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The ability to filter heavy metals of lead, copper and zinc in some species of tree and shrub

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ABSTRACT

Heavy metals found in urban air with its toxic effects have a direct impact on human health. Selection of appropriate tree species and shrub refining capacity of heavy metals in urban areas can greatly reduce the toxic effects of these materials. This study aimed to identify the most suitable tree and shrub species of broadleaf evergreen, deciduous and coniferous refinement of heavy metals lead, copper and zinc in the air in both units and total leaf weight. 12 species of tree and shrub leaves in City Park in Gorgan in summer (August 2010) was sampled. Heavy elements present in the samples were prepared and measured by atomic absorption instrument. The results showed that the performance of the trees in comparison to shrubs refinement of heavy metals lead, copper and zinc were more appropriate. Among the species present for purification of Pb and Zn, refine Shiraz, Magnolia and Cypress Pine copper refinery in Shiraz were the best and Tehran and Palvnya had the best performance for copper.

Key words: Season, Species, Absorb, Heavy metals, lead, copper, zinc, Gorgan province,

INTRODUCTION

Green wooden elements have extremely high impact on the shaping of land cover compared to other forms of green space (grass, clay work, landscaping, etc.). In this regard, urban forestry has high impact on declining the bio problems in cities. Urban forestry refers to the arts, science and technology, managing trees and forest resources in and around urban community ecosystems for economic benefits, social and psychological communities from trees. Inadequate and irregular texture and structure of cities requires that we use urban forestry and it's lied characteristics in all inconsistencies. Living in urban ecosystems, with huge buildings, cars, congestion and noise have increased human and environmental problems. In recent years, the idea of salvation of congestion and pollution in urban areas is of great significance. In this regard, one of the most effective solutions to mitigate the adverse effects of urbanization and pollution problems is different natural environments within cities (Zare *et al*, 2009). Design and management of urban forests as an environmental biotechnology applied normally to reduce some adverse effects which are combined with the phenomenon of the Nation to address long-term planning and policies. So it has always been a basic question that which species have higher capacity for air filtering and urban forestry to benefit of the species diversity could be achieved in all seasons. In recent years, the use of trees to measure heavy metal pollution has increased (Djingova and Kuleff 1993 and Aksoy *et al*, 1997). Al-Shayeb *et al*, (1995) used the leaves of palm trees for monitoring the distribution of heavy metals Cu, Ni, Cr, Pb and Zn in the air of Riyadh. Comparison of washed and

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unwashed leaves showed that significant amounts of heavy metals are absorbed by the leaves. Beckett et al (1998) studied on the Tree species effects on air quality management in the region. Their results showed that greater amount of suspended particles are attracted to species of conifers than hardwood. Rosselli et al, (2003) studied five species of deciduous phytoremediation potential in refining copper, zinc and cadmium and concluded that willow and birch have the ability to refine and transport the contaminated dirt, leaves and branches. Species of alder, ash and mountain ash are lacking in the ability to detect these species. Ali *et al*, (2004) used from the leaves of Robinio pseudo-acacia species for monitoring heavy metal pollution in the city of Denizli. Decomposing leaves of this species in industrial areas, parks and along highways showed that the concentration of Fe, Zn, Mn and Cd was higher in industrial areas and elements of Pb and Cu was significantly higher in the parks and highways. Also there exists a direct relation between the contamination and concentration of these elements in the leaves of species which can be used for monitoring heavy metals. Tomasevic *et al*, (2005) studied the pollutant elements in leaves of two species of Aesculus Hippocastanum L. and Corulys Colurna L. in urban areas. Chemical analysis showed that leaf elements such as Pb, Zn, Ni, V, Cd, Ti, as and Cu over the growing period in high-traffic areas, is detected. Mingorance *et al*, (2006) studied the content of heavy elements in the leaves of oleander Nerium oleander as an index to determine the level of pollution in urban areas. Trace elements of Al, Ba, Cu, Fe, Pb, Mg, Mn and Zn were determined during the sampling of leaves. The results of this study showed that about 30% of the elements of the air pollution come from Nerium oleander and it is one of the appropriate species as indicators of air pollution in urban environments. Nowak *et al*, (2006) studied the removal of pollution by urban trees and shrubs in the United States. In this study, it was found that urban trees can improve air quality by removing large amounts of air pollution. Comprehensive studies of the effect of trees on air pollution showed that urban canopy management can be effective in improving air quality, permanently and sustainably. Sengupta *et al*, (2011) evaluated the ability to filter pollutants and toxic elements in Mangifera indica varieties during one year. Leaf analysis showed that the ability of these species in refining heavy elements such as Pb, Cd and Cr is more than other polluting elements. Winter is the best season to determine the concentration of heavy elements in these species. This study compares the ability to refine heavy metals in 12 species of tree and shrub in the summer. Most species of conifers and deciduous tree and shrub for refining of heavy elements per unit weight of leaf and canopy were determined.

