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LEAD ACCUMULATION IN THE ROADSIDE SOILS AND PLANTS

ESKİŞEHİR'DE YOLKENARI TOPRAK VE BİTKİLERİNDE KURŞUN BİRİKİMİ

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Soil and grass specimens from 10 different traffic-dense roads and 5 control places from heavy-traffic were analyzed by atomic absorption spectrophotometry for the control of vehicle-derived lead contamination in Eskişehir.

Pb concentrations of the surface soils (46.69±14.70 mg/kg) were significantly higher than those of the control areas. When the samples were washed, it was observed that there was an decrease in Pb concentrations for the surface specimens while there was no difference for the deep ones. From 31.3.1997 (a rainy day) to 7.7.1996 (when the soil was dry) significant decreases were observed in all groups. The Pb concentrations of the subject grass specimens were 15±8.35 mg/kg, and 2.69±0.96 mg/kg for the controls and a significant difference was observed between the two groups. Data obtained from the analyses of grass samples taken on rainy and dry seasons showed significant decreases in all groups expect in washed grass specimens taken from control areas.

In conclusion, higher Pb concentrations were observed in both the soil and the grass samples from traffic-dense areas than those from the control areas. It was also observed that Pb concentrations in both the soil and plant samples decreased after washing and that this contamination can thus be spread by rain.

Eskişehir'de taşıtların neden olduğu Pb kirliliğini ortaya koymak amacıyla yapılan çalışmada trafiğin yoğun olduğu 10 farklı noktadan, kontrol grubu için de trafikten uzak parklardaki 5 farklı noktadan alınan toprak ve bitki örnekleri incelendi.

Örneklerdeki Pb konsantrasyonları atomik absorbsiyon spektrofotometresi ile ölçüldü.

Trafiğin yoğun olduğu yol kenarlarında yüzeyden alınan toprak örneklerindeki Pb konsantrasyonu (46.69±14.70 mg/kg) kontrol bölgelerine göre yüksek idi. Alınan örnekler yıkandığında yüzey örneklerindeki konsantrasyonlarda azalma yönünde farklılık gözlenirken, derinden alınan örneklerde fark gözlenemedi. Yağışların fazla olduğu 31.3.1996 tarihiyle toprağın kuru olduğu 7.7.1996 tarihlerinde elde edilen veriler karşılaştırıldığında tüm gruplarda azalma saptandı. Alınan çayır tipi bitkilerdeki Pb konsantrasyonu çalışma bölgelerinde (15±8.35 mg/kg) kontrol bölgelerine göre (2.69±0.96 mg/kg) yüksek idi. Tüm bitki örneklerinde de yıkamakla Pb konsantrasyonunda azalma saptandı. Yağışların fazla olduğu dönemle toprağın kuru olduğu dönemde elde edilen veriler karşılaştırıldığında (kontrol bölgesinden alınan yıkanmış bitki örnekleri grubu dışında) azalma saptandı.

Trafiğin yoğun olduğu bölgelerde kontrol bölgelerine nazaran hem toprakta hem de buralarda yetişen çimen tipi bitkilerde daha yüksek Pb konsantrasyonları tesbit edildi. Toprak, ve bitki örneklerinde yıkama ile Pb konsantrasyonunun azaldığı, dolayısıyla yağmur suları ile bu kirliliğin yayılabileceği sonucuna varıldı.

Key words: *Soil; Plant; Roadside; Lead contamination*

Anahtar Kelimeler: *,Toprak; Bitki; Yolkenarı; Kurşun bulaşması*

Introduction

With the use of fossil energy sources, such as coal and petroleum, environmental pollution has increased. One of the human factors polluting the environment is the exhausts of vehicles. It has been reported that human, animals and plants living

close to main roads with heavy traffic were affected by lead and that their tissues contain more lead than the tissues of those who live remote from main roads(1-3).

Lead tetraethyl, which is regularly added to benzine as an antiknock agent, is known as the main source for lead poisoning(4). As a result of burning, these conponents added to benzine are emitted into the air by exhaust fumes in the form of various lead components such as lead, halojenated compounds, lead oxide and lead oxycarbonate. Therefore, in cities with heavy traffic, the lead concentration in the air may increase up to 1-10 mcg/m^3 or more.

Although solid and liquid fuels combusted in stationary sources can also pollute air depending on their properties, their effects are considered as secondary when compared to the automobile exhausts(5).

Lead in soil results from various municipal and industrial wastes, automobile emissions, decompsition of paints in aged homes and sewage waste(6,7).

Although lead concentrations in soil and dust may range widely, it is present at an average concentration of 12 ppm in the earth's crust. In general, the lead concentration of the surface is higher than that of deeper layers(8).

