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The pollution of tree leaves with heavy metal in Syria

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Abstract: Cupressus sempervirens, *Ligustrum ovalifolium* and *Euonymus japonicus* (ever green) needles were evaluated as the possible biomonitors of heavy metal air pollution in Damascus (Syria). The needles were sampled from three sites with different degrees of metal pollution (near roads). The concentrations of Pb, Zn, Cr, Cd, Co, Ni, and Cu were measured by using a flame atomic absorption spectrophotometer. The maximal values of these metals were found in *Ligustrum ovalifolium* in site 1. Furthermore, sites with high traffic density and frequency of cars stoppage showed high heavy metal concentrations. However, the comparison of concentrations of all metals showed that the zinc and lead had the highest concentration of all. Cupressus sempervirens, *Ligustrum ovalifolium* and *Euonymus japonicus* can be successfully applied in biomonitoring of air pollution.
Key words: Cupressus sempervirens, *Ligustrum ovalifolium* and *Euonymus japonicus*, pollution, heavy metal.

Introduction

The metals are classified as “heavy metals” if in their standard state they have a specific gravity of more than 5 g/cm3. There are known sixty heavy metals. Heavy metals get accumulated in time in soils and plants and could have a negative influence on physiological activities of plants (e.g.photosynthesis, gaseous exchange, and nutrient absorption), determining the reductions in plant growth, dry matter accumulation and yield [1,2]. In small concentrations, the traces of the heavy metals in plants or animals are not toxic [3]. Lead, cadmium and mercury are exceptions; they are toxic even in very low concentrations [4].

Heavy metal pollution represents an important environmental problem due to toxic effect of metals, and their accumulation throughout the food chain leading to serious ecological and health problems. In developing countries an estimated 0.5-1.0 million peoples die prematurely each year as a result of exposure to urban air pollution [5]. The emission of toxic substances into the environment has spread mainly from industrialized countries. However, many industrial plants and especially road traffic may emit heavy metals into the atmosphere. LEYGONIE [6] noted that, fossil fuels contain many kinds of heavy metals which are emitted during the combustion of those fuels. Furthermore, the wear of auto tires, degradation of parts and especially paint, and metals in catalysts are all suspected.

[7,8,9,10,11] Generally, traffic related pollutants include toxic metals like lead, cadmium, copper and zinc [12]. On the other hand, some trace metals are essential in plant nutrition, but plants growing in a polluted environment can accumulate them at high concentrations [13,14].

The first attempts for (in the early 1960s) biomonitoring and assessment of environmental pollution coming from exhaust gases of automobiles in road traffic were based on the analyses of different trees, grasses and vegetables that grow near highways and in the cities. Since then phytomonitoring is increasingly used as an alternative to the traditional methods, for studying the regional deposition of natural and anthropogenic pollutants from the atmosphere to the terrestrial environment [15,16,17] An advantage of plants as biomonitors is that they are effective collectors which reflect the summarized effect of environmental pollution and accumulation of toxicants from the atmosphere (deposition, binding and solubility of metals on the leaf surface)[18,19].

Recently, different bio-indicators are used in monitoring of the air pollution especially in urban areas. Botanical materials such as fungi, lichens, tree rings and leaves of higher plants have been used to detect pollution level [20]. The use of higher plants, especially different parts of trees, for air monitoring purpose is becoming more and more widespread. Tree leaves have been widely used as indicator of atmospheric pollutions [21,22], and they are effective alternatives to the more usual monitoring methods, including mosses and lichens. Trees are long-lived organisms, which can take up trace elements from the soil, water, or air, and retain them for a long time [23]. However, the foliage of tree species from contaminated regions can be considered as an accumulation monitor where significant amount of chemical elements is cumulated on the leaf surface [24,25,26]. The aim of this study is to determine the Pb, Cd, Cu,Zn, Ni, Co and Cr concentrations in leaves of Cupressus sempervirens, *Ligustrum ovalifolium* and *Euonymus japonicus* (ever green) were taken from trees growing at urban areas of Damascus(Syria) .

Materials and Methods

Experimental Site

The study area is Damascus, the capital of Syria , has a continental climate in which the winters are cold and the summers are dry and hot. The mean traffic density in the streets with heavy, medium and low traffic.

