# Heavy Metal (Pb and Ni) Accumulation in the Branch and Bark Tissues of Street Tree *Sophora japonica* L.

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**Abstract**
In this research, the authors present the lead and nickel accumulation and its monthly variation in the branches and barks of the street tree, *Sophora japonica* L. in Ankara which has a heavy traffic circulation. Of the trees in the street, the ones near the crossroads and the traffic lambs have a heavier accumulation in their branches and barks. The lead and nickel accumulation especially in the branches and barks increases unexpectedly in the rainy seasons. The lead and nickel accumulates slowly in barks but its ratio depends on the age of tree.
**Key words:** Ankara, Street trees, *Sophora japonica* L., Heavy metal, Lead and nickel accumulation.

## Cadde Ağacı *Sophora japonica*'nın Dal ve Kabuklarındaki Ağır Metal Birikimi

**Özet**
Bu çalışmada, araştırmacılar trafik akışının yoğn olduğu Ankara'da yetişen cadde ağacı *Sophora japonica* L.'nın dal ve kabuklarında biriken kurşun ve nikel miktarının aylık değişimini ortaya koymuşlardır. Trafik ışıkları ve kavşaklara yakın olan ağaçlarda ağır metal birikiminin daha yoğun olduğu tesbit edilmiştir. Yağmurlu mevsimlerde beklenmedik bir şekilde dallardaki ve kabuktaki kurşun ve nikel birikiminin arttığı görülmüştür. Kurşun ve nikel birikimi ağacın yaşına bağlı olarak kabukta dallara göre daha yavaş olmaktadır.
**Anahtar kelimeler**: Ankara, Cadde ağaçları**,** *Sophora japonica* L., Ağır metal, Kurşun ve nikel birikimi.

## Introduction

Plants, which produce oxygen through photosynthesis, enrich and beautify the environment with their green cover; keep and protect the soil by their root systems, and provide shelter for other living beings, are most valuable beings in nature with a great importance in the food chain of the nature and in our ecosystem.

In this research, it is aimed to prove accumulated lead and nickel which come from exhaust gas and from the friction of tires, in the tissues of branches and bark of the *Sophora japonica* L., which are planted on each side of Ankara's streets with heavy traffic indicating the air pollution.

Today our environment is frequently polluted by many harmful matters that come from various sources. Chimney gases, industrial wastes, the exhaust gas of the vehicles leave a lot of harmful matters to the environment. Air pollution gains, besides soil and water pollution, more and more importance in environment pollution. The main causes of air pollution are the rapidly increasing population and consequently urbanization and industrialization.

It is claimed that especially in Turkey air pollution in the cities results from the bad quality of fuel, the inadequacy of burning techniques and to a great degree the heating systems. Additionally, the influence of traffic is even more important. This is because the air pollution coming from the traffic is not seasonal, but continuous throughout the year.

As it is known, large numbers of vehicles enter traffic every day in Turkey. This number is about 45.000–50.000 vehicles per month. The inevitable result of this, is that the amount of lead and other metals accumulating in the environment increases. This situation adds a new problem to the environmental problems in Turkey, which are getting more and more popular. It is not difficult to predict the dimension of pollution on the plants which will be exposed in such a polluted environment.

## Materials and Methods

For the research carried out in Ankara, we chose sample plots on both sides of the

streets with a heavy traffic circulation and where nearly 4700 vehicles pass per hour. From the *Sophora japonica* L. which are planted on the sidewalks on both sides of the street, branch and bark samples were collected in the months October, November, and December 1996, when the traffic is the heaviest because of rain and snow fall. Since the Japanese *Sophora* is a deciduous tree, and our work was carried out in the winter months, we just worked on only branch and bark samples. Considering that the accumulation on the side of the tree facing the street will be different from that on the back side of the tree, bark samples were only taken from the front side of each tree

**The taking of samples**

Trees from six different site were chosen: 5 experimental trees on the streets, and 1 control tree in the Park at Turgut Reis Street where traffic and pollution is very less. In the months indicated, branch samples were taken from each tree at a height of 2 m. from branches 3–4 years of age (the age was determined by counting the nodes) by using pruning scissors. The bark samples were taken from each tree at a height of 75–100 cm. without harming the wood tissue.

**Extraction**

The taken samples were put in plastic bags, labeled, and brought to the laboratory. They were washed with distilled water in order to clean the gathered particles on the surfaces. Then they were dried for 24 hours in room temperature. After this, they were given numbers, put in certain amounts (1–5 g) into 35 cc porcelain crosses for which the tare was allowed, dried for 24 hours in the hot air stove at 100 $^{o}$C and weighed on a sensitive balance, by which its dry weight was determined. Then it was burned for 4 hours at 600 $^{o}$C in a burner oven with thermostat, until it turned to white ash. After that 10 ml 1,5 N HCl (Merck, pure) was added to it and it was mineralized 1/2 hour on a hot plate at 80 $^{o}$C. Then it was filtered by means of a glass funnel through a coarse filter paper into 50 cc seized gauging balloons and completed to 50 ml with distilled water. (Devas, 1978; Toker ve ark., 1990). Later these prepared extracts were transferred into closed, colored, 100 cc seized sample bottles. In this way from every sample to three parallel was prepared and all this procedure was carried out every month.