MATERIALS AND METHODS

Site description

The study area, Gorgan Gorgan Park is located in the city center with longitude '26, ° 54 Longitude '50, ° 36, which has the highest traffic and as a result, the air pollution was high. In order to investigate the heavy metals copper, lead, zinc and cadmium uptake by 12 species of evergreen tree and shrub including *Platanus orientalis*, *Magnolia grandiflora*, *Citrus aurantium, Cupressus sempervirens, Nerium oleander, Buxus hyricana*, served with an *Platycladus orientalis, Poulownia tomentosa*, *Lagerstroemia* sp, *Juniperus communis*, *Pinus eldarica, Acer negundo* based on the abundance of plant species in the city were selected.

Data sampling and Analysis

Sampling of leaves was done from the crown (lower, middle and upper), and the samples were pooled and considered to be homogeneous. Leaf sampling was done in August 2010 and was followed by at least a month of rain and immediately transported to the laboratory. First, in order to isolate dust, leaves were rinsed with some weak acid and then distilled with water and then were oven-dried for 48 h at 75 °C. Each sample of dried leaves was kept in a hot furnace to the temperature of 550 °C. The samples were then burned completely to ashes and then some water and 5 CC of hydrochloric acid 2 normal was added to the ash and kept at 100 degrees centigrade in the water bath for half an hour. Then passing through the filter paper and adding some distilled water to the volume of 100 CC followed by homogenization using Shaker, samples were prepared to put in the atomic absorption instrument. Heavy metals such as copper, lead, zinc and cadmium in the samples were measured by atomic absorption instrument so much heavy elements per unit leaf weight for all 12 species were examined in this study ; But as the average size of crowns are different, the effective sizes for the crown of 12 species for refining heavy components of copper, lead, zinc and cadmium using frames with dimensions of 10 × 10 × 10, 20 × 20 × 20 and 30 × 30 × 30 cm proportional to the canopy species were prepared. Using the above method, the amount of heavy metals, copper, lead, zinc and cadmium on each sample was determined. Then the total volume and value of any specified Crown refining the heavy elements in a given volume copper, lead, zinc and cadmium was calculated. Data were analyzed using one-way analysis of variance by SPSS software. In analysis of variance, in which the main effect or interaction was significant at the 95% confidence level, the means were compared using the SNK test.

Results

Analysis of variance showed that refined zinc, copper and lead, the entire species is significant at the 95 percent of confidence level (table 1).

