Effect of Air Pollution on Biochemical and Anatomical Structure of *Conocarpus lancifolius* Leaves Growing in Jeddah - Saudi Arabia

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Abstract: ***In this study, which was conducted in different locations, including North, South, East and Western parts of Jeddah city. The sites include main and branch roads at each location (2 in each location). These sites named as North Jeddah (main road site 1, branch road site 2), South Jeddah (site 3 & 4), East Jeddah (site 5 &6) and West Jeddah (site 7 and 8). The control site was chosen from a garden far away from roads. Conocarpus lancifolius was used as an indicator ofa vital and processor of contamination with heavy metals arising from cars and other sources of pollution. Three heavy metals were measured in plant and soil of all these sites, these are Cr, Pb and Ni. In addition, the pH and the electrical conductivity of soil as well as soil texture were estimated. Results revealed that, the amounts of heavy elements in soil were much more than the amount in plant. This may be due to some physiological functions in Conocarpus lancifolius that prevent the absorption of heavy metals from soil. In addition, pH value indicated the acidity of control and the alkalinity of other sites.***

Keywords: *Conocarpus lancifolius*, air pollution, biochemical, anatomical, heavy elements

1. Introduction

Air contamination is a main trouble plaguing the majority countries of the earth nowadays. Pollution of the atmosphere could be accredited largely to manufacturing and expansion. Air contamination is the pollution of the atmosphere, this pollution is generally said to be largely due to increased human activities (Randhi and Reddy, 2012). Air contamination is therefore the emanation of substance into the air in quantity that would alter the ordinary composition of air to the level of cause hurt, or uneasiness of alive things and / or spoil to the ecological [Begun and Harikrishna, 2010]. Air pollution arises as a fall-out from industrialization and urbanization (Begun and Harikrishna, 2010, Randhi and Reddy, 2012). Plants are known to take part in a main function in removing contaminant from the surroundings as component of their usual performance (Tripathi, and Gautam, 2007; Begunand Harikrishna, 2010; Lalitha et al., 2013).

2. Materials and Methods

Study Area

Nine sits were chosen from different location in Jeddah city. All sites were selected according to traffic density taking main roads and their branches in four direction in Jeddah. The sites include main and branch roads at each location (2 in each location). These sites named as North Jeddah (main road site 1, branch road site 2), South Jeddah (site 3 & 4), East Jeddah (site 5 &6) and West Jeddah (site 7 and 8). The control site was chosen from a garden far away from roads. Site 1 and 2 near Petroleum Refinery (Petromen Aramko), site 3 and 4 at King Faisal road, site 5 and 6 at Al-Andalusroad, site 7 and 8 ALQahirah control site taken from a garden away from roads.

Collection of Soil and Leaves of Plant Species

Samples were collected during March (2015). Soil samples were collected from (0-30) cm under the soil plane. leaves samples were collected randomly from five plants at each site.

Analysis of Soils at Different Sites

A 2-mm plastic sieve was used for the air-dried soil samples for removing large gravel-sized materials. Soil samples were subjected to different investigations, including soil texture, pH, EC and heavy metals. The hydrometer method proposed by Gee and Bauder (1994) was used to determine the soil texture. pH was determined by pH meter Thomas (1996). Electrical conductivity in a 1:5 soil water extract was estimated following Rhoades (1996).

Digestion of plant and soil samples

According to EPA (1996), a mixture of 69% of HNO_3 and 30% H_2O_2 (5:2 v/v) was used to digest plant and soil samples. Inductively coupled plasma-optical emission spectroscopy has been determined through the concentrations of heavy metals and minerals in digested solutions (Polyscan 61E, Thermo Jarrell-Ash Corp., Franklin, MA, USA).

Anatomy of leaves

T.s of *Conocarpus lancifolius* leaves were made for plants at different sites to detect the effects of air pollution. Using Premiere® Microscope Camera model MA88-500 (5.0 Megapixels with a 2592 x 1944 resolution).

3. Results

Heavy Elements

The amount of Cr in soils showed low amount at control site 1.12 μg/g d.wt compared to all other sites, where their value ranged from 133.3 μg/g d.wt in site 4 to 48.73 μg/g d.wt in site1, while in plants location 4 recorded the highest amount (30.7 μg/g d.wt), while control site recorded the lowest amount of Cr (7.50 μg/g d.wt), compared to the other sites (Table 1). It is worth mentioning is that, the amounts of Cr in plants are extremely less than that in soils at all locations.

