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Evaluation of "*Conocarpus erectus*" Plant as Biomonitoring of Soil and Air Pollution in Ahwaz Region

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Abstract: Effects of soil and atmosphere pollution on some heavy metals (Fe, Zn, Pb, Cu, Mn and Cd) concentration in Button-tree (*Conocarpus erectus*) leaves were studied in the city of Ahwaz (Khouzestan, Iran). Samples were collected from four sampling sites representing area of high traffic density, area future away from traffic and Industrial area. Samples were collected in two stages (May and October) in 2011 for chemical analysis. Samples from village near the city also analyzed for comparison. Based on the results, the stages of leaf sampling did not showed any significant effect on the concentration of the measured heavy metals in leaf samples. Chemical analysis of soil samples at depth of 0-10cm showed that concentration of most of these elements was lower than the maximum recommended levels. Concentrations of measured heavy metals in washed leaves were lower than those of unwashed leaves of Conocarpus and different was significant. In spite of that, there was no significant correlation between the concentrations of heavy metals in washed leaves and soil samples. Results of this assessment showed that the industry and traffic were the main source of air heavy metal pollution in Ahwaz and Conocarpus is a dependable biomonitor for air and soil pollution investigations.

Key words: Air pollution · Biomonitoring · Conocarpus · Heavy metals · Soil pollution

INTRODUCTION

Heavy metals are naturally present in soil; contamination comes from local sources, mostly industry, agriculture, waste incineration, combustion of fossil fuels and road traffic. Long-range transport of atmospheric pollutants adds to the metal load and is the main source of heavy metals in natural areas [1]. Plants interact with environment and thus, changes in the environment, like impaired air quality; can be mirrored in the physiological status of plants, for example, in the plant elements concentrations. In severe case, pollutants can cause visible plant injuries and, in some extreme cases, even plant death [2]. Environmental pollution has unpleasant changes on physical, chemical and biological characters of main sources such as water, air and soil which has dangerous effect in health and survival of human and other living organs or limit their activities [3]. Due to pollutant dangerous of living organs it is considerable to collect about its quality and quantity. One of the newest ways for determined amount and kind of environmental pollutants is natural biomonitoring. Recently, biomonitors mostly used for estimating air pollution but nowadays they use for estimating and measuring water and soil pollution [4]. Biomonitoring with plants is cheap and valuable method for studying effects of air and environmental pollutions [5]. Density of air pollution and collecting data for this aim could be helpful to find applied solution for air pollution controlling [6]. Earlier investigations have shown a positive relation between deposition of atmospheric pollutants and foliar concentrations of the same pollutants in ornamental plants [2]. In addition to anthropogenic factors, variation in the element composition in plants is influenced by, for instance, climatic factor causing temporal fluctuation [7]. Biomonitors were classified as active biomonitoring and inactive biomonitoring. Some plants grown in research areas used as inactive biomonitoring plants such as

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aborigine, Horticultural plants and Crops. Some of these plants used in last researches are poplar, pine, palm, silverberry, fig, ash, apple, birch, ailanthus, elder, oak and acacia. Leaves, bark and sometimes wood of them used for tracing the pollutions [8]. also some kinds of herbs used as inactive biomonitors [3]. Mosses and lichens used for studying air pollution. In addition fish and most other animals (especially aquatics) used for these researches [8]. In active biomonitoring, plants showed genetically reaction to air pollution were planted in research areas or collected from other unpolluted area and transferred there [9]. Pollutants disturb the ecosystems and heavy metals in low density (because of indissoluble and physiological effects on organism such as plants and animals) need more studies [10]. To determine air and soil pollution in some industrial and non-industrial areas of Ahwaz city by biomonitoring method, this research was done. In this research, evaluating the reliability of Button-tree leaves as biomonitor for some heavy metals such as Cu, Fe, Mn, Cd, Zn, Pb in high traffic area, industrial area and suburb area with inactive Biomonitoring method was studied.

MATERIAL AND METHOD

Study Area: The experiment was performed in four places in Ahwaz region to study the kind and density of soil and air pollutants.