The lead concentration in plants is generally less than 1 mg/kg in fruits and seeds, 1 to 3 mg/kg in leaves and much more in roots while it is present at high concentrations is soil(9). In various studies, lead concentrations is grass samples have been found to range between 2-5 mg/kg(10).

The initial results of this research conducted in 1996 to determine Pb, Cd, Zn, Ni, Cr and Mn pollution originating from vehicles in Eskişehir have been presented in the Second National Toxicology Congress and published in Acta Pharmaceutica Turcica(11-13). However, since Pb poisoning is of special importance for public health, this paper discusses Pb poisoning in Eskişehir in more detail.

Materials and Method

The present analytical study was conducted on roadside soils and plants from the main roads and streets as subject group and parks remote from traffic as control group, in Eskişehir. Subject samples were taken from 10 and the control samples from 5 different regions. Since point determination was not possible, human and animal samples were not taken into account. The investigations on two groups were conducted in four periods as: March 31, after heavy rain, April 23 and May 5 after mild rain and July 7, 1996 when the soil was dry. The soil samples were taken from 0-15 cm and 15-30 cm depth and plant samples were taken from grass type plants from the same place. All samples, analyzed before and after washing, were extracted for the solution phase as described by Que Hee SS and Boyle Jr. and analyzed for Pb by using Hitachi (180-70) Polarized Zeeman Atomic Absorption Spectrophotometer(14). All the samples were analyzed in triplicate and the mean values were calculated. Statistical analyses were based on "paired t tests" and "t tests for independent samples".

Table 1. Time distribution of Pb Concentrations in the roadside soils (mg/kg)

Date	Samples from surface		Samples from deeper layers	
	Non-washed	Washed	Non-washed	Washed
31.3.1996	49.029	47.296	44.533	43.325
23.4.1996	47.595	46.206	43.208	41.905
5.5.1996	45.983	44.606	41.448	40.392
7.7.1996	44.154	43.343	40.032	38.511

$p=16.68$, $p<0.05$* $t=11.07$, $p<0.05$* $t=15.69$, $p<0.05$* t 12.24, $p<0.05$*
*Comparing the data 31.3.1996 and 7.7.1996

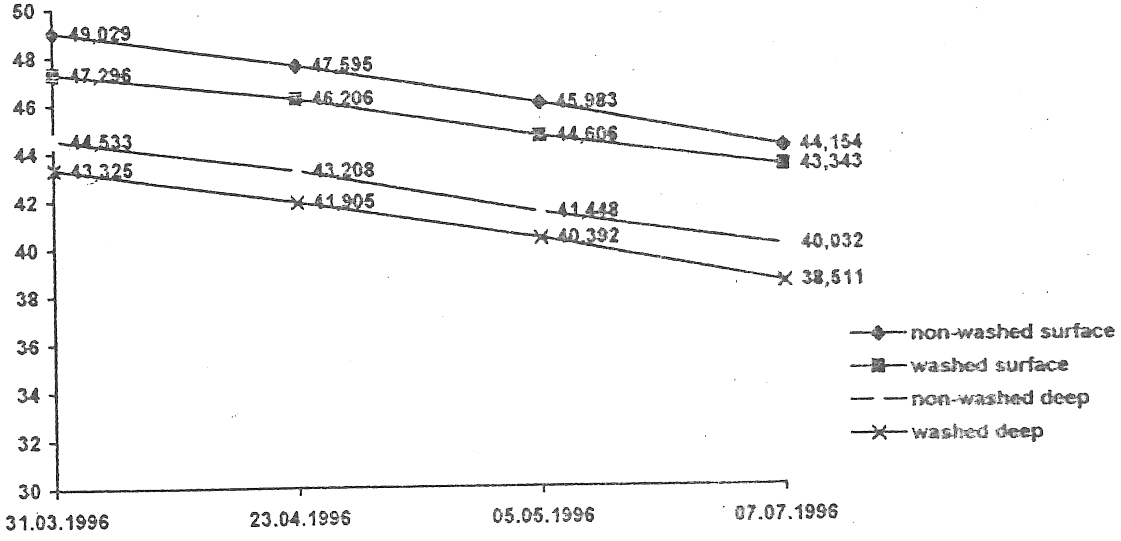

Fig.1. Time distribution of Pb Concentrations in the roadside soils (mg/kg)

Results

Time distribution of Pb concentrations in the roadside soils are given in Table 1 and Fig 1.and soil samples from control areas, roadside and control area plants are given in Tables 1, 2, 3, 4 and Figs 1, 2, 3.

