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The Heavy Metal Concentration along Roadside Trees of Quetta and its Effects on Public Health

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Abstract: The degree of air pollution in Quetta city was determined on heavy traffic areas using roadside trees as an indicator. The leaves of *Cupressus* sp., *Fraxinus excelsior, Pinus longifolia, Rubinea pseudoaccasia* were collected and analyzed for their macro, micro elements and heavy metal concentration. These elements were detected and estimated by using atomic absorption spectrophotometer. Significantly high contents of zinc, manganese, lead and cadmium were found. These are highly toxic for all living systems. The common source of these elements on tree leaves is motor vehicles. M.A. Jinnah road was found to be most polluted.

Key words: Air pollution, macro, micro elements, tree leaves, atomic absorption spectrophotometer

INTRODUCTION

Pollution has been defined as the undesirable change in the physical, chemical or biological characteristics of air, land and water that may or will be harmful to the human life, living conditions and cultural assets, or that may or will waste, or deteriorate our raw natural resources. Pollution of the environment with toxic metals has increased dramatically since the beginning of the industrial revolution[1]. Quetta is facing acute contamination problems, because of the growing population, increasing number of vehicles and industrial areas. The use of various transportation media, especially owned vehicles increased tremendously within a relatively short span of time and therefore, Quetta is faced with peculiar traffic pollution. This is mainly caused by the faulty vehicles using inappropriate fuel mixtures. Moreover, the high mountains surrounding the valley do not allow the pollutants to escape and instead covers the city with a thick layer of toxic gases. Therefore, it is considered necessary to elucidate the level of environmental pollution in Quetta city.

Smoke and unburned fuel from faulty vehicles may contain heavy metals, which are toxic not only to human health, but also effects the plants on which they are deposited. This study is particularly directed toward the determination of Cadmium (Cd), and lead (Pb) levels and other heavy metals on roadside plant leaves.

Due to the potential hazards to the health of human animals and plants the use of these metals beyond a permissible limit can cause various kinds of diseases[2]. The metals like Cadmium (Cd), lead (Pb), Zinc (Zn) and Nickel (Ni) are the important heavy metals present especially near urban areas and road ways. High levels of heavy metals in soil, plants and atmosphere are often related to the proximity to industries and roads and to the use and dumping of waste materials, impure chemical fertilizers and metals containing pesticides, but the automobiles appear to be a key factor in air pollution because of their increased number during the past years[3].

Determination of the levels of Phosphorus (P), Pottasium (K), Manganese (Mn), Ni, Zn, Iron (Fe), Pb and Cd in plant leaves of the trees along roadside in Quetta was conducted because the roadside contamination is a well established phenomenon[4].

MATERIALS AND METHODS

Fresh leaves were collected from trees present on heavly traffic volumed roads such as Iqbal road, Chamman road, Double road, Gulistan road, Jammali road, Jinnah road, Liaquat road, Makran road, Prince road, Sabzal road, Sirki road, Sariab road, Staff College road, Urak road and Zarghoon road. The traffic density on these roads is 1540 to 7728 vehicles in 24 h[5]. Leaves from 25-30 trees were collected in polythene bags prewashed

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with 3% nitric acid and deionized water. Seasonal sampling was made Mn, Cu, Ni, Pb and Zn were digested and analyzed quantitatively by atomic absorption spectrophotomete[6], Philips, Pye Unicam.

RESULTS AND DISCUSSION

Table 1 and 2 reveal that Fe, Zn, Mn, Pb, K, Ni, P and Cd are present in noticeable amounts in the atmosphere of Quetta city. They are hazardous, nonessential and non-beneficial for all living things. These elements pose a great threat to the environment when present in large quantities. The discharge of unburnt fuel from the vehicles waiting for the signals might have caused an increase in the metal concentration. Heavily polluted areas were Jinnah road, Sariab road, Zarghoon road, Iqbal road and Sirki road (Table 1). As many as 4202 to 7728 vehicles ply on these roads per 24 h[5]. Moderately polluted roads were Masjid road, Prince road and Macongy road. The numbers of vehicles plying on these roads per 24 h vary around 2982 to 3862. The least polluted areas included Sabzal road and Urak raod. The vehicles plying per 24 h on these roads vary from 1091 to 1934 in number.