The Treatments Were:

- Pasdaran boulevard (light traffic area and adequate green space)
- City center of Ahwaz (heavy traffic area of city)
- Khouzestan steel company area (Industrial zone)
- Mollasani and vaice area (very light traffic and as check place)

Methods: The leaves of Conocarpus and soil samples were all collected from different areas in May and October 2011. For determining amount of heavy metals in soil, 20 numbers of soil samples from 0 to 10 cm of soil surface from 4 zones were sample. The soil organic matter of samples was determined by Walkley-Black method (wet oxidation) [11]. In laboratory, pH of samples with using pH-meter (HORIBA F11) was determined [12]. Density of heavy metals measured by Atomic Absorption spectrophotometer (Perkinelmer 400). Conocarpus plant was selected as inactive biomonitoring and leaf sampling (in May and August) was done. In each zone, samples were taken from 5 trees randomly at their 4 sides and youngest leaves. Samples of each tree were mixed and divided into two equal parts, subsequently. On part was washed with distilled water for cleaned dust and matters and other part were remained intact. Vales of Fe, Zn, Pb, Cu, Mn and Cd were determined with Atomic Absorption spectrophotometer (Perkinelmer 400) [13].

Data Analysis: To determine important of leaf washing, T test was employed to compare the means of amount of heavy metals in washed and unwashed leaves on each zone. Also F test (ANOVA) was employed to compare the means of different places and heavy metal in washed leaves and soil. The required statistical calculations were carried out by SPSS software.

RESULT AND DISCUSSION

Soil Analysis: Means Comparison of some soil chemical characteristics and heavy metals are in Table 1. Soil pH is effective on amount of soluble and ability of absorption in rare metals such as heavy metals. Various kind of heavy metals, because of having various solubility on various pH, have different pattern on absorption, transfer to air organs and accumulation in plant organs specially in leaves [14]. Results shown that pH in all zones hasn't differentiation and all soils were in alkali soils class. Soil organic materials increase cation exchange capacity and make complex with heavy metals in soil area. Means of organic materials in research samples were between 0.23 and 0.61 %. Effects of organic materials and pH on bioavailability of heavy metals studied and results shown that increasing of pH and organic materials in soil decrease on bioavailability of heavy metals in the plants [15]. Lime exist in soil have effects on bioavailability of heavy metals [14]. Means of lime in four zones have significant differences and were 47.2, 45.9, 59.8 and 37.8 respectively. Amount of heavy metals such as Pb, Zn, Cd, Mn, Cu and Fe on soils of research zones were measured and results are in table 1. Comparison of means of Pb, Zn, Mn, Cu and Fe between research zones shown that City center of Ahwaz (heavy traffic area of city) has higher level of heavy metals and it shown significant variation. Source of major part of them in sample soil probably were corrosion of tire of vehicles, power fuel burning and traffic in this zone. Means of Manganese in studied zones were 337.500, 315.625, 359.375 and 265.625 mg/kg respectively. Between research zones, zone 3 (Steel company area) has highest and zone 4 (Mollasani and vaice area with light terrific) has lowest amount of Manganese. High amount

Table 1: Comparison of the means of heavy metals concentration (mg/kg) and some other soil properties

	Mean of Squares								
Zone	pH	O.M%	T.N.V%	Pb	Zn	Cd	Mn	Cu	Fe
Pasdaran Boulevard	7.58 b*	0.23 c	47.2 b	38.75 b	75c	3.025b	337.5 b	16.5b	9937.5a
Ahwaz City Center	7.61 b	0.61 a	45.9 b	137.5 a	175a	3.125a	315.62 b	32.2a	10600a
Steel Company	7.79 a	0.59 a	59.8 a	34.75 b	103.25 b	3.000b	359.375 a	16.2b	10350a
Mollasani and Vaice	7.60 b	0.46 b	37.8 c	23.00c	31.25d	2.775c	265.625 b	11.7c	7600a
Normal Values**	-	-	-	2-200	10-300	0.01-7	100-4000	2-100	50-500