Table 2. Time distribution of Pb Concentrations in soil samples from control areas (mg/kg)

Date	Samples from surface		Samples from deeper layers	
	non-washed	washed	non-washed	washed
31.3.1996	13.265	11.88	11.002	10.372
23.4.1996	12.1	11.063	10.211	9.542
5.5.1996	10.731	9.971	9.144	8.249
7.7.1996	9.928	9.044	8.359	7.429

t=3.93, p<0.05* t=7.45, p<0.05* t= 5.00, p<0.05* t=4.18, p<0.05*
*Comparing the data of 31.3.1996 and 7.7.1996

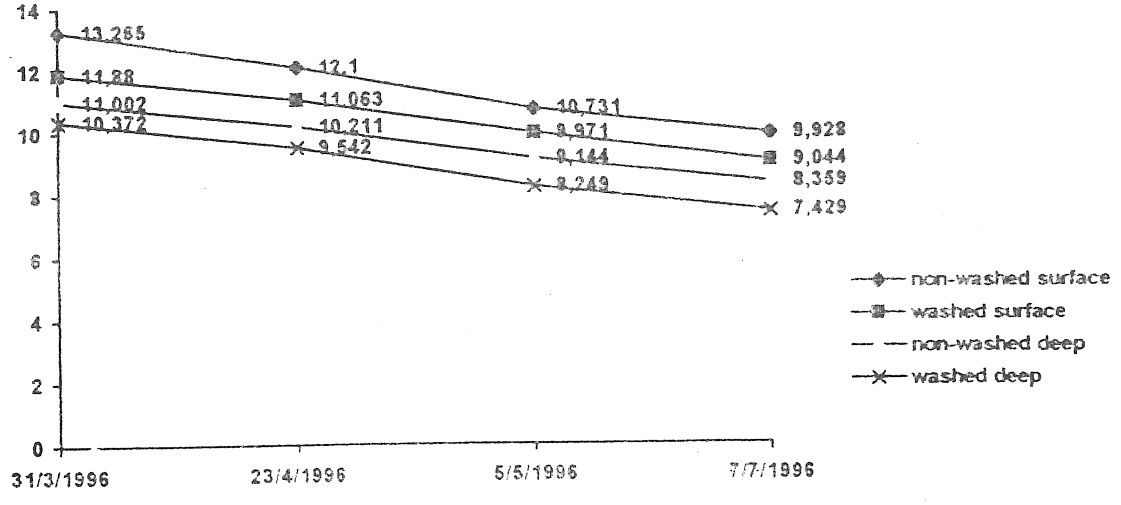

Fig.2. Time distribution of Pb Concentrations in soil samples from control areas (mg/kg)

Table 3. Pb concentrations in the roadside and the control area plants (mg/kg)

		Non-washed plant	washed plant	
subject	mean	15.49	14.18	t=7.29
areas	sd	8.35	7.85	p<0.05
n=10	range	1.751- 26.071	1.612-24.132	
control	mean	2.69	2.33	t=4.51
areas	sd	0.96	0.80	p<0.05
n=5	range	1.721-4.193	1.528-3.625	
		t=3.35	t=3.31	
		p<0.05	p<0.05	

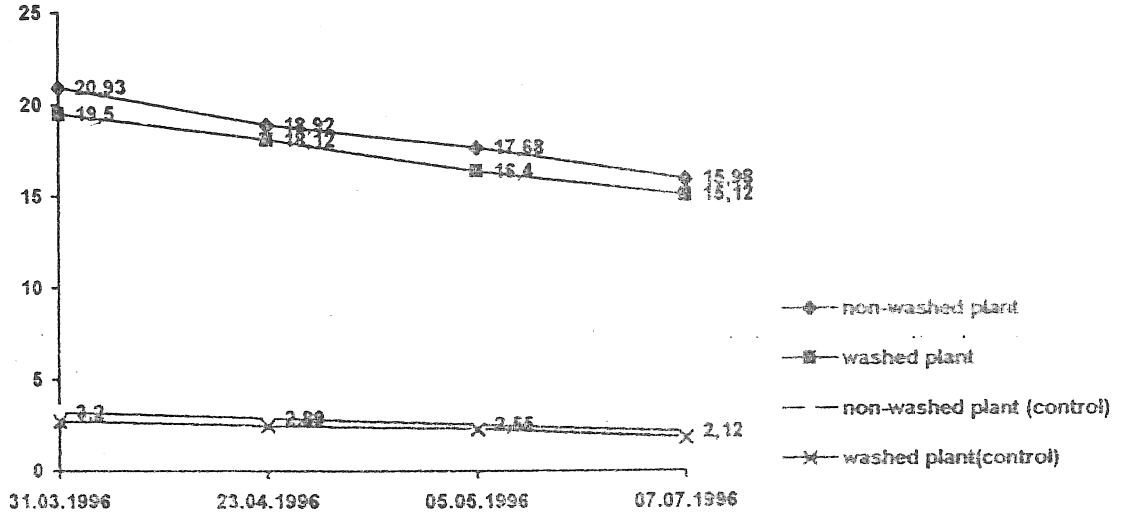

Fig.3. Time distribution of Pb concentrations in the roadside and control area plants (mg/kg)