Leaves collected during summers were heavily polluted, while those collected during winters had lesser concentration of all the elements (Table 1 and 2). This could be attributed to the winter rainfall which washed away the pollutants from the leaves. Concentration of all the elements analyzed varies from one location to the other. Iron and Zn were found to be most abundant. The amount of Fe was found to be maximum amongst all the elements present. Its mean value was 705.45 with standard deviation of 455.325. The highest amount of Fe was found on the trees of Jinnah road, Sariab road, Double road and Iqbal road (Table 1). Zn was also found in high amounts. Its mean value was 348.80 with standard deviation of 275.138. Abundant amounts of Zn were recorded from Jinnah road, Sariab road and Prince road. Mn and Pb were present in medium amounts. The mean value of Mn was 0.066 with 25.735 standard deviation. Its highest amount was recorded from the trees of Jinnah

Table 1: Mean±SEM concentrations of elements present in trees leaves of different roads in Quetta, in June 1995

Road name	Tree name	Fe (ppm μg^{-1} g^{-1})	Mn (ppm μg^{-1} g^{-1})	Cd (ppm μg^{-1} g^{-1})	Pb (ppm μg^{-1} g^{-1})	Ni (ppm μg^{-1} g^{-1})	Zn (ppm μg^{-1} g^{-1})	N (% g/ 100 g)	P (%g/ 100 g)	K (% g/ 100 g)
Jinnnah	1.F	1833±98	88±12	0.90±0.4	71±23	4.18±0.22	680±53	2.3±0.02	0.40±0.03	4.9±0.77
	2.R	1028±83	54±5.3	0.71±0.3	66±8.2	3.25±0.4	260±77	2.6±0.004	0.50±0.01	6.8±0.4
	3.P	1202±92	64±18	1.25±0.1	85±13	5.0±0.02	802±92	1.1±0.02	0.03±001	2.9±0.1
	4.C	2340±99	138±36	1.54±0.2	90±29	3.216±0.1	680±58	1.6±.03	0.05±001	3.2±0.02
Prince	1.F	819±74	70±11	0.60±0.01	42±7.8	3.6± 0.1	521±40	1.1±0.02	0.11±0.03	4.8±0.1
	2.R	527±60	56±9.2	0.72±0.01	40±8.2	3.2± 0.1	403±51	2.0± 0.01	0.24±0.02	6.7±0.2
	3.P	1410±96	60±9.9	0.62±0.01	53±8.1	4.08±0.01	670±73	1.7±0.04	0.24±0.01	2.7±0.04
	4.C	518±22	55±11	0.81±0.03	60±11	3.06±0.02	702±32	1.8±0.01	0.22±0.01	2.6±0.02
Mchongy	1.F	550±92	51±8.3	0.62±0.11	60±7.5	0.89±0.02	102±15	2.4±0.02	2.25±0.02	0.26±0.01
	2.R	434±68	39±2.9	0.50±0.01	51±8.6	0.56±0.04	90±28	2.6±0.01	4.3±0.03	0.37±0.03
	3.P	520±23	83±9.4	0.63±0.02	68±12	1.00±0.01	130±24	1.2±0.01	2.9±0.01	0.19±0.01
	4.C	501±59	61±15	0.66±0.02	64± 9.2	1.27±0.01	215±32	2.0±0.03	2.8±0.02	0.22±0.02
Double	1.F	1332±99	70±5.8	0.66±0.0	39±2.3	4.29±0.2	527±26	2.0±0.05	0.24±0.01	4.4±0.1
	2.R	908±74	64±19	0.07±0.00	41±2.8	3.01±0.01	320±19	2.4±0.11	0.34±0.03	6.2±0.3
	3.P	707±36	72±6.8	0.81±0.03	50±3.1	4.01±0.03	733±27	1.2±0.00	0.12±0.00	2.4±0.08
	4.C	1868±99	76±17	0.83±0.02	62±3.8	4.25±0.22	880±34	1.51±0.02	0.02±0.00	2.9±0.04
Sirki	1.F	728±78	48±11	0.66±0.01	35±2.7	1.19±0.01	168±15	2.2± 0.1	0.35±0.06	4.6±0.3
	2.R	800±72	45±20	0.48±0.01	32+1.6	2.15±0.03	172±20	2.8± 0.1	0.30±0.02	6.5±0.1
	3.P	600±52	50±13	0.79±0.03	33+1.0	1.66±0.01	300±28	1.3±0.02	0.20±0.01	3.1±0.04
	4.C	526±45	54±26	0.89±0.01	49+1.2	1.48±0.05	422±25	1.6±0.01	0.25±0.01	3.0±0.02
Zarghoon	1.F	920±51	74±8.8	1.55±0.1	58±2.6	4.19±0.3	691±49	2.5± 0.2	0.22±0.01	4.9±0.1
	2.R	888±49	99± 8.6	0.75±0.01	64± 9.3	3.01±0.2	644±44	3.0±0.2	0.20±0.01	5.7±0.1
	3.P	1060±86	69±7.8	1.50±0.03	39± 2.1	3.48±0.3	478±39	1.4±0.01	0.31±0.01	3.1±0.04
	4.C	945±64	60±5.9	1.0±0.02	74±0.4	3.91±0.04	560±40	1.5±0.1	0.21±0.02	3.1±0.1
Urak	1.F	205±25	11±0.4	0.23±0.0	29±1.7	0.76±0.03	107±12	1.15±0.03	0.29±0.01	2.7±0.03
	2.R	361±40	20±0.2	0.35±0.02	20±0.81	0.42±0.01	42±3.1	1.30±0.01	0.30±0.00	4.4±0.2
	3.P	220±35	21±1.0	0.31±0.01	48±2.1	0.88±0.01	37±1.7	0.91±0.01	0.09±0.00	1.8±0.01
	4.C	484±59	87±3.5	0.40±0.03	45±1.3	1.00±0.01	45±5.8	0.98±0.02	0.20±0.01	3.4±0.2
Sariab	1.F	823±84	76±17	0.60±0.10	66±12	5.00±0.1	789±66	2.25±0.1	0.36±0.02	5.0±0.3
	2.R	945± 83	60±14	1.09±0.10	50±13	4.20±0.2	560±32	2.69±0.06	0.28±0.00	6.7±0.7
	3.P	1221±93	92±20	0.85±0.03	7±7.20	4.78±0.1	500±32	1.20±0.03	0.65±0.01	3.0±0.1
	4.C	1630±94	100±25	1.48±0.02	82±13	4.25±0.3	882±71	1.90±0.5	0.45±0.00	3.3±0.1
Sabzal	1.F	366±21	50±2.2	0.61±0.1	60±11.0	2.29±0.1	160±12	2.40±0.2	0.12±0.00	2.6±0.1
	2.R	380±25	52±4.8	0.50±0.02	36±8.6	0.66±0.02	50±3.6	2.62±0.2	0.25±0.01	5.5±0.8
	3.P	424±28	52±6.1	0.52±0.1	66±16	2.22±0.1	220±30	1.20±0.00	0.012±0.00	4.2±0.2
	4.C	472±32	58±5.9	0.60±0.03	58±7.9	2.92±0.1	301±66	1.23±0.1	0.25±0.03	3.0±0.3

