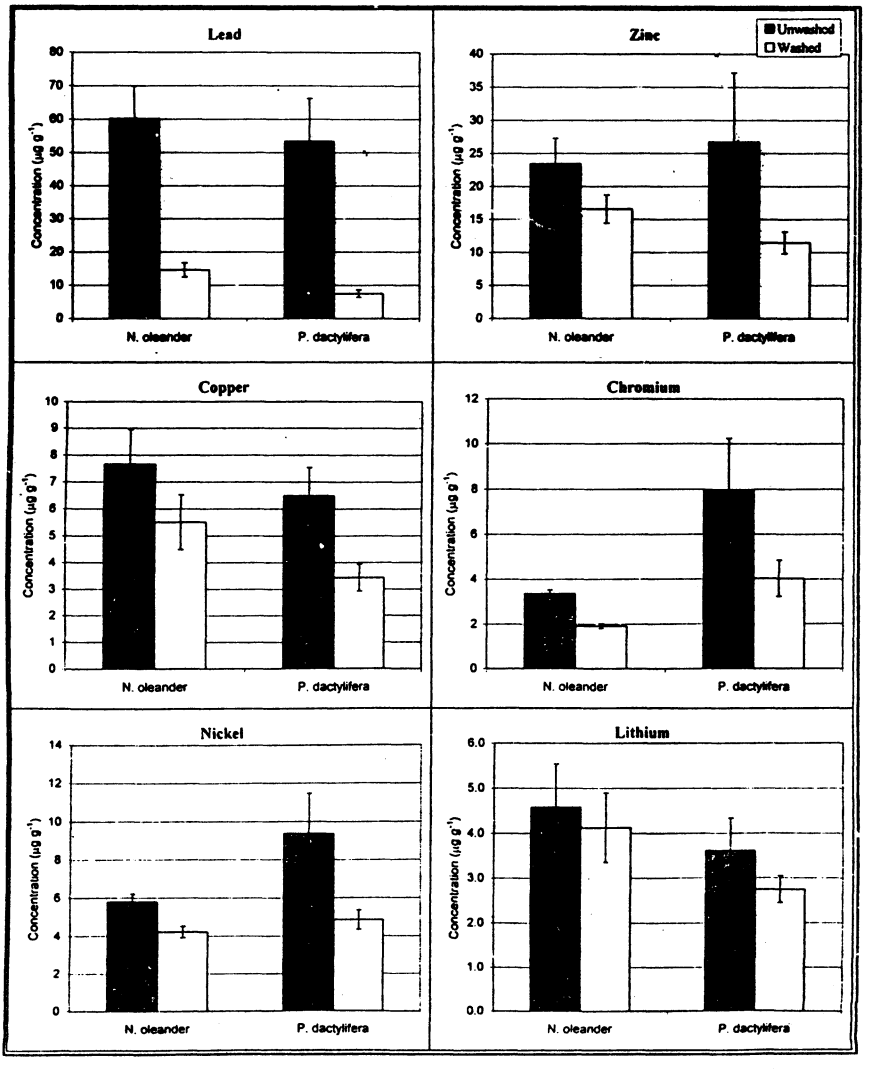

Fig. 1. Metal concentrations (µg/g dry weight; mean ± SE) in *Nerium oleander* leaves and *Phoenix dactylifera* leaflets

and copper levels in the washed leaves than *P. dactylifera* leaflets which could be attributed to their adsorption in leaf surfaces. This can be shown by the difference in the amount of element removed by washing procedures. The percentages of Pb, Zn and Cu removed from *N. oleander* surface were 75.24, 27.19 and 29.85 respectively whereas in *P. dactylifera* they were 79.09, 35.07 and 40.07 respectively. These three metals showed high correlation in unwashed *N. oleander* and *P. dactylifera* leaves (65, 90 and 67% respectively), whereas in washed leaves only lead showed 61% correlation between these two species.