Table 1: The number of heavy elements mean ± SD in the leaves of *Conocarpus lancifolius* sites (n = 16)

	Soil (µg/g d.wt)			Plant (µg/g d.wt)		
	Cr	Pb	Ni	Cr	Pb	Ni
Site I	48.73^{bc}±13.01	5.10^{b}±1.27	21.64^{e}±0.05	8.60^{c}±4.81	10.80^{b}±8.49	1.10^{d}±0.71
Site 2	55.47^{bc}±5.18	0.10^{b}±0.14	26.17^{de}±0.52	14.50^{bc}±1.27	8.40^{b}±4.53	7.10^{bcd}±0.42
Site 3	49.30^{bc}±3.72	5.77^{b}±4.67	21.63^{e}±1.84	17.10^{bc}±2.12	57.40^{a}±7.64	9.10^{bc}±0.71
Site 4	133.3^{a}±91.40	128.8^{a}±114.98	28.10^{cd}±0.61	30.70^{a}±2.97	20.40^{b}±1.70	19.60^{a}±7.64
Site 5	50.93^{bc}±2.55	17.80^{b}±4.34	22.80^{e}±0.95	12.0^{bc}±4.81	9.10^{b}±1.56	6.70^{bcd}±3.25
Site 6	49.73^{bc}±0.85	5.27^{b}±4.33	28.40^{cd}±2.26	23.20^{ab}±14.71	19.30^{b}±17.11	7.80^{bcd}±1.41
Site 7	95.97^{ab}±13.53	1.50^{b}±1.65	36.20^{ab}±3.21	24.60^{ab}±5.94	15.20^{b}±11.03	14.10^{ab}±4.67
Site 8	67.47^{ab}±1.61	56.94^{ab}±52.70	31.50^{bc}±2.12	15.30^{bc}±1.84	6.0^{b}±0.85	8.30^{bcd}±0.71
Control Site	55.10^{bc}±6.55	88.50^{ab}±18.63	37.50^{a}±3.63	7.50^{c}±3.25	10.30^{b}±3.25	5.90^{cd}±0.99
F	2.691	2.501	25.004*	3.631*	7.869*	4.385*
p	0.069	0.085	<0.001*	0.028*	0.002*	0.015*
LSD (5%)	66.096	90.253	5.143	12.743	17.062	7.542

Data was expressed by using mean ± SD. F, p: F and p values for ANOVA test, Sig. bet. grps was done using Post Hoc Test (LSD). Means with Common letters are not significant (Means with Different letters are significant)*: Statistically significant at $p \leq 0.05$

On the other hand, pb recorded the highest values at soil of site 4 (128.8 µg/g d.wt) and the lowest values at soil of site 2 (0.10 µg/g d.wt). In plants however, this element showed wide variations. In general, its values ranged between 57.40 µg/g d.w at site 3 and 6.0 µg/g d.w at site 8.control side 0n the other hand, recorded 88.5 µg/g d.w, which considered high. Concerning Ni in soils of different sites, the values showed no wide variations compared to control, they ranged between 37.50 µg/g d.w at control site to 21.63 µg/g d.w at site 3. In plants however, Ni amounts showed low values than in soils. For instance, site 1 recorded 1.10 µg/g d.was the lowest value while site 4 recorded 19.60 µg/g d.was the highest value.

Ec, pH and proportions of soil particles to soil sites Conocarpus lancifolius

Table 2 represent the results of EC, pH and soil texture. Ec of soil of site 5 showed high EC readings (1.59 mS/cm), while the control site showed the lowest readings (0.35 mS/cm), soil of the control site recorded 0.54 mS/cm, which is higher than that of site 1, 2 and 9. Nonetheless, the pH of soil extracts ranged from 7.94 in the soil of site 6 as higher value and 6.79 in control site.

Table 2: Ec, pH and Proportions of Soil Particles of Different Soil Sites of *Conocarpus lancifolius*