Samples

Samples of Cupressus sempervirens, *Ligustrum ovalifolium* and *Euonymus japonicus* leaves (ever green) were taken from trees growing at urban areas of Damascus (Albramicka, Site1, city center areas exposed to heavy vehicular traffic, and with dense populations ,Almazh, Site2, 6K west from city center, has medium level vehicular, Alsbabahrate, Site3, 4K east from city center, has medium level vehicular, in two seasons, February and July. Each leaf was picked on the side of the crowns facing heavy traffic streets at about 5 m from the street. The samples were collected in clean cellulose bags separately and were brought to the laboratory on the same day. The leaves were prepared without washed with water, dried at 60ºC, powdered and dried again at110 ºC to constant weight (to remove moisture)**[27].**Then the dried sample after charing, was heated in a furnace for 4h at 550oC [28]. The contents of china dish were cooled in desiccator and 2.5 mL 6M HNO3(65% - Merck- Germany) was added into the dish to dissolve its contents(Digestion procedure) [29]. The solution was filtered and transferred to a 25 mL flask and diluted to the mark [30].Estimation of heavy metals was carried out on flame atomic absorption Spectrophotometer [FAAS] (Varian SpectrAA-55 model).

Calibration of Equipment

Concentrations of Pb, Zn, Cu, Cd, Co, Cr, and Ni were determined by atomic absorption spectroscopy using the Spectra (AA 55 Varian). For the elements under investigation we established the following sensitivity and detection limits respectively of the used FAAS apparatus Pb 0.2 and 1.0 ppm, Cr 0.5 and 3.0 ppm, Cd 0.2 and 1.0 ppm, Cu 0.5 and 3.0 ppm , Zn 0.05 and 5.0 ppm, Co 1.0 and 5.0 ppm, Ni 0.5 and 4.0 ppm.

Results and Discussion

The heavy metals are introduced into the environment through so many sources which include, decomposition of fossil fuels, smelting, glazing, electroplating, **density of traffic** [31, 32]. Some heavy metals like Cd and Pb have been reported to have noknown bio-importance in human biochemistry and physiology and consumption even at very low concentrations can be toxic [33, 34].The chemical analysis revealed a significant difference in Pb, Zn, Cu , Cd, Cr, Co and Ni concentrations in needles samples collected from different sites[35]. This can be attributed to the different traffic density between the three sites (Table 1,2, Figure 1,2). According to SRINIVAS [36] atmospheric metals are deposited on plant surfaces by rain and dust. On the other hand, airborne pollutants can retain on leaf surfaces and some elements could enter via the stomata and accumulate in leaf tissues.

Table 1. Heavy metal contents (ppm ± SD) in plant in February .

Site	plant	Ni	Co	Cd	Cr	Zn	Cu	Pb
Site 1	*Ligustrum ovalifolium*	**0.430±0.11**	**4.260±1.23**	**0.333±0.12**	**2.530±1.0**	**50.359±1.67**	**7.872±1.23**	**7.120±1.09**
	Euonymus japonicus	**0.249±0.121**	**3.676±1.02**	**0.166±0.056**	**0.401±0.141**	**44.500±1.28**	**5.018±1.04**	**6.251±1.33**
	Cupressus sempervirens	**0.196±0.097**	**1.648±0.891**	**0.061±0.013**	**0.211±0.089**	**30.651±1.03**	**3.824±1.0**	**4.694±1.11**
Site 2	*Ligustrum ovalifolium*	**0.334±0.102**	**3.246±1.09**	**0.208±0.088**	**2.007±1.01**	**40.371±1.1.54**	**6.271±1.23**	**6.083±1.72**
	Euonymus japonicus	**0.207±0.10**	**2.259±0.977**	**0.149±0.086**	**0.351±0.10**	**25.689±1.11**	**4.389±1.05**	**5.174±1.06**
	Cupressus sempervirens	**0.135±0.096**	**1.403±0.994**	**0.010±0.0**	**0.101±0.085**	**16.542±1.32**	**3.752±1.10**	**4.161±1.24**
Site 3	*Ligustrum ovalifolium*	**0.319±0.131**	**3.108±1.21**	**0.174±0.093**	**1.616±0.90**	**38.271±1.90**	**6.052±1.22**	**5.335±1.11**
	Euonymus japonicus	**0.211±0.099**	**2.481±0.999**	**0.116±0.078**	**0.120±0.087**	**22.060±1.04**	**4.253±1.07**	**4.500±1.04**
	Cupressus sempervirens	**0.110±0.087**	**1.028±0.953**	**0.030±0.013**	**0.068±0.020**	**13.351±1.081**	**2.659±1.42**	**3.467±1.22**

Table 2. Heavy metal contents (ppm) in plant in July .

