

## NOTE

## Assessment of Plant Leaves as a Biomonitor for Atmospheric Pollution by Lead in an Arid Environment: A Comparative Study

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A study is carried out on the possible use of plant leaves as a biomonitor for air pollution by lead in Riyadh City, Saudi Arabia. The distribution of lead concentrations is compared for four plant species in relation to two environmentally different areas (industrial and rural sites). For this, leaves of the following plant species were collected from both sites: *Phoenix dactylifera* L., *Prosopis juliflora*, *Conorcapus erectus* L. and *Zizyphus spina christi* Jujuba. Results show that the highest average lead levels are found in the industrial site in the leaves of *Zizyphus spina christi* Jujuba (16.77 g/g) in comparison with *Phoenix dactylifera* L. (7.45 g/g), *Conorcapus erectus* L. (12.44 g/g) and *Prosopis juliflora* (10.10 g/g). The index of pollution (industrial/rural ratio) showed the highest pollution factor related to *Zizyphus spina christi* Jujuba (47.91). Results points towards the fact that *Zizyphus spina christi* Jujuba is the most suitable biomonitor for atmospheric pollution by lead in Riyadh City and areas of the globe with a similar climate.

**Key Words:** Plant leaves, Biomonitor, Pollution, Lead, Riyadh city.

Riyadh, the capital city of Saudi Arabia, is located in the middle area of the country and is surrounded by sand dunes and desert lands. The ambient atmosphere of the city is very rich in inhalable particulates<sup>1</sup> and lead concentration<sup>2, 3</sup> in these particles is very high especially during working days with an average of  $5.0 \mu\text{g m}^{-3}$ . The use of date palm *Phoenix dactylifera* L. as a biomonitor in this city was assessed by Al-Shayeb *et al.*<sup>4</sup> for heavy metals and the study concluded on the possible use of the leaves of this species for the biomonitoring of atmospheric pollution by heavy metals such as lead. The use of roadside plants (*Dodonea viscosa*, *Prosopis juliflora*, *Clerodendron inerme* and *Pithecellobium dulce*) was also investigated as a possible indicator for air pollution in Riyadh<sup>5</sup>. In another study<sup>6</sup>, the use of fibre from date palm (*Phoenix dactylifera* L.) was assessed as a means for the biomonitoring of lead and other heavy metals in Riyadh City; the study concluded on the suitable use of fibre as a biomonitor for atmospheric pollution in arid environments.

This study aims at assessing plant leaves from species that are widespread in Riyadh city, Saudi Arabia, but so far not investigated, as a biomonitor of air pollution by lead.

Samples were collected from 2 environmentally different areas: the Second

Industrial Zone and a rural area located at 180 km from Riyadh city centre where anthropogenic input of heavy metals in the atmosphere is very limited. The plant leaves were taken from very common 4 plant species: *Phoenix dactylifera* L., *Prosopis juliflora*, *Conorcapus erectus* L. and *Zizyphus spina Christi Jujuba*. A number of 10 and 5 samples were collected from each plant species, in the industrial and rural sites respectively. Samples were collected in craft paper using a stainless steel pair of scissors. The leaves were then cut, washed with deionized water, dried and finally 1 g of sample was ashed at 450°C for 24 h. The ash was digested in boiling concentrated nitric acid to near dryness and the residue diluted in 1% (v/v) hydrochloric acid. Ten per cent of the total number of samples, chosen randomly, was also prepared and analyzed for lead to assess analytical precision which was found to be equal to 15%. Lead was measured by FAAS and GFAAS.

The comparison of mean lead concentrations in both industrial and rural areas is shown in Fig. 1. Lead average levels are very low in the rural area (0.35–0.55 µg/g) compared to the Second Industrial Zone where they are extremely high (7.45–16.77 µg/g), the highest average value being found in the leaves of *Zizyphus spina christi Jujuba* (16.77 µg/g). The pollution ratio (Second Industrial Zone/ rural lead concentrations) shows very high values: 47.91 (*Zizyphus spina christi Jujuba*), 13.45 (*Phoenix dactylifera* L.), 22.26 (*Conorcapus erectus* L.) and 27.30 (*Prosopis juliflora*).