	EC(mS/cm)	pH	Soil Texture%		
			Sand	Silt	Clay
Site I	0.44^{b}± 0.12	7.72^{b}± 0.04	93.0^{ab}± 1.41	2.0^{c}± 0.0	5.0^{a}± 1.41
Site 2	0.44^{b}± 0.11	7.47^{c}± 0.06	85.0^{bc}± 7.07	11.0^{b}± 7.07	4.0^{ab}± 0.0
Site 3	0.65^{b}± 0.22	7.63^{bc}± 0.03	85.0^{bc}± 2.83	13.0^{ab}± 2.83	2.0^{bc}± 0.0
Site 4	0.56^{b}± 0.11	7.59^{bc}± 0.10	80.0^{c}± 0.0	18.0^{ab}± 0.0	2.0^{cd}± 0.0
Site 5	1.59^{a}± 0.71	7.69^{b}± 0.06	80.50^{c}± 6.36	18.0^{ab}± 5.66	1.50^{cd}± 0.71
Site 6	0.68^{b}± 0.22	7.94^{a}± 0.05	84.0^{c}± 5.66	14.50^{ab}± 4.95	1.50^{dc}± 0.71
Site 7	0.75^{b}± 0.04	7.73^{b}± 0.14	77.50^{c}± 0.71	20.50^{a}± 0.71	2.0^{dc}± 0.0
Site 8	1.44^{a}± 0.04	7.64^{bc}± 0.01	77.0^{c}± 2.83	20.0^{a}± 4.24	3.0^{bc}± 1.41
Control Site	0.35^{b}± 0.01	6.79^{d}± 0.04	94.50^{a}± .71	1.0^{c}± 0.0	4.50^{ab}± .71
F	5.562*	34.844*	4.933*	7.314*	7.081*
P	0.007*	<0.001*	0.010*	0.002*	0.003*
LSD (5%)	0.5681	0.1737	8.5137	8.2622	1.6524

Data was expressed by using mean ± SD. F, p: F and p values for ANOVA test, Sig. bet. groups was done using Post Hoc Test (LSD). Means with Common letters are not significant (Means with Different letters are significant)*: Statistically significant at $p \leq 0.05$

On the other hand, soil texture clarified that all soils are more or less sandy. Results revealed that high percentage of sands was in the control site (94%), while less percent of sand was recorded in site 8 (77%). High silt percent was recorded at site 7 (20.5%), and the lowest was in the control site (1.0%). Concerning clay, the highest percent was recorded in site 1 (5.0%) while the lowest percent was recorded in sites 5 and 6 (1.50%).

Anatomical Features of Conocarpus lancifolius Leaves at Different Sites

The picture showed Accumulation of some pollutant in the upper and lower epidermis surfaces of the leaf in all site. Vascular bundles can be seen in site from Abrugh Ragama, and form Al Haramain High way in north of Jeddah. Even the same result in site from AlAndalus Road (Table 3).

Table 3: Correlation between Plants with different parameters of *Conocarpus lancifolius*

	Plant (μg/g d.wt)					
	Cr		Pb		Ni	
	r	p	r	p	R	p
EC(mS/cm)	-0.286	0.282	-0.316	0.233	-0.153	0.571
pH	0.222	0.409	0.081	0.764	-0.011	0.968
Sand %	-0.517*	0.040	0.040	0.884	-0.555*	0.026
Silt %	0.548*	0.028	0.010	0.971	0.587*	0.017
Clay %	-0.425	0.101	-0.220	0.413	-0.450	0.081
Cr Soil	0.470	0.066	-0.012	0.966	0.441	0.087
Pb Soil	0.330	0.211	-0.043	0.875	0.322	0.224
Ni Soil	0.452	0.079	-0.318	0.230	0.483	0.058

4. Discussion

Along with natural xerophytes plant, *Conocarpus lancifolius* as a dominant and a frequent desert plant so as to grow commonly in warm and urbanizing regions. There is a high ability in each of the types to absorb heavy aspects into its tissues because of their competencies for taking up and tolerating heavy metals regardless of their staid physiological spoil (Hashem and Al-Farraj, 1997;Tulyan and Al-Farraj, 2002; Al-Faeeaj and Al-Wable, 2007) in Saudi Arabia. The environmental bioaccumulation of nutritent and contamination researches have been deliberated with several authors on water, soil, and wild plants in some areas of Saudi Arabia. For instance, heavy elements content of wild plants in several areas of Saudi Arabia have been studied by Hashem (1993).

Dueto the increase of urban witnessed by thecity of Jeddah, Saudi Arabia has become a need for expansionin the factories and the establishment of new factories to meet this requirement, and where the cement industry is the development of the industries it is a basic foundation for the building materials industry. Based on the great importance of the issue of pollution of the environment and how to overcome this problem and maintain the ecological balance the objective of this study was treatment environmental pollution using bioremediation, which works to reduce pollution levels and through the use of wild plants is wide spread in parts of the Kingdomin addition to the availability different seasons of the year, has been used *Conocarpus lancifolius* as an indicator of a vital and processor of contamination with heavy metals arising from different sources of pollution. The amounts of heavy elements in soil were much more than the amount in plant. This may be due to some physiological functions in *Conocarpus lancifolius* that prevent the absorption of heavy metals from soil, *Conocarpuslancifolius* was observed to has the ability to reject the heavy elements like Cr and Pb and Ni through roots. This aspect was also verified by Ramamurthy and Kannan (2009) in *Calotropis gigantean* and Nadia *et al.*, (2012) in different plants Viz (*Calotropis procera*, *Citrullus colocynthis, Rhazya stricta, Cassia italic, Phragmites australis, Cyperus laevigatus and Argemone mexicana*).