Site	plant	Ni	Co	Cd	Cr	Zn	Cu	Pb
Site 1	*Ligustrum* ovalifolium	**0.434±0.140**	**4.798±1.22**	**0.373±0.162**	**2.998±1.001**	**50.412±2.12**	**8.684±0.997**	**7.666±0.544**
	Euonymus japonicu	**0.264±0.088**	**3.993±1.09**	**0.158±0.055**	**0.658±0.230**	**48.560±2.033**	**5.590±1.003**	**6.910±0.534**
	Cupressus sempervirens	**0.177±0.096**	**1.850±0.056**	**0.083±0.026**	**0.298±0.044**	**31.090±1.910**	**4.444±0.999**	**4.837±0.662**
Site 2	*Ligustrum ovalifolium*	**0.352±0.996**	**3.824±1.043**	**0.250±0.098**	**2.115±1.010**	**43.689±1.45**	**6.754±1.011**	**6.750±0.989**
	Euonymus japonicus	**0.273±0.10**	**2.828±1.01**	**0.191±0.035**	**0.513±0.102**	**28.949±1.11**	**4.448±0.996**	**5.983±0.557**
	Cupressus sempervirens	**0.140±0.091**	**1.918±0.078**	**0.072±0.020**	**0.211±0.088**	**18.045±1.088**	**3.900±0.992**	**4.642±0.565**
Site 3	*Ligustrum* ovali*folium*	**0.337±0.102**	**3.556±1.20**	**0.183±0.032**	**1.849±0.732**	**38.789±1.32**	**6.906±1.001**	**5.770±0.761**
	Euonymus japonicus	**0.238±0.069**	**2.979±1.024**	**0.125±0.089**	**0.240±0.066**	**24.215±1.070**	**4.640±0.0778**	**4.854±0.721**
	Cupressus sempervirens	**0.114±0.095**	**1.621±0.840**	**0.066±0.022**	**0.089±0.010**	**14.093±1.202**	**2.800±0. 989**	**9.950±0.743**

However, comparison of concentrations of all metals showed that the zinc one had the highest concentration of all. The average highest value of Zn (50.412 ppm) were detected in *Ligustrum ova*lifoliu*m* collected from site 1 in **July**, whilst the lowest (13.351 ppm) was measured in Cupressus sempervirens collected from the site3 **in February** . It was observed that the second highest values were found in *Euonymus japonicus*collected from site 1in **July** (48.560 ppm). The environmental pollution of Zn greatly influences the concentrations of this metal in plants [36]. Zn arises mainly from atmospheric deposition and could also be derived from vehicular traffic[37]. Zinc levels can be enhanced in automobile exhaust, may be elevated near roadways due to tire wear. On the other hand, zinc is an essential element for plants and is considered as an important factor in the biosynthesis of enzymes, auxins and some proteins. But when their concentrations reach a certain level, they become toxic to plants and reports produce various physiological and biochemical changes in plants. A critical toxic level of Zn in the leaves is about 100ppm [38,39]. According to these values, the **sampling locations** Zn concentrations found in our study are smaller than the normal limits. Therefore, it can be supposed that all the three sites studied were un polluted with Zn.

The Pb concentrations were the highest in *Ligustrum ova*lifoliu*m* at site1 in July (7.666 ppm), and the lowest in Cupressus sempervirens collected from the site3 **in February** (3.467 ppm), whereas the second highest value was found in*Euonymus japonicus* at site 1 in July (6.910 ppm). Lead pollution on a local scale is caused by emissions from vehicles using leaded gasoline [39,40,41]. Lead is known as a deadly and cumulative poison even when consumed in small quantities and is capable of deadening nerve receptors in man [41]. The relationship between lead concentrations and traffic intensity has been demonstrated in detail by many authors [42,43,44]. ALLEN [45] considered that the normal content of Pb in plants is less than 3ppm. In general, Pb concentrations in vegetation grown in industrial and urban areas have increased in recent decades owing to human activities and road traffic. According to our results, there is lead pollution in all samples in all sites.