1.F. *Fraxinus excelsior*, 2.R. *Rubinea Pseudo acacia*, 3.P. *Pinus longifolia Roxb.ex.* sp., 4.C. *Capresses* sp.

road. Lead was also found in medium amounts. Its mean value was 44.30 with standard deviation of 18.384. Its highest concentration was recorded from Jinnah road Zarghoon road and Sariab road, having the highest number of traffic. K, Ni, P and Cd recorded low concentrations. The mean value of K was 3.848 with standard deviation 1.578. It was found in almost equal amounts everywhere. Ni was present in all the analyzed samples of leaves. Ni emissions are accounted by oil combustion. The mean value of Ni was 2.398 with standard deviation 1.435. The highest concentration was recorded from Jinnah road and Sariab road. The mean value of P was 0.325 with standard deviation 0.442. Relatively high amounts of P were found on Prince road. Low amounts of Cd on different roads of Quetta city were found. Its mean value was 0.673 with standard deviation 0.316. The highest amount of Cd was found on Jinnah road, Sariab road and Zarghoon road. Only negligible amounts of Cd were recorded from other roads.

Cd is of particular concern because it accumulates in the human body with a half-life exceeding 10 years and has been linked with a number of health problems including renal tubular dysfunction, pulmonary emphysema, significant kidney damage and possibly osteoporosis. Moreover, in 1993 the International Agency for Research on Cancer (IARC) classified Cd and compounds containing Cd as human carcinogens[2].