5. Conclusion

According to the outcome of this study, the national plants and soil can well current additional in sequence about the elements contented of their site. Plant and soil analysis exposed with the aim of the increase is significantly the effect of a type of element. some plants could be decreasing the quantity of heavy metals by commendation it in their roots or stems or leaves. Theses plant species are good to grow it in roads for many reasons some of them are beautiful view, fresh air and clean up pollution. *Conocarpus lancifolius* now make many problems Such as cracking sidewalks in the roads and deepening the roots of the plant and access to water drains and reservoirs of houses planted.

References

[1] Ali, B.A.A. and Ali, H.H., (2014). Possibility of using Conocarpuslancifolius Engl. in remediation of some Iraqi soils polluted by crude oil. Advances in Bio Research, 5, 185-190.

[2] Badr, N., Fawzy, M., and Al-Qahtani, K.M., (2012). Phytoremediation: An ecological solution to heavy-metal-polluted soil and evaluation of plant removal ability. World Applied Sciences Journal, 16, 1292-1301.

[3] Hashem, A.R., and Alfarhan, A.H., (1993). Minerals content of wild plants from Ashafa, Toroba, Wahat and Wehait (Saudi Arabia). JKS Unio Sci, 5, 101-106.

[4] Hashem, A.R., and Al-Farraj, M.M., (1997). Soil analysis, fungal flora and mineral content of Citrulluscolocynthis from Saudi Arabia. Umm Al-Qura Journal for Science, Medicine, and Engineering, 1, 9-26.

[5] Ma, Y., Oliveira, R.S., Freitas, H., and Zhang, C., (2016). Biochemical and molecular mechanisms of plant-microbe-metal interactions: relevance for phytoremediation. Frontiers in plant science, 7, 918.

[6] Macpherson, A.J., Simon, H., Langdon, R., and Misenheimer, D., (2017). A mixed integer programming model for national ambient air quality standards (NAAQS) attainment strategy analysis. Environmental Modelling & Software, 91, 13-27.

[7] Ramamurthy, N., and Kannan, S., (2009). SEM-EDS analysis of soil and plant (Calotropisgigantea Linn) collected from an Industrial village, CuddaloreDt, Tamil Nadu, India. Romanian Journal of Biophysics, 19, 219-226.

[8] Randhi, U. D., and Reddy, M. A., (2012). Evaluation of Tolerant plant species in Urban Environment: A case study from Hyderabad, India. Universal Journal of Environmental Research & Technology, 2.

[9] Thakur, S., Singh, L., Ab Wahid, Z., Siddiqui, M. F., Atnaw, S. M., and Din, M. F., (2016). Plant-driven removal of heavy metals from soil: uptake, translocation, tolerance mechanism, challenges, and future perspectives. Environmental monitoring and assessment, 188, 206.

[10] Tulyan, H. N., Al-Farraj, M. M., (2002). Pollution measurement by some heavy metals in Riyadh, Saudi Arabia using Calotropisprocera as bioindicator 3. Copper. Saudi Journal of Biological Sciences, 9, 32-39.

[11] Wei, X., Lyu, S., Yu, Y., Wang, Z., Liu, H., Pan, D., and Chen, J., (2017). Phylloremediation of air pollutants: exploiting the potential of plant leaves and leaf-associated microbes. Frontiers in plant science, 8, 1318.