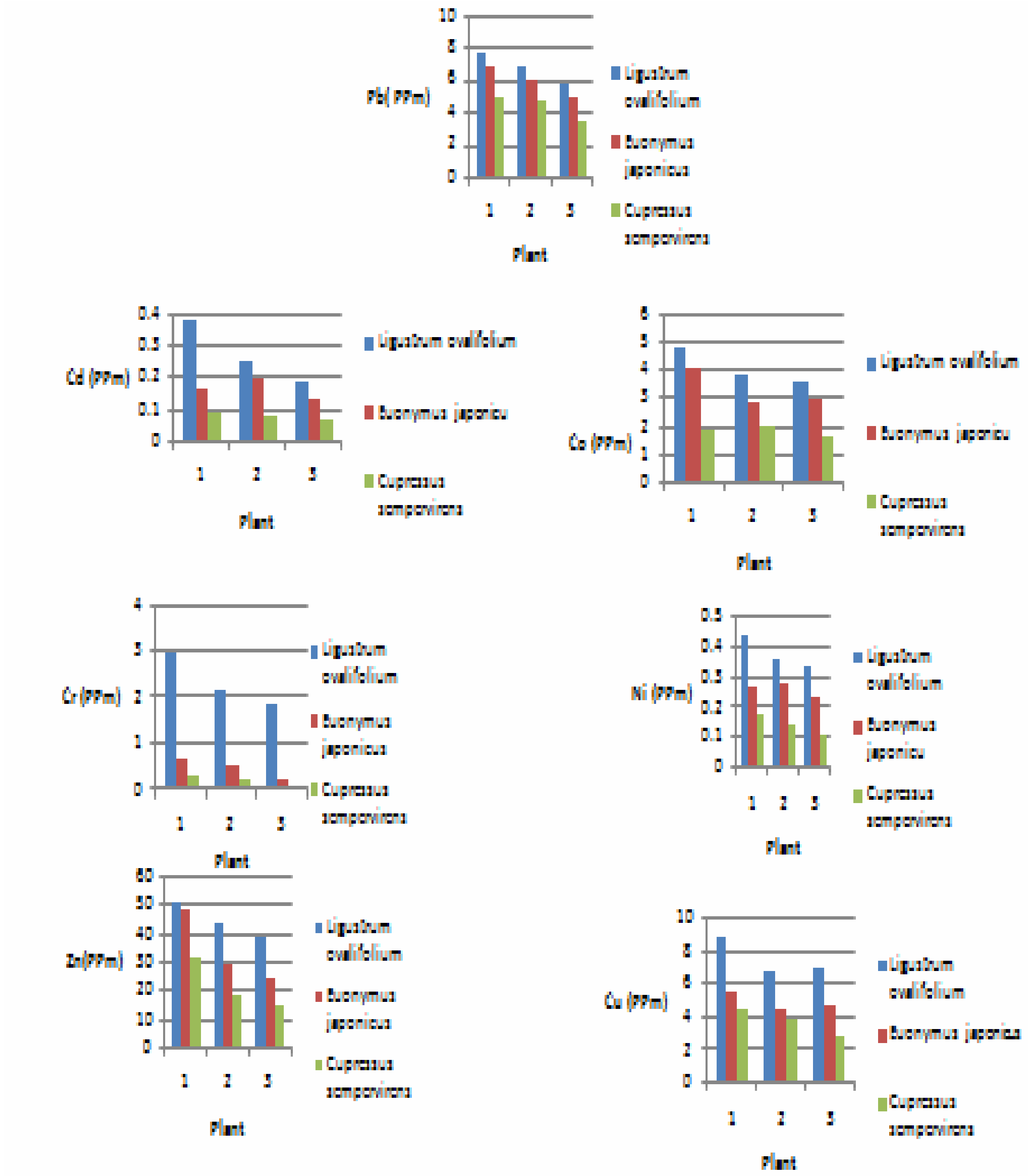

Figure 1 . Heavy metal contents (ppm) in plant in February.
(1:Site 1 , 2: Site 2 , 3: Site 3)