(*: The similar data is non-significant in 1 and 5 percent of Duncan test) **Reference: *kabata-pendias (1994)*

Table 2:Comparison of the Means of Heavy Metals Concentration (mg/kg) in Conocarpus Leaves

	Fe	Mn	Cu	Zn	Cd	Pb
	ZONE					
Pasdaran boulevard	528b*	40 a	13.62 a	36 a	2.4 a	No Show
City center of Ahwaz	475b	41 a	11.5 a	33 a	2.85 a	No Show
Steel company area	1733a	67.5 a	18.85 a	38.5 a	3.2 a	No Show
Mollasani and vaice area	242c	69.25 a	12.23 a	18.5 b	2.25 a	No Show
Normal Value**	20-100	15-100	4-15	15-200	0.2-0.8	0.1-10
	SAMPLING TIME					
May	785.52 a	48.23 a	15.85 a	33.41 a	2.85 a	No Show
October	832.35 a	52.95 a	18.15 a	38.12 a	3.21 a	No Show
	TREATMENT					
Washed	275.46 b	46.21 a	10b	27.31 b	2.39 a	No Show
Unwashed	874.15 a	53.57 a	18.85a	37.78 a	2.73 a	No Show

(*: The similar data is non-significant in 1 and 5 percent of Duncan test) **Reference: kabata-pendias (1994)

of Cd in zone 3 was probably because of industrial sludge or transfer of factorial dust with wind. Results shown that amount of heavy metals in measured soil samples had recommended values except Mn and Fe. Variation of Fe and Mn in research areas hadn't significant differences but Pb, Zn, Cd, Cu and organic material in 1% and pH in 5% had significant differences. This research had shown that source of heavy metals in all research zones directly or indirectly related to human activities and classified as "pollution with human source".

Plant Analysis: The mean comparison of heavy metals (Pb, Zn, Cd, Mn, Cu and Fe) concentrations measured in washed and unwashed leaves in stage one (May) and stage two (October) in four separate zones are in Table 2. Iron is of the essential microelement for plants and plant couldn't complete its survival cycles without it. But high density of iron in plant had a toxicity effects. Its recommended value in plant issue is about 50-500 mg/kg and critical value in some plants is 50 mg/kg [14]. Iron is released by combustion process of fossil fuels and an important part in fly ashes [16]. Thus, both Fe and Cu are easily transported via air and deposited on plant surfaces. Other sources of Fe are soil dust and asphalt. Result shown that density of Iron in washed and unwashed leaves were difference and is lower on washed leafs. This result shown that all of deposit Iron on leaves hadn't enough time for absorbed by this organ and partial of it with soluble iron content in soil, absorbed by plants. Also mean of density in both stage were similar. Mean squares of sampled plants had significant difference at 1% levels of probability. Density of iron in all zone were higher than recommended value (150 mg/kg) [3]. Maximum value of Iron density was in Steel company area (1733mg/kg) and minimum value was in Mollasani and vaice (242 mg/kg). Researches shown that density of Iron in soil and plant in industrial and heavy terrifically areas were higher than recommended values. As an essential element, iron was used by special enzyme and protein in respiration and photosynthesis reactions. Iron was also reported as the accumulation factor in photosynthesis associated with accumulation of iron in chloroplasts [17]. Iron is one of the principal elements in the earth crust. The high values of iron detected in this study may be partly due to the absorption from soil by the roots of plants [18]. Manganese is of the microelement, essential for plants.