Figures

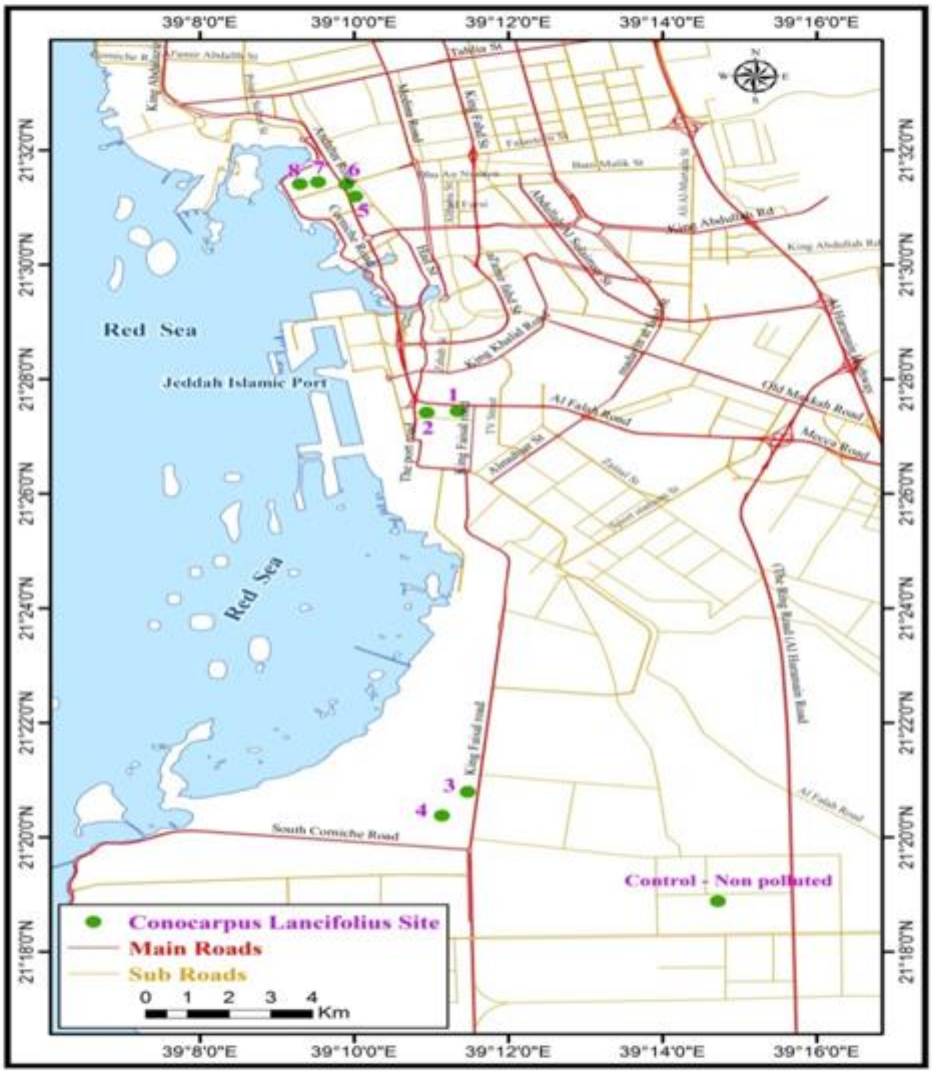

Figure 1: *Conocarpus lancifolius* site in Jeddah . Source: Field study 2018

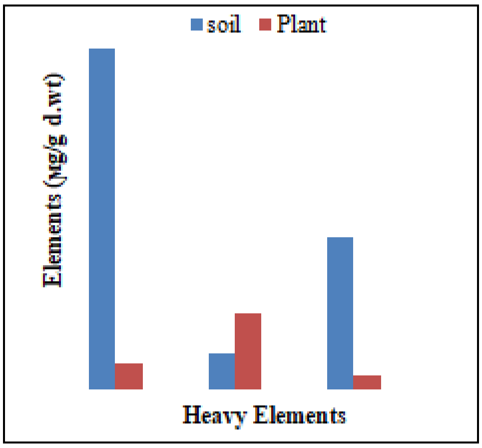

Figure 2: Comparison of heavy metal of soil and plants at site 1

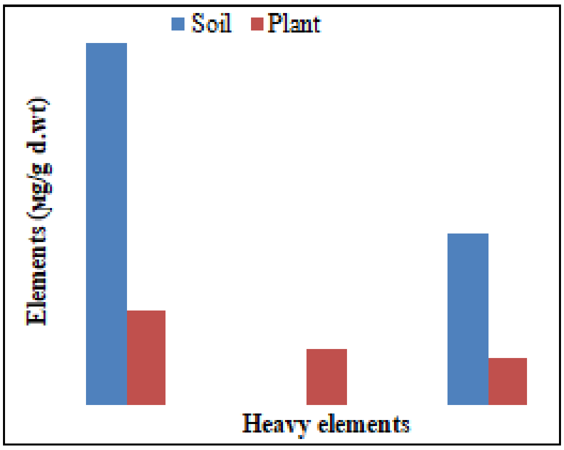

Figure 3: Comparison of heavy metal of soil and plants at site 2

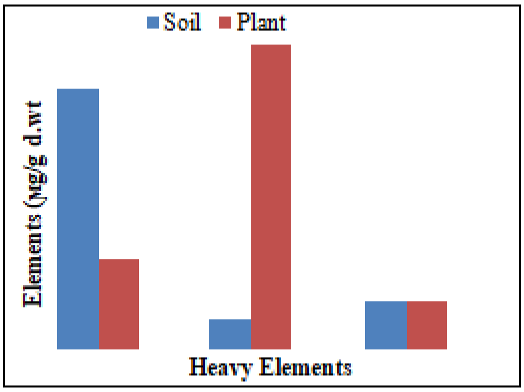

Figure 4: Comparison of heavy metal of soil and plants at site 3

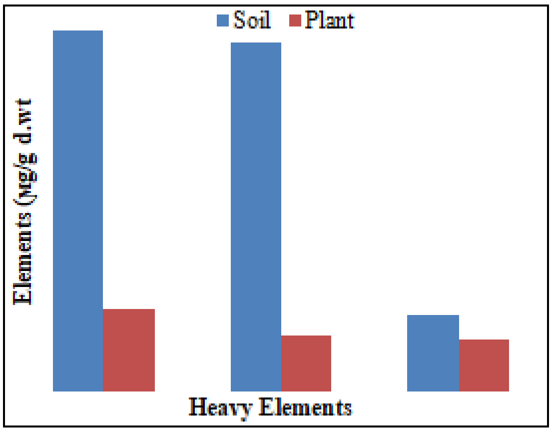