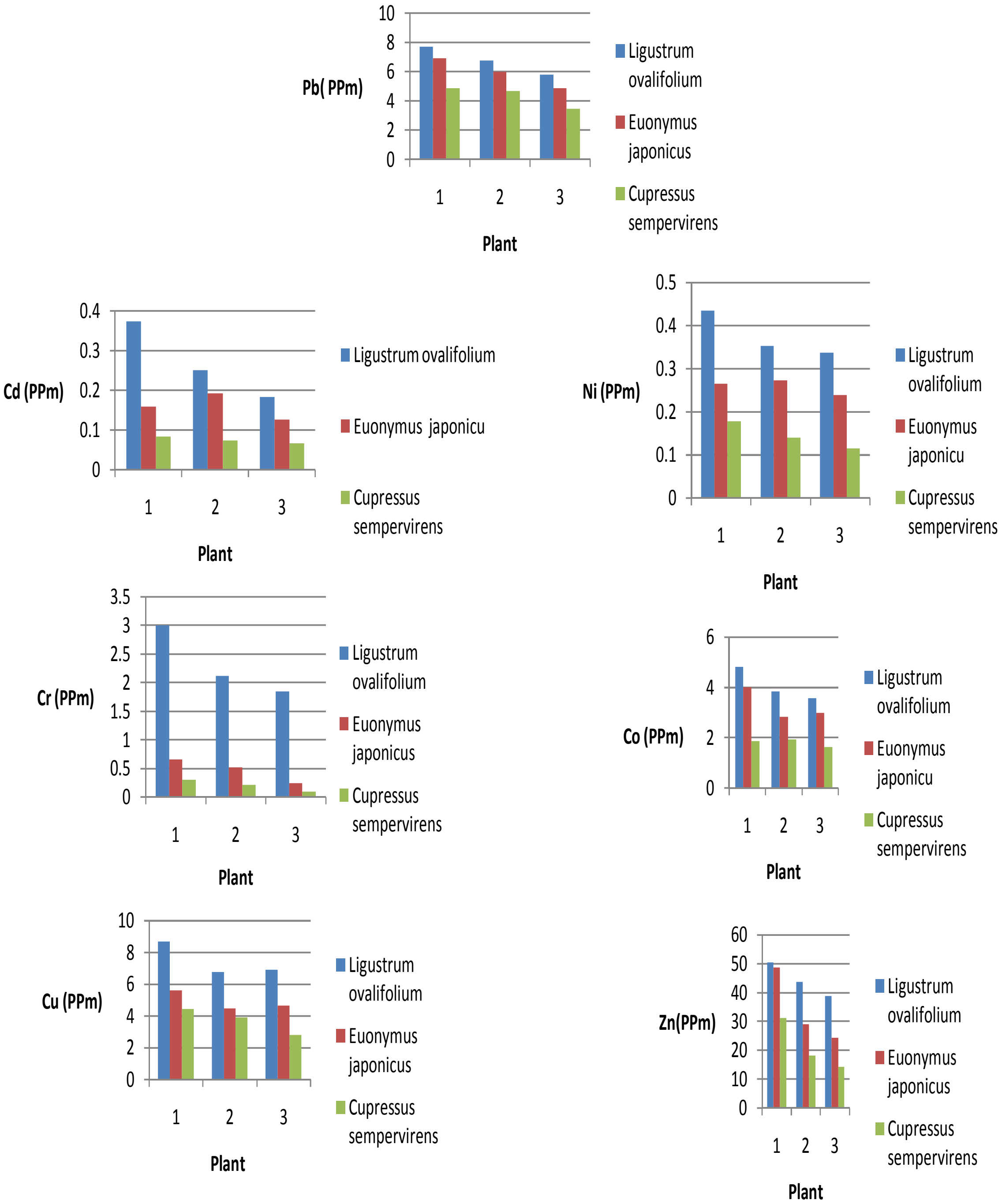

Figure 2 . Heavy metal contents (ppm) in plant in July.
(1:Site 1 , 2: Site 2, 3: Site 3)

The average highest value of Cu (8.684 ppm) was found in *Ligustrum ova*lifoliu*m* in July at site1, whilst the lowest ((2.659 ppm) was measured inCupressus sempervirens collected from the site3 **in February**. Copper is an important component for many enzymes, which catalyze oxidation and reduction reactions. The main sources of Cu are home tools production, metal manipulating, road traffic and ashes [46]. KABATA-PENDIAS & PIOTROWASKA [47] reported that the normal content of Cu in plants ranges to be 2-20 ppm, but in most cases it is in a narrower range of 4-12 ppm. According to these values, the Cu concentrations found in this study are near the normal limits. The average highest value of nickel (0.434ppm) was found in *Ligustrum ova*lifoliu*m* in July collected from site 1, whereas the lowest mean value was determined in inCupressus sempervirens in February at site 3(0.110ppm). It was observed that the second highest values were found in *Euonymus japonicus* collected in July collected from site 1 (0.264ppm). These results indicate that the origin of nickel in the investigated locations is related to vehicular traffic. Ni is essential element for plants in low concentrations and is absorbed easily and rapidly by them [48].According to AL-SHAYEB & SEAWARD[49] the highest concentrations of nickel are attributed to emissions from motor-vehicle that use nickel gasoline and by abrasion and corrosion of nickel from vehicle parts.