Iron and manganese oxides play an important role in the soil in fixing trace elements such as cobalt, copper, zinc and nickel as well as pollutants like lead.The association of these elements with manganese and iron in soils has important implications for agriculture and plant growth in general. The toxicity of Mn is commonly associated with acidic soils and warm climates. Recommended value in plant issue is about 100-500 mg/kg. Critical values of Mn in most of the plants 200-300 mg/kg were reported [14]. Research zones hadn't significant differences also mean values of Mn in leaves in all zone were under recommended value. Main source of Mn existing in air and soil was skid [5]. Copper is of the microelement that is essential for plants. About 70% of Copper in leaves contained in the chloroplast of land plants [19]. Amount of copper in the atmosphere is usually related to traffic density, since it is produced by tire and broke shoe abrasion [15]. Recommended value of it in plant issue is about 5-30 mg/kg and more than 20-30 mg/kg have toxicity effects in plants [14]. Mean squares of Copper in all research zones hadn't significant difference and compactness of Copper in two steps of sampling was approximately same (Table 1). Means of density in stage one and two were near-by each other's But values were more than 10 mg/kg [3].Maximum value of pollution was in Steel company area (18.85 mg/kg) afterward Pasdaran Boulevard had high Cu density (13.62 mg/kg). This research had similar result comparing other researches that shown source of copper pollution in air were oil oxidation, corrosion of tire of vehicles and industrial wastage [5].Zinc is an essential microelement in all organism and play an important role in the biosynthesis of auxins, enzymes and some proteins that are essential for plants and plant with symptoms of Zn deficiency experiences a retarded elongation of cells [20]. Recommended value in plant issue is about 20-100 mg/kg. Critical value of Zn in most of the plants 15 mg/kg was reported [14]. Mean squares of Zn in four research zones at 1% levels of probability had significant differences. But in two steps of sampling were approximately same in additional amount of Zn in leaves in research zones, were below of recommended values (Table 1). Therefore, pollution in research areas hadn't seen. Cadmium is an especially mobile element in the soil and is taken up by plants primarily through the roots. Decisive for transfer into plants are cadmium levels, pH values and humus levels that determine cadmium levels in the soil solution and there by the plants availability to cadmium [21]. Mean amounts of Cd in all of four research zone were more than Recommended Values [14]. (table2).Researcher reported that amount of Cd in plant is 0.1-1 mg/kg. Also plant and animals are needless from this element [5]. Lead is available to plants from soil and aerosol sources. Amount of Pb in most of leaf samples under study in this research, were below the level of machine detection. Recommended value of it in soil and plant were 30-189 and 30-300 mg/kg respectively [22]. Several researches reported that density of Pb in soil had significant relation with amount of traffic [5, 22].

The Influence of Leaves Washing: The ability to distinguish airborne and soil borne contamination was assessed by washing the leaves. A comparison of the amount of metal extracted from unwashed with that from washed leaves (Table 2). The results given in table 2 indicated that removal of the metals from the leaves by washing was significantly different depending on the pollutant level as the sampling sites and there was substantial aerial deposition on the leaves for all four, which were removed by washing procedure. Metal concentrations are affected by washing, which can remove different amounts of pollutants, but this varies according to the species and physical and chemical characters of pollutants. Some studies have demonstrated that washing does not affect some elements such as Zn concentration. However, other investigations showed that Zn can be eliminated by washing [23]. This suggests that the effect of washing varies from one species to another. In this study, washing the leaves significantly reduced the Zn, Cd, Cu and Fe concentrations in conocarpus from all sites (as indicated by t- test results). It was not possible to compare washing effects for Pb because most values for this element were below detection limits. As Manganese is not an important component of adhering dust washing does not make any significant difference. In some cases, including the control sample, there is an even higher concentration in washed than in unwashed samples but in this study, unwashed leaves have higher amount of Manganese than washed leaves.

The main reason of high concentrations of heavy metals in plants localized in industrial areas and in urban roadsides are the industrial activity and density of the traffic. Nonetheless, results of this study that Conocarpus leaves is not a reliable biomonitor for heavy metals such as Cu, Mn, Cd and Pb in the urban area, since Conocarpus seems not to retain in amounts, high enough to relate to their variation within different impact zones. Therefore, using bark of Conocarpus same as leaf for tracing air pollution need more exact. In view of the fact that content of metals in serious part of plant had significant differences, hence, using bark and leaf together for tracing heavy metals in air, Because of directly exposed to air, had suggested. Exclusive of Conocarpus that is broad leaved, some of narrowed leaved plants such as pine because of their thick and rough bark are suitable for biomonitoring. This idea need more research in future.

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