Table 1. Anova between different species of zn, cu and pb in summer

F	Mean-square	Sum of Squares	Degree of freedom	element	Source of variation
5/587*	49/490	544/385	11	zinc	
5/859*	22/521	274/730	11	copper	Total species per unit weight of leaf
1/904 ns	9/289	102/184	11	lead	
9/059**	$3/179\times10^{13}$	$2/225\times10^{14}$	7	zinc	
4/785**	$1/529\times10^{12}$	$1/070\times10^{13}$	7	copper	All species in volume of canopy
3/727*	$3/111\times10^{12}$	$2/187\times10^{13}$	7	lead	
5/099*	51/679	361/725	7	zinc	
6/271*	30/996	216/974	7	copper	Tree species
2/766*	9/974	69/819	7	lead	

5/447*	34/348	103/043	3	zinc	Shrub species
1/738 ns	2/859	8/578	3	copper	
0/564 ns	4/191	12/572	3	lead	
0/597 ns	13/225	26/451	2	zinc	Three groups (conifers, broadleaf Ever-green broad-leaved deciduous)
0/497 ns	4/966	9/932	2	copper	
2/104 ns	12/400	24/800	2	lead	

* Different letters indicate significant differences in 5% level, ** Different letters indicate significant differences in 1% level. ns; no significant different

Table 2-Comparison of Zn, Cu and Pb in the total species in unit weight of leaf Concentration (ppm)

copper	zinc	species
10/24 d	24/73 bc	Pine Tehran
15/35 bc	21/78 cd	Cypress Shiraz
13/32 bcd	24/72 bc	An ax head
10/53 d	24/75 bc	Aras
10/27 d	27/57 ab	Magnolia
16/42 ab	17/52 d	Orange
12/19 cd	21/94 bcd	Shamshad
12/85 bcd	20/82 cd	Oleander
12/85bcd	21/81 cd	Buttonwood
19/09 a	23/88 bc	Palvnya
10/74 bc	31/44 a	Ornamental Maple
11/90 bc	16/60 d	Lace

The comparison of the refined zinc, copper and lead among all species in a single leaf, maple decorative element on top and orange respectively had the highest and lowest level and minimal refinement for Cu was for Palvnya Tehran pine, magnolia and Aras.To refine the elements in a crown of pine, cypress Tehran and Shiraz had the most refinement and lace, ornamental maple and Shamshad refinement was the least (Tables 2 and 3).

Table 3: The mean of copper, zinc and lead concentration in the different species

copper	zinc	lead	species
3/81 b	9/36 a	1/26 ab	Pine Tehran
5/11 a	7/24 ab	1/81 a	Cypress Shiraz
1/03 de	1/85 c	0/48 bc	An ax head
0/38 e	0/9 c	0/13 c	Aras
2/34 c	6/06 b	1/34 ab	Magnolia
0/56e	0/64 c	0/19 c	Orange
0/18 e	0/32 c	0/06 c	Shamshad
0/49 e	0/77 c	0/21 c	Oleander
0/79 de	1/31 c	0/45bc	Buttonwood
2/02 cd	2/53 c	0/64 bc	Palvnya
0/12 e	0/37 c	0/11 c	Ornamental Maple
0/08 e	0/11 c	0/02c	Lace

Analysis of variance for refining the elements of copper, zinc and lead between shrub species showed that only zinc refinery for shrub species are significant at the 95 percent confidence level (table 1). Most of juniper species is also related to the refined form. Analysis of variance of refined copper, zinc and lead in the three groups of conifers, broadleaf evergreen and deciduous broadleaf refinement showed that none of the elements is significant at the 95 percent confidence level (table 1).

Table 4. Comparison of Zn, Cu and Pb in the trees

Copper (ppm)	Zinc (ppm)	Lead (ppm)	species
10/24 c	24/73 b	3/51 c	Pine Tehran
15/35 ab	21/78 bc	6/08 bc	Cypress Shiraz
13/32 bc	24/72 b	6/46 abc	An ax head
10/27 c	27/57 ab	6/00 bc	Magnolia
16/42 ab	17/52 c	5/27 bc	Orange
12/85 bc	21/81 bc	7/50 ab	Buttonwood
19/09 a	23/88 b	5/96 bc	Palvnya
10/74 c	31/44a	9/87a	Ornamental Maple

The analysis of variance for the refined zinc, copper and lead for each element of the tree species showed that the species tree is significant at 95% confidence.(table 1) For both species of maple and ornamental, elements of Pb and Zn were the most and Cu was refined more by Palvnya (table 4).