Co content in the leaves of all the sampling places was much higher than the critical limit value [50], the toxic level in plant is about 0.5 ppm [51]. Our results show that the investigation area runs a risk of Co pollution in all samples. The maximum chromium value (2.998 ppm) in this study was found in *Ligustrum ova*lifoliu*m* samples collected from Site 1 in July (Table 2). It is lower than Critical levels of Cr for the plants (5-10 ppm) [52], (0.006-18 ppm) [53].The main source of nvironmental Cr pollution Mining, industrial coolants, chromium salts manufacturing, leather tanning ,lead acid batteries, paints, E-waste, Smelting operations, coal- based thermal power plants, ceramics, bangle industry [54].

Our findings for Cd in the leaves samples showed higher levels and there is risk from cadmium in the investigation area. The samples have higher Cd content than critical levels for plants (0.05 ppm; [55]). The results showed that there was cadmium pollution in plants, main source of environmental Cd pollution is the ferrous-steal industry. In addition, vehicle wheels, mineral oils and usage of waste mud may introduce cadmium into the soil and this increases Cd levels of the plants [56,57].

Conclusion

The results of this study show that the highest and the lowest concentrations of Pb, Cu, Zn,Co, Cr,Cd and Ni were found near the road. This indicates that the vehicular traffic has been major source of heavy metal contamination in urban areas. Tree leaves have been widely used as indicator of atmospheric pollutions. Atmospheric metals are deposited on plant surfaces by rain and dust. On the other hand, airborne pollutants can retain on leaf surfaces and some elements could enter via the stomata and accumulate in leaf tissues.

References

1 Devkota, B.; Schmidt, G.H. Accumulation of heavy metals in food plants and grasshoppers from the Taigetos Mountains, Greece. Agriculture, Ecosystems and Environment 2000, 78(1), 85-91.5.

2 Baker, A.J.M. Accumulator and excluders: Strategies in response of plant to heavy metals. J. Plant.Nutr. 1981, 3, 643-654.

3 De Vries, W.; Romkens, P.F.; Schutze, G. Critical soil concentrations of cadmium, lead, and mercury in view of health effects on humans and animals. Reviews of Environmental Contamination and Toxicology 2007, 191, 91-130.

4 Galas-Gorchev, H. Dietary Intake of Pesticide Residues: Cadmium, Mercury and Lead. Food Add. Cont. 1991, 8, 793-806.

5 KOJIMA M.L. 2001. Urban air quality management. World Bank, Washington D.C.

6 LEYGONIE R. 1993. Heavy metals in the atmosphere: sources, emissions, measurement, effects. - Pollution Atmospherique, 35: 63-74.

7 SADIQ M., I.ALAM, A. EL-MUBAREK, H.A. AL-MOHDHAR. 1989. Preliminary evaluation of metal pollution from wear of auto tires. - Bulletin of Environmental Contamination and Toxicology, 42: 743-748.

8 WEI C., M. MORRISON. 1994. Platinum in road dust and urban river sediments. - The Science of the Total Environment, 146/147: 169-174.

9 MONACI F., F. MONI E. LANCIOTTI D. GRECHI R. BARGAGLI. 2000. Biomonitoring of airborne metals in urban environments: New tracers of vehicle emissions, in place of lead. - Environmental Pollution, 107: 321-327.

10. OZAKI I., I. WATANABE. K. KUNO. 2004. As, Sb and Hg distribution and pollution sources in the roadside soil and dust around Kamikochi, Chubu Sangaku National Park, Japan. -Geochemical Journal, 38: 473-484.

11. SUZUKI K., T. YABUKI Y. ONO. 2009. Roadside leaves as bioindicators of heavy metal pollution in traffic areas of Okayama, Japan. – Environmenta Monitoring and Assessment, 149: 133-141.

12. VIARD B., F. PIHAN, S. PROMEYRAT, C. PIHAN. 2004. Integrated assessment of heavy metal (Pb, Zn, Cd) highway pollution: bioaccumulation in soil, Gramineae and land snails. – Chemosphere, 55: 1349-1359.