Figure 5: Comparison of heavy metal of soil and plants at site 4

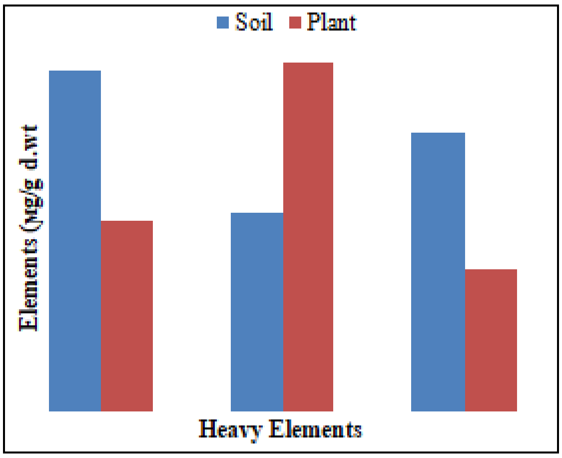

Figure 6: Comparison of heavy metal of soil and plants at site 5

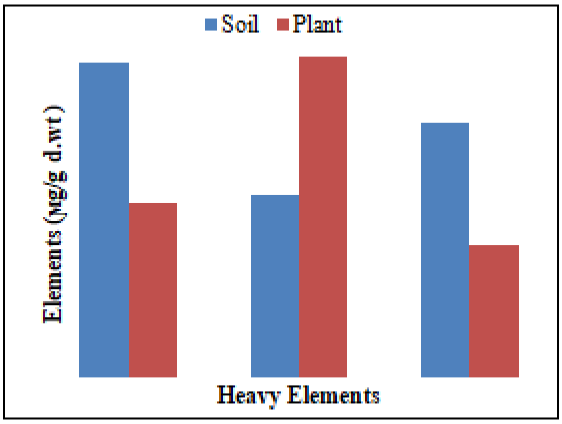

Figure7: Comparison of heavy metal of soil and plants at site 6

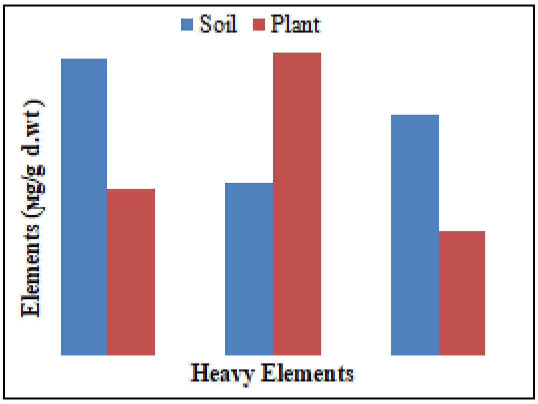

Figure 8: Comparison of heavy metal of soil and plants at site 7

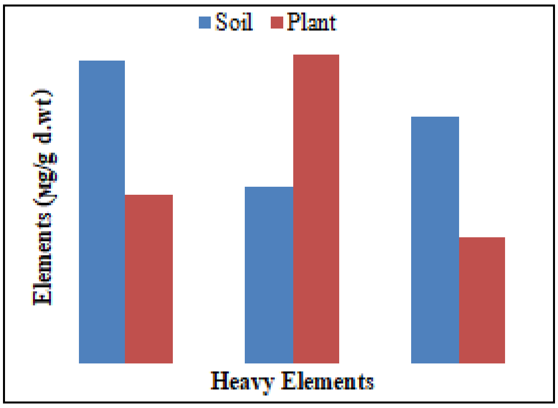

Figure 9: Comparison of heavy metal of soil and plants at site 8

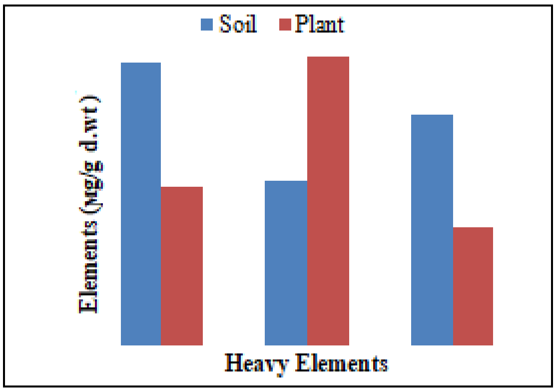