It is believed that the probable contribution to the particulate matter at Quetta arises mainly from locomotive exhaust, particularly smoke due to poor maintenance of vehicles, solid waste disposal and their fuel combustion, soil dust due to strong ground turbulence by wind and poor sanitation. Refuse incineration results in the emission of large quantities of many elements such as Cd, Pb, Zn and Fe[7]. These elements get into the atmosphere along with the soil dust as a result of ground wind turbulence Women exposed environmentally or occupationally can have higher levels of Cd, Pb and Hg in their breast milk. Many factors affect both the distribution of cadmium, lead and mercury in breast milk and the health consequences to an infant[8]. We believe that this finding may be only the tip of the iceberg and that the high concentration of lead in the air may cause damage to the nervous system of hundreds of thousands of children

Table 2: Mean±SEM concentrations of elements present in leaves of trees of different roads in Quetta, in December, 1995

Road name	Tree name	Fe (ppm μg^{-1} g^{-1})	Mn (ppm μg^{-1} g^{-1})	Cd (ppm μg^{-1} g^{-1})	Pb (ppm μg^{-1} g^{-1})	Ni (ppm μg^{-1} g^{-1})	Zn (ppm μg^{-1} g^{-1})	N (% g 100 g)	P (%g 100 g)	K (% g 100 g)
Jinnnah	1.F	401±56	31±5.7	0.31±0.01	36±2.6	1.21±0.1	308±51	1.12±0.10	0.24±0.01	3.3±0.5
	2.R	339±31	42±4.8	0.24±0.02	29±3.0	0.39±0.1	321±50	1.41±0.30	0.31±0.01	3.3±0.4
	3.P	438±50	49±3.9	0.38±0.02	29±2.7	1.25±0.2	246±47	0.99±0.10	0.38±0.02	3.0±0.7
	4.C	681±45	49±5.0	0.54±0.03	31±2.9	1.21±0.1	280±50	1.29±0.20	0.34±0.01	3.2±0.5
Prince	1.F	489±32	32±2.9	0.61±0.02	32±2.6	3.02±0.25	340±28	0.21±0.00	0.20±0.01	3.1±0.11
	2.R	522±37	39±2.4	0.45±0.01	30±2.1	3.21±0.18	289±22	0.20±0.00	0.20±0.00	3.1±0.16
	3.P	520±29	31±2.5	0.38±0.01	39±.0	0.81±0.06	307±24	0.78±0.01	1.9±0.020	2.0±0.08
	4.C	321±16	55±3.7	0.41±0.01	41±3.3	1.00±0.08	236±17	1.31±0.02	0.22± 0.00	3.1±0.21
Macongy	1.F	226±21	31±2.9	0.23±0.00	41±3.8	0.31±0.01	186±22	0.49±0.01	0.38± 0.01	1.9±0.1
	2.R	149±18	27±2.5	0.32±0.01	30±2.7	0.26±0.00	192±24	2.3±0.170	0.32± 0.00	1.4±0.11
	3.P	201±24	39±3.1	0.35±0.01	36±2.9	0.23±0.00	148±18	1.46±0.10	0.80±0.01	0.2±0.00
	4.C	121±13	44±3.5	0.33±0.02	39±3.5	0.41±0.01	136±18	1.78±0.11	0.24± 0.00	2.1±0.20
Double	1.F	426±48	52±3.9	0.31±0.01	41±2.8	1.39±0.12	241±30	1.86±0.11	0.22±0.00	2.6±0.45
	2.R	381±40	62±4.1	0.30±0.00	35±2.1	1.26±0.20	234±29	1.20±0.10	0.22±0.01	2.3±0.37
	3.P	522±50	55±4.0	0.38±0.01	42±3.6	1.78±0.16	249±34	1.32±0.20	0.24±0.01	2.9±0.51
	4.C	485±41	40±3.7	0.33±0.01	38±3.0	1.82±0.11	282±39	1.34±0.15	0.15±0.00	2.2±0.20
Sirki	1.F	424±48	61±7.1	0.29±0.00	20±0.80	1.20± 0.03	272±48	2.21±0.23	0.20±0.00	2.1±0.30
	2.R	385±49	48±3.8	0.31±0.01	26±1.1	1.20±0.15	193±29	1.09±0.02	0.22±0.00	2.4±0.22
	3.P	682±56	46±3.0	0.41±0.01	24±0.97	0.76±0.01	281±44	0.80±0.01	0.24±0.01	2.8±0.24
	4.C	280±30	50±4.3	0.39±0.02	29±1.5	0.98±0.04	248±31	1.32±0.08	0.26±0.02	3.0±0.29
Zarghoon	1.F	401±39	31±2.8	0.31±0.01	36±2.0	1.21±0.01	308±25	1.12±0.04	0.24±0.00	3.3±0.05
	2.R	339±35	42±3.0	0.24±0.00	29±1.4	0.39±0.00	321±30	1.41±0.06	0.31±0.01	3.3±0.21
	3.P	438±41	49±3.6	0.38±0.01	29±1.7	1.25±0.02	246±19	0.99±0.01	0.38±0.01	3.0±0.20
	4.C	681±48	49±4.0	0.54±0.02	31±2.1	1.21±0.01	280±25	1.29±0.01	0.34±0.00	3.2±0.18
Urak	1.F	89± 0.8	29±2.7	0.22±0.01	19±2.0	0.21±0.00	26±2.0	0.84±0.02	0.23±0.01	2.0±0.13
	2.R	91±9.9	21±2.0	0.24±0.01	21±1.9	0.32±0.02	23±1.5	1.21±0.40	0.22±0.00	2.1±0.20
	3.P	123±14	52±3.9	0.32±0.00	26±2.3	0.32±0.01	32±2.2	1.21±0.25	0.29±0.01	2.5±0.18
	4.C	101±10	38±3.1	0.31±0.01	29±2.7	0.41±0.02	33±2.0	1.31±0.22	0.32±0.02	2.4±0.30
Sariab	1.F	380±42	61±5.0	0.42±0.02	39±1.8	1.45±0.04	346±31	0.95±0.04	0.37±0.00	2.9±0.20
	2.R	342±44	48±3.8	0.54±0.01	35±1.4	1.61±0.07	309±28	1.11±0.09	0.28±0.00	3.1±0.20
	3.P	699±49	46±2.9	0.65±0.10	37±2.1	1.91±0.20	355±32	1.23±0.05	0.67±0.02	3.1±0.10
	4.C	950±57	59±4.2	1.41±0.14	45±2.0	2.91±0.201	488±39	1.41±0.10	0.43±0.01	3.0±0.21
Sabzal	1.F	216±18	32±2.9	0.29±0.01	31±1.2	0.38±0.02	115±9.9	0.56±0.02	0.39±0.01	1.8±0.11
	2.R	152±10	29±2.4	0.26±0.00	34±1.2	0.32±0.01	112±9.2	2.5±0.22	0.32±0.00	1.5±0.10
	3.P	131±11	35±3.4	0.32±0.01	39±2.0	0.49±0.02	132±12	1.32±0.12	0.54±0.031	0.29±0.00
	4.C	121±10	43±3.6	0.35±0.02	38±1.5	0.45±0.02	123±10	1.41±0.10	0.32±0.01	2.2±0.16