13. HOVMAND M.F., J.C. TJELL H. MOSBAEK. 1983. Plant uptake of airborne cadmium. - Environmental Pollution, 30: 27-38.
14. HUCKABEE J.W., F. SANZ DIAZ S.A. JANZEN J. SOLOMON. 1983. Distribution of mercury in vegetation at Almaden Spain. - Environmental Pollution, 30: 211-224.
15. ALLOWAY B.J. 1990. Heavy metals in soils. Blackie Academic & Professional, Glasgow, 339 p.
16. VOUSTA D., A. GRAMANIS C. SAMARA. 1996. Trace elements in vegetables grown in an industrial area in relation to soil and air particulate matter. - Environmental Pollution, 94: 325-335.
17. SHARMA O., P. BANGAR, K.S. RAJESH JAIN, P.K. SHARMA. 2004. Heavy metals accumulation in soils irrigated by municipal and industrial effluent. - Journal of Environmental Science and Engineering, 46(1): 65-73.
18. PACHECO A.M.G., M.C. FREITAS, L.I.C.BARROS, R. FIGUEIRA. 2001. Investigating tree bark as an air pollution biomonitor by means of neutron activation analysis. - Journal of Radioanalytical and Nuclear Chemistry, 249(2): 327-331.
19. DOGAN Y., N. DURKAN, S. BASLAR. 2007. Trace element pollution biomonitoring using the bark of Pinus brutia (Turkish red pine) in the Western Anatolian part of Turkey. - Trace Elements and Electrolytes, 24: 146-150.
20. HUSEYINOVA R., H. G. KUTBAY, A. BILGIN, D. KILIÇ, A. HORUZ, C. KIMANOGLU. 2009. Sulphur and some heavy metal, contents in foliage of Corylus avellana and some roadside native plants in Ordu Province, Turkey. – Ekoloji, 18(70): 10-16.
21. KOVÁCS M. 1992. Trees as biological indicators. – In: Kovacs M. -18(Ed.)Biological indicators in environmental protection, New York, Ellis Harwood, pp. 207.
22. PETROVA S. 2011. Biomonitoring study of air pollution with Betula pendula Roth., Plovdiv, Bulgaria. - Ecologia Balkanica 3(1): 1-10.
23. MANKOVSKÁ B., GODZIK O B., and SHPARYK P M.2004. Chemical and morphological characteristics of key tree species of the Carpathian Mountains. -Environmental Pollution, 130(1): 41-54.
24. MADEJÓN P., T. MARAÑÓN, J.M. MURILLO. 2006. Biomonitoring of trace elements in the leaves and fruits of wild olive and Holm oak trees. - Science of the Total Environment, 355(1-3): 187-203.
25. Lakhdari A,and Benabdeli K. Determining the Heavy Metal Pollution in Mascara (Algeria) by Using Casuarina equisetifolia .Ecologia Balkanica http://eb.bio.uni-plovdiv.bg Union of Scientists in Bulgaria – Plovdiv University of Plovdiv Publishing House.ECOLOGIA BALKANICA- 2012, Vol. 4, Issue 1.
26. Ioan S, Constantin C, Mihai Tand Sorana D. 2008.Analysis of Soil Heavy Metal Pollution and Pattern in Central Transylvania.Int. J. Mol. Sci. 9, 434-453.
27. Onder1 S. , Dursun S., and Gezgin A. Determination of Heavy Metal Pollution in Grass and Soil of City Centre Green Areas (Konya, Turkey). Polish J. of Environ. Stud. Vol16, No. 1.2007. 145-154.
28. Toma. M , ord-evic D, Tasic J, and Krstic V.2004. Heavy metals accumulation in tree leaves from urban areas.Environ Chem Lett . 2:151–154.
29. Manzoor Iqbal K And Rukhsana J. 2012. Detection of Heavy Metals in Leaves of Melia Azedarach And Eucalyptus citriodora as Biomonitring Tools in the Region of Quetta Valley.Pak. J. Bot., 44(2): 675-681.
30. Iqbal H,Khan B. M. and Naveed A. 2008.PROFILE OF HEAVY METALS IN SELECTED MEDICINAL PLANTS. Pak. J. Weed Sci. Res. 14(1-2): 101-110.
31. Alloway BJ, Ayres DC (1997). Chemical principles of environmental pollution, Second Edition, Blackie Academic and Professional,Chapman and Hall, London, pp. 190 -216.
32. Robert M.H. (1997), Encyclopedia of Physical Science and Technology, Academic Press Inc. New York p. 13.
33. European Union (2002). Heavy metals in wastes, European commission on environment (http://ec.europa.eu/environment/waste/studies/pdf/ heavy_metalsreport.pdf).
34. Nolan K .2003. Copper toxicity syndrome, J. Orthomol. Psychiatry 12(4): 270-282.
35. Yahaya M, Ezeh G .C, MusaY. F. and S. Y. Mohammad S.Y.2010. Analysis of heavy metals concentration in road sides soil in Yauri, Nigeria .African Journal of Pure and Applied Chemistry Vol. 4(3), pp. 022-030.Available online at http://www.academicjournals.org/ajpac.