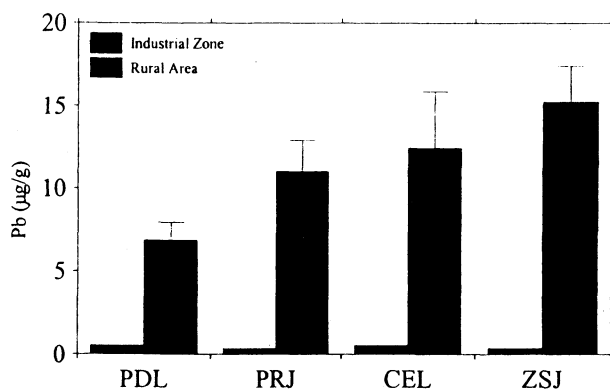


Fig. 1. A comparison of lead average concentrations in both the Second Industrial Zone and rural areas in four plant species. PDL: *Phoenix dactylifera* L., PRJ: *Prosopis juliflora*, CEL: *Conorcapus erectus* L., ZSJ: *Zizyphus christi spina Jujuba*. The vertical line shows the standard error of the mean

The statistical significance of the difference among means of lead in relation to the four plant species, in the Second Industrial Zone, was investigated using analysis of variance (ANOVA); for this, data was log-transformed in order to be compliant with normal distribution prerequisite in ANOVA tests<sup>7</sup>. From the results of this test (Table-1), it appears clear that lead mean concentration in *Zizyphus spina christi Jujuba* leaves is statistically different from the other types of plants, at  $p = 0.05$ , i.e., 95% confidence level.

This study shows that lead levels in the leaves of the 4 plant species are characterized by high values in the Second Industrial Zone compared to the rural

area as revealed by the index of pollution. The underlying cause for the high pollution factor is the input of anthropogenic lead in the atmosphere of Riyadh City by the different industries found in the Second Industrial Zone. It has been shown that plant leaves such as those from date palm (*Phoenix dactylifera* L.) can directly absorb metals from the air in an arid environment<sup>8</sup>.

TABLE-1  
RESULTS OF ANOVA TEST  
(Significant results at 95% confidence level are shown in bold.)

	<i>Phoenix dactylifera</i> L.	<i>Prosopis juliflora</i>	<i>Conorcapus erectus</i> L.	<i>Zizyphus spina christi</i> J.
<i>Phoenix dactylifera</i> L.	—	0.64	0.71	<b>0.01</b>
<i>Prosopis juliflora</i>	0.64	—	0.91	<b>0.04</b>
<i>Conorcapus erectus</i> L.	0.71	0.91	—	<b>0.03</b>
<i>Zizyphus spina christi</i> J.	<b>0.01</b>	0.04	0.03	—

The high lead levels are in accordance with another study by the Natural Resources and Environment Research Institute<sup>5</sup> as regards *Prosopis juliflora* which was found to hold the highest lead average content (32.0 µg/g in comparison with 10.10 µg/g in the present study). The difference in mean levels of lead is probably due to the samples being taken in their study from roadside vegetation where traffic is very high and to the fact that gasoline was leaded; in the present study gasoline is not. In other studies related to *Phoenix dactylifera* L., Bounessah *et al.*<sup>8-10</sup> demonstrated that palm leaves are characterized by high lead values in polluted areas and suggested their use as a biomonitor for air pollution by heavy metals. In the present study, palm leaves also indicate a pollution by lead, however less acute than in the other studies, probably due to the same reasons as mentioned above.

In conclusion, this study shows that leaves from the species *Phoenix dactylifera* L., *Prosopis juliflora*, *Conorcapus erectus* L. and *Zizyphus spina christi* J. are very good indicators of pollution by lead in Riyadh City environment; the latter species being the most suitable of them all and it can be used for air biomonitoring for lead metal pollution in arid climates.

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