Figure 10: Comparison of heavy metal of soil and plants at site 9

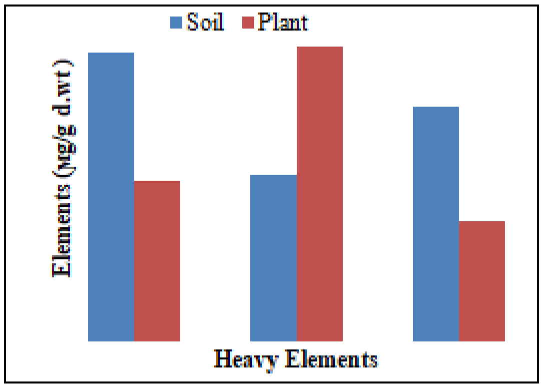

Figure 11: Comparison of heavy metal of soil and plants at control site

Appendix

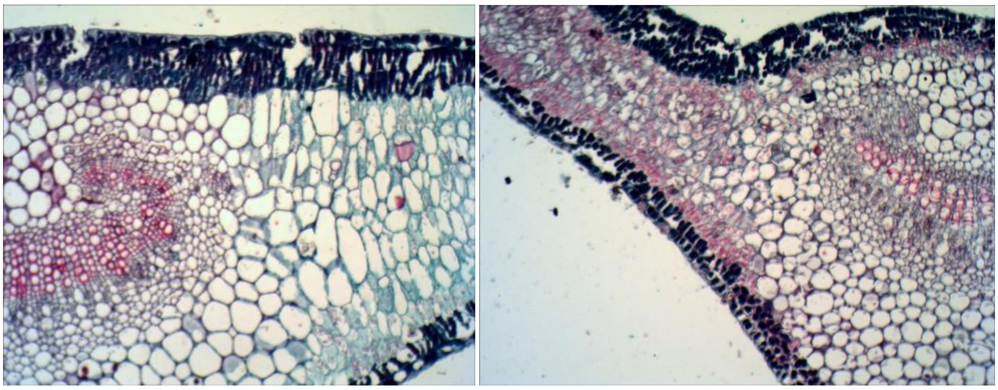

Figure 1(A): (a) T.S of *C.lancifolius* leaf from Sari (branch) (b) TS of *C.lancifolius* leaf from Ubhur North (Main)

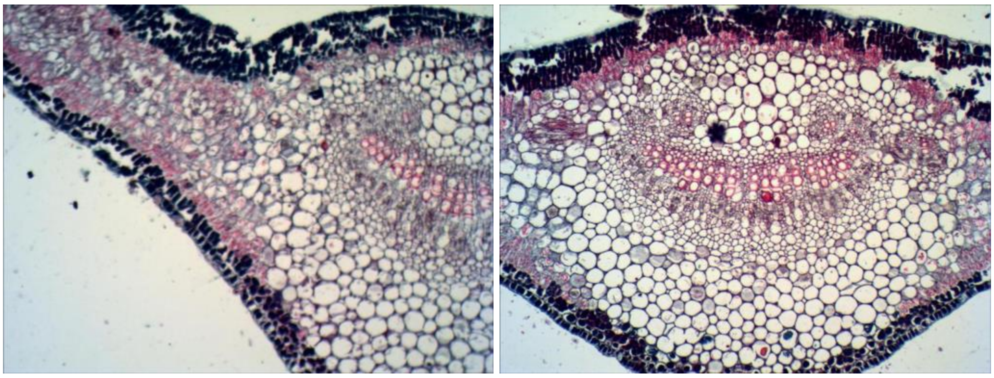

Figure 2(A): (a) T.S of *C.lancifolius* leaf from Petromen Aramko (branch), (b) T.S of *C.lancifolius* leaf Near King Faisal Sea Hall (main)