36. SRINIVAS N. S. RAMAKRISHNARAO K. and SURESH KUMA R. 2009. Trace metal accumulation in vegetables grown in industrial and semi-urban areas. A case study.- Applied Ecology and Environmental Research, 7(2):131-139.
37. CONTI M E., PINO B.,and BOCA A. 2008. Lichen Usnea barbata as a biomonitor of airborne elements deposition in the Province of Tierra del Fuego (southern Patagonia, Argentina)- Ecotoxicology and Environmental Safety, 72: 1082-1089.
38. ALLEN S.E., H.M. GRIMSHAW J.A. and PARKINSON C. 1974. Chemical analysis of ecological materials. Blackwell Scientific Publications. Oxford, London, 565 p.
39. YILMAZ S.,and ZENGIN M . 2004. Monitoring environmental pollution in Erzurum by chemical analysis of Scots pine (Pinus sylvestris L.) needles. - Environment International, 29(8): 1041-1047.
40. VIARD B. F., PIHAN S. and PROMEYRAT C. 2004. Integrated assessment of heavy metal (Pb, Zn, Cd) highway pollution: bioaccumulation in soil, Gramineae and land snails. – Chemosphere, 55: 1349-1359.
41. KOEPP D. E. 1981. Lead: understanding the minimal toxicity of lead in plants. - In: LEPP N. W. (Ed.), Effect of heavy metal pollution on plants. Effects of trace metals on plant function. Applied Science Publishers, London, pp. 55-76.
42. NWAEDOZIE J. M. 1998. The determination of heavy metal pollution in fish samples from River Kaduna. - Journal of Chemical Society of Nigeria, 23: 21-23.
43. GROMOW S. and EMELINA E. 1994. Lead emission evaluation over the European part of the former Soviet Union. - The Science of the Total Environment, 158: 135-137.
44. LI X C and POON P L . 2001. Heavy metal contamination of urban soils and street dusts in Hong Kong. - Applied Geochemistry, 16: 1361-1368
45. ALLEN S.E. 1989. Chemical analysis of ecological materials (second edition). Blackwell Scientific Publications, Oxford, London.
46. AKSOY A., DEMIREZEN. F and DUMAN A. 2005. Bioaccumulation, detection and analyses of heavy metal pollution in Sultan Marsh and its environment. - Water Air Soil Pollution, 164 (14): 241-255.
47. KABATA-PENDIAS A.,and PIOTROWASKA M. 1984. Zanieczyszczenie Glebi Roslin Uprawnych Pierwiastkami Sladowymi. CBR opracowanie problemowe, Warsazawa, Poland.KOVÁCS M. 1992. Trees
48. GUNES A.,and ALPASLAN A M. 2004. Plant growth and fertilizer. Ankara university. Agriculture Publications N° 1539, Ankara.
49. AL-SHAYEB S.M.,and SEAWARD M. R. D. . 2001. Heavy metal content of roadside soils along ring road in Riyadh (Saoudi Arabia). - Asian Journal Chemistry, 3: 407- 423.
50. RO BSON, A. D., DI LWOR TH, M. J.,and CHATEL, D. L.,Cobalt and Nitrogen Fixation in Lupinus angustifolius L. I.Growth Nitrogen Concentrations and Cobalt Distribution.New Phytol. 83, 53-62, 1997.
51. Pendia S. K., And Pendia S, H. Trace elements in soil and plant. CRC Press. Boca Raton. 1992.
52. ÇIÇEK, A.and KO PARA L A.S. Accumulation of sulphur heavy metals in soil and tree leaves sampled from the surroundings of Tunçbilek Thermal Power Plant. Chemosphere, 57, 1031-1036, 2004.
53. SHANKER A.K., CER VAN TES C. LOZA -TAVERA , H. and AVUDAINAYA GAM, S.2005. Chromium toxicity in plants. Environ.Intern. 31, 739-753.
54. Bahadurshah.2011. Hazardous Metals Andminerals Pollution In India: Sources, Toxicity And Management. A Position Paper. Indian National Science Academy.
55. SCHEFFER , F., SCHACHTSCHABEL, P. Lehrbuch der Bodenkunde 12. Neu bearb. Aufl. Unter Mitarb. Von W.R.Fischer. FEV Stuttgart, 1989.
56. GÜNE A., ALPASLAN M., INA L A.2004. Plant growth and fertilizer. Ankara Univ. Agriculture Pub. No: 1539, Ankara,Turkey (in Turkish).
57. VIARD , B., PIHAN , F. PROMEYRA T, S.and PIHAN . J.C.2004. Integrated ssessment of heavy metal (Pb, Zn, Cd) highway pollution: bioaccumulation in soil, Graminaceae and land snails, Chemosphere, 55.1349-1359.

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