TABLE-1
METAL CONCENTRATIONS (μg/g DRY WEIGHT; MEAN ± SE)
IN *NERIUM OLEANDER* LEAVES AND *PHOENIX DACTYLIFERA* LEAFLETS

Element	*Nerium oleander*		*Phoenix dactylifera*	
	Unwashed	Washed	Unwashed	Washed
Pb	60.24 ± 9.59	14.59 ± 2.16	53.46 ± 12.80	7.52 ± 1.11
Zn	23.47 ± 3.82	16.56 ± 2.13	26.76 ± 10.42	11.47 ± 1.66
Cu	7.67 ± 1.28	5.51 ± 1.02	6.50 ± 1.03	3.43 ± 0.50
Li	4.58 ± 0.96	4.13 ± 0.77	3.61 ± 0.72	2.75 ± 0.30
Cr	3.37 ± 0.16	1.91 ± 0.10	7.98 ± 2.26	4.03 ± 0.81
Ni	5.80 ± 0.40	4.22 ± 0.29	9.38 ± 2.09	4.85 ± 0.50

The highest lead concentration shown by the unwashed *N. oleander* leaves was 121.44 $\mu g\ g^{-1}$ recorded in the industrial workshops area. In the same location unwashed *P. dactylifera* leaflets showed the highest lead level which was 124.2 $\mu g\ g^{-1}$. But the washed *N. oleander* leaves were found to contain 21.96 $\mu g\ g^{-1}$ whereas washed *P. dactylifera* leaflets were containing 9.84 $\mu g\ g^{-1}$.

The mean lead content in unwashed *N. oleander* leaves was 60.24 $\mu g\ g^{-1}$ which is about three times greater than the levels reported by Amin[10] in Riyadh city which was 19.50 $\mu g\ g^{-1}$. Our mean lead content in washed *N. oleander* leaves (14.59 $\mu g\ g^{-1}$) was comparable with the levels reported by Amin[10] which was 15.75 $\mu g\ g^{-1}$. For example, lead content in unwashed and washed leaves collected from Al-Shimaisi were 98.16 and 24.24 $\mu g\ g^{-1}$, whereas they were reported by Amin[10] to be 19.5 and 14.8 $\mu g\ g^{-1}$respectively. This can be attributed to the increase of pollution sources in Riyadh city in general and number of automobiles in particular during this period of time. Table-2 shows comparative data for the unwashed leaves of *N. oleander* in Riyadh city with those of other locations. Apart from the data reported by Zolaly[8], lead levels in Riyadh city showed to be the highest among the city reported.

As a conclusion, the use of *P. dactylifera* leaflets for monitoring heavy metals in Riyadh city provided results comparable to those obtained by *N. oleander* leaves which has been used by several researchers to monitor atmospheric metal

pollutants, such as Seaward and Mashhour[9] in Yanbu and Zolaly[8] in Jeddah, Saudi Arabia.

TABLE-2
METAL CONCENTRATIONS (μg/g) FOR *NERIUM OLEANDER* LEAVES FROM DIFFERENT COUNTRIES

Location	Elements			References
	Pb	Zn	Cu	
Yanbu, Saudi Arabia	12.00 ± 3.5	11.90 ± 5.04	5.00 ± 2.9	9
Near Rome, Italy	18.40 ± 3.5	27.00 ± 10.50	7.00 ± 0.5	9
Izmir, Turkey	7.20 ± 0.6	11.50 ± 3.4	5.90 ± 2.97	9
Alexandria, Egypt	23.40 ± 9.4	12.90 ± 9.2	8.20 ± 5.7	9
Jeddah, Saudi Arabia	184.00 ± 25.7	178.00 ± 14.02	—	8
Thessaloniki, Greece	46.99 ± 6.3	59.35 ± 3.73	—	7
Riyadh, Saudi Arabia	60.24 ± 9.59	23.47 ± 3.82	7.67 ± 1.28	Present study

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