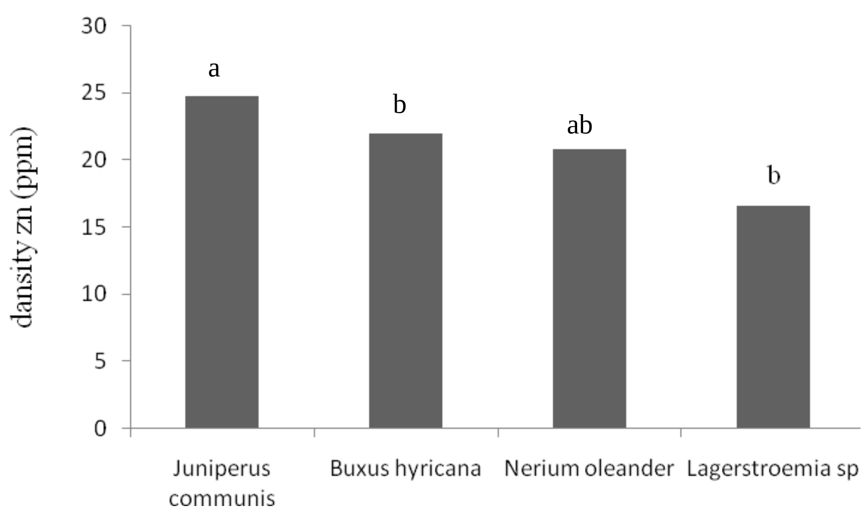

Figure 1: Comparison of Zn, Cu and Pb in shrub

The results showed that the refining of zinc, copper and lead are different between different species in unit weight of the leaf. The refinement of these elements in the same environmental conditions is mostly affected by genetic characteristics of the species. Sengupta *et al*, (2011) showed that even heavy elements are differently refined and some elements are more and some less refined. Maple hardwood and ornamental species, Palvnya had the maximum amount of refined copper, zinc and pine species of conifers Tehran, juniper and deciduous magnolia, refine these elements at the lowest level. Refinement of the heavy elements in leaf and crown regardless of conifers or deciduous or evergreen and deciduous species depend on the nature of the species. The sycamore and ash species showed that reductions in pollution from lead are more uptaken in the organs of sycamore than ash. (Khademi and Kord, 2010). Willow and birch species have more ability to refine than alder, ash and mountain ash. Mingorance *et al,* (2006) also showed that the species of Nerium oleander is presented as the indicators of air pollution in urban environments. Ali *et al,* (2004) also showed that the ability of a species to absorb heavy elements is different. With increasing the concentrations of these elements in the environment, the absorption rate is also increased. The results of the refinement of the elements copper, zinc and lead among different species of canopy and leaf canopy showed a significant factor in increasing the refinement of heavy elements. Tehran and Shiraz cypress pine cano had the highest levels of refinement and the types of lace, an ornamental maple and Shamshad have made the least amount of refinement. Results obtained with Beckett *et al,* (1998) showed that the greater the amount of pollution is consistent from heavy metals removal by coniferous to hardwood. Also, results of refined copper, zinc and lead between tree and shrub species showed better performance than tree species and shrub species in refinement of the elements. This result is the effects of species and the nature of the crown of shrubs. Among the shrub species such as conifers Juniperus showed better performance in comparison to broadleaf zinc in contamination of contaminants because it is higher in LAI than deciduous. The results are consistent with the result of Nowak *et al*, (2006) that removes greater amounts of urban air pollution by trees and shrubs and with the result of Beckett *et al,* (1998).

CONCLUSION

Refinement of Zn, Cu and Pb species depend on large canopy leaf area index. Tree species are more capable of refining of zinc, copper and lead than the shrub species. Among the species studied and refined for Pb and Zn, respectively, Cedar and pine Tehran and Shiraz Shiraz served to refine copper Palvnya with the best performance.

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