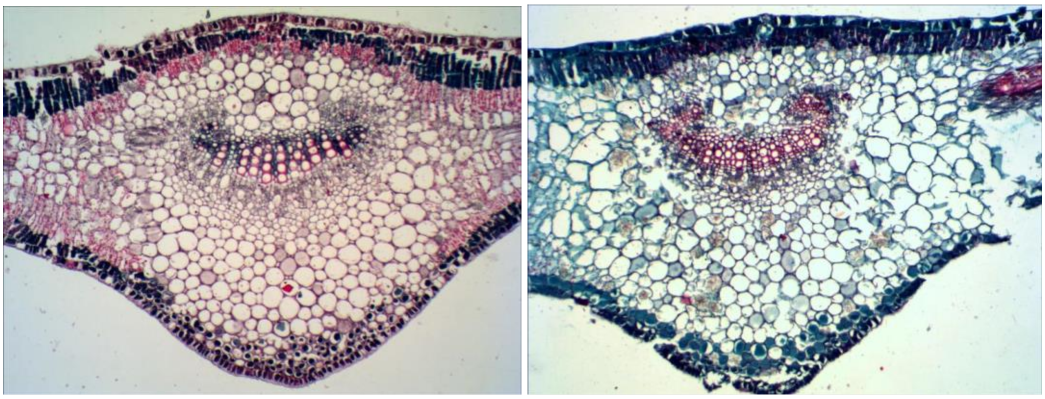

Figure 3(A):(a) T.S of *C.lancifolius* leaf from Abrugh Ragama (branch); (b) T.S of *C.lancifolius* leaf from Haramain Highway (main)

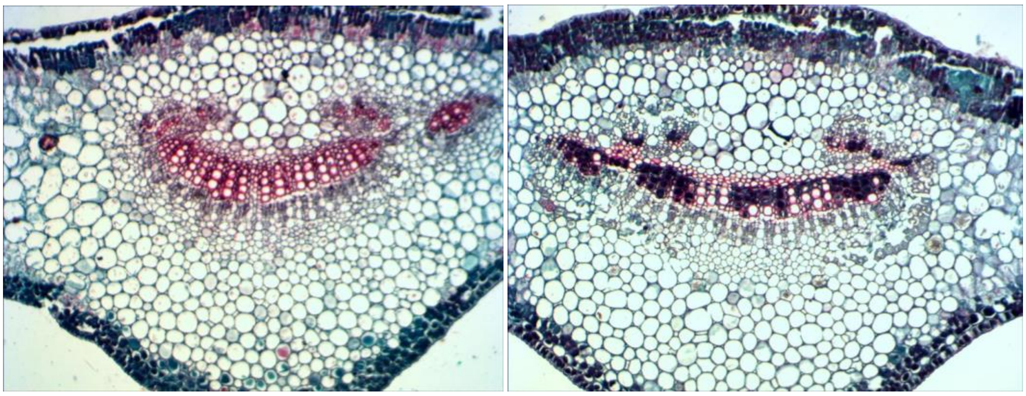

Figure 4(A): (a) T.S of *C.lancifolius* leaf from Ciro road (branch), (b) T.S of *C.lancifolius* leaf from Al-Andalus Rood (main)

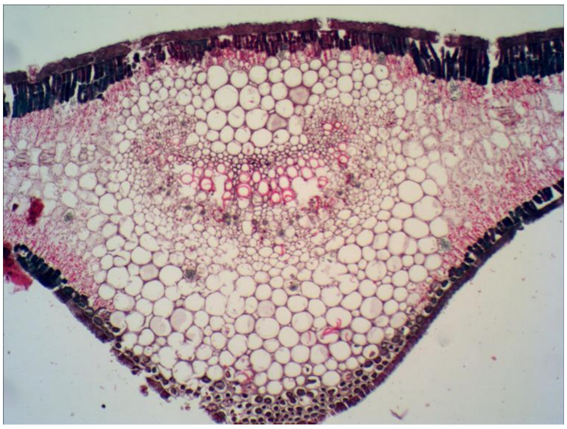

Figure 5(A): T.S of *C.lancifolius* leaf from a Garden (Control)