1.F. *Fraxinus excelsior*, 2.R. *Rubinea Pseudo acacia*, 3.P. *Pinus longifolia Roxb.ex.* sp., 4.C. *Capresses* sp.

who live in the urban slum populations of the city[9, 10]. We urge health professionals and policy-makers in our country to urgently impose a ban on leaded (smuggled) petrol and to identify children who have already been affected by this toxic metal.

It can be concluded that the particulate load of Quetta atmosphere originates from automobile exhausts and the pollutants being blown to Quetta city from the adjoining arid zone by the land breeze. Other factors involved in increasing pollution may be heavy metals, industrial and municipal wastes, agrochemicals and other chemicals, corrosive gases, cyclic and halogenated hydrocarbons, noise and odour. The pollution is increasing day by day and it has become a potent factor as regards the general health of its citizens. For control of air pollution, economically viable facilities exist to promote good maintenance of motor vehicles which should be compulsorily utilized in Quetta. ENERCON reports that a well tuned engine discharges 50% less carbon monoxide and hydrocarbons while obtaining 5-6% better fuel efficiency[11,12]. From the data collected during this study, it is evident that the maximum concentration of various pollutant metals was found on Jinnah road. Therefore it is suggested that the Jinnah road area should be declared as the most polluted area of Quetta city.

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