Table 4. Time distribution of Pb concentrations in the roadside and control area plants (mg/kg)

	Non-washed plant	Washed-plant	Non-washed plant (control)	Washed plant (control)
31.3.1996	20.93	19.5	3.2	2.71
23.4.1996	18.92	18.12	2.89	2.47
5.5.1996	17.68	16.4	2.55	2.3
7.7.1996	15.98	15.12	2.12	1.83

Discussion

The average Pb concentration of surface soil samples from roadsides with heavy traffic (46.69±14.70 mg/kg) was significantly higher than that of control areas (t=5.24, p<0.05). The average Pb concentration in control areas (11.51±1.11 mg/kg) was close to 12 ppm which is given by Grandjean (8) whereas the results obtained from roadsides with heavy traffic were significantly high.

According to Grandjean(8), Pb concentrations in the surface were higher than those in deeper layers. However, in our study no significant differences were observed between the surface and deeper parts for both the subject and control soil samples (respectively t=0.70, p<0.05). Harrison et al.(1981) determined 245-6190 μg/g

Pb in samples from 1-5 cm depths at Lancaster roadsides(15). Victorian et al.(16) determined 30-300 μg/g Pb concentrations in a study carried out in samples from surface soil in Stockholm, and Thornton et al. (17) reported Pb concentrations up to 300 μg/g in a study carried out with surface soil samples from places with heavy traffic in 1990 in England. In this study Pb concentrations ranging from 28.57 to 76.18 mg/kg were found in subject surface soil samples.

In a study carried out in Sapanca by Çap et al.(18) it was found that the Pb concentration of the soils at a 8 m distance from Istanbul-Ankara highway showed an average amount as 44.16 ppm and that this concentration decreased to 16.88 ppm at 100 m distance from the highway(18).

When our subject and control soil samples were washed with deionized water, there were significant decreases in surface samples (respectively $t=13.55$, $p<0.05$; $t=5.64$, $p<0.05$), but no differences were observed in deeper samples (respectively $t=1.36$, $p>0.05$; $t=1.12$, $p>0.05$). Significant differences were observed between the surface and deeper layers in both washed subject and control soil samples (respectively $t=3.13$, $p<0.05$; $t=3.76$, $p<0.05$). These findings support the findings of Grandjean(8) reporting Pb concentrations higher in deeper layers than the surface.

Significant differences in the direction of decrease were observed in all groups (Tables 2, 3 and Figs 1, 2) regarding the data obtained on 31.03.1996 when there was heavy rainfall and 7.7.1996 when the soil was dry.

The average Pb concentration of grass type plant samples, taken from the same places where soil samples were collected, was 15.49±8.35 mg/kg for subject samples and 2.69±0.96 mg/kg for control samples. A significant difference was observed between the subject and control groups ($t=3.35$, $p<0.05$). In the literature, the Pb concentrations of grass type plants have been reported as 2.0-5.0 ppm (10). Mclean et al. reported that, Pb concentrations ranged from 0.65 to 2.05 ppm among grass type plants with a mean of 1.36 ppm(19). These findings match the findings for control areas in our study. Çap et al. found an average of 17 ppm Pb concentration in tree leaves at a distance of 8 m from the highway and 4.50 ppm at a distance of 102 m(18).

Significant differences were observed, regarding washing, in both the subject and control plants (respectively, $t=7.29$, $p<0.05$; $t=4.51$, $p<0.05$).

Considering the data obtained on 31.3.1996 and 7.7.1996, significant differences were observed in the direction of decrease in all of the groups except the washed control plant samples (table 5, Fig 3).

Although Pb concentration decreased in both the soil and plant samples by washing, a high Pb concentration was observed on rainy days when compared to sunny days, This may be due to the fact that dusts on the roads with a high Pb concentration have been carried by rain to roadside soils.

Conclusion

Higher Pb concentrations were determined in both the soil and the plant samples in the areas with heavy traffic.

It is concluded that Pb concentrations decrease by washing in both the soil and plant samples and that this pollution can be transported by rain.

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