**Method of measuring**

The amount of Pb and Ni in the extracts has been measured with the A.A.S device HITACHI Model 180–80, at mode Zeeman A. A, with double ray ways, by using air-acetylene flame and by performing deuterium background correction. The following parameters were chosen and used during the study (Table1). 5 time with 5 seconds intervals the figures were read, average values were taken and amount of Pb and Ni in the solution was calculated and indicated as ppm (mg/kg) D.W.

Table 1. The parameters were chosen and used during the study

| | |
|---|---|
| Wave length (nm) | 283.3 |
| Slit interval (nm) | 1.3 |
| Lamp flow (μA) | 7.5 |
| Flame | Air-Acetylene |

**Results**

In the branch and bark samples taken in October, November, and December from trees at the sites on Streets which are exposed to heavy traffic, quite high accumulation of Pb and Ni was evident. On the other hand, in branch and bark samples taken from the control tree, Pb and Ni accumulation was quite low in regard to the experimental trees. Pb and Ni concentrations of the control and the other experimental trees are presented in Table 2 to 7.

Table 2. Sample types of the tree in site 1 and proved Pb and Ni concentrations [ppm (mg/kg) D.W. (dry weight)]

| DATE | Pb (Lead) | | Ni (Nickel) | |
|---|---|---|---|---|
| | Branches | Bark | Branches | Bark |
| 1994 October | 15 | 54 | 11 | 40 |
| 1994 November | 12 | 20 | 9 | 27 |
| 1994 December | 26 | 75 | 35 | 66 |

Table 3. Sample types of the tree in site 2 and proved Pb and Ni concentrations [ppm (mg/kg) D.W.]

| DATE | Pb (Lead) | | Ni (Nickel) | |
|---|---|---|---|---|
| | Branches | Bark | Branches | Bark |
| 1994 October | 19 | 70 | 25 | 90 |
| 1994 November | 10 | 55 | 19 | 36 |
| 1994 December | 37 | 94 | 38 | 71 |

Table 4. Sample types of the tree in site 3 and proved Pb and Ni concentrations [ppm (mg/kg) D.W.]

| DATE | Pb (Lead) | | Ni (Nickel) | |
|---|---|---|---|---|
| | Branches | Bark | Branches | Bark |
| 1994 October | 66 | 89 | 52 | 62 |
| 1994 November | 34 | 51 | 21 | 35 |
| 1994 December | 77 | 102 | 49 | 72 |

Table 5. Sample types of the tree in site 4 and proved Pb and Ni concentrations [ppm (mg/kg) D.W.]

| DATE | Pb (Lead) | | Ni (Nickel) | |
|---|---|---|---|---|
| | Branches | Bark | Branches | Bark |
| 1994 October | 70 | 90 | 38 | 99 |
| 1994 November | 33 | 47 | 28 | 71 |
| 1994 December | 92 | 127 | 47 | 169 |

Table 6. Sample types of the tree in site 5 and proved Pb and Ni concentrations [ppm (mg/kg) D.W.]

| DATE | Pb (Lead) | | Ni (Nickel) | |
|---|---|---|---|---|
| | Branches | Bark | Branches | Bark |
| 1994 October | 110 | 121 | 80 | 130 |
| 1994 November | 73 | 81 | 60 | 75 |
| 1994 December | 139 | 199 | 87 | 154 |

Table 7. Sample types of the tree in site 6 and proved Pb and Ni concentrations [ppm (mg/kg) D.W.]

| DATE | Pb (Lead) | | Ni (Nickel) | |
|---|---|---|---|---|
| | Branches | Bark | Branches | Bark |
| 1994 October | 13 | 27 | 10 | 23 |
| 1994 November | 8 | 11 | 7 | 15 |
| 1994 December | 21 | 32 | 23 | 27 |

**Discussion**

As can be recognized from the high evidence of Pb and Ni concentrations in the control and experimental trees on which we studied in our research work, the main source for Pb and Ni pollution in nature is the motorized vehicles traffic. Together with other living beings especially the plants on the street sides are influenced and largely harmed by the Pb and Ni pollution in the environment. Various researches have shown that this pollution of which the main source are motorized vehicles, cause the accumulation of heavy metals like Pb and Ni in plants, and that the amount of Pb and Ni decreases as you get away from the street.

The findings also show that the amount of Pb and Ni in different plant organs, though within 3 months, exhibits monthly changes depending on the traffic. This indicates that the amount of Pb and Ni in different organs of the plants depends in short periods, even if monthly, on traffic, monthly rainfall, and various climatic conditions. Monthly total precipitation (Pi) is shown in Table 8.

Table 8. Monthly total precipitation (Pi) mm*

| | | |
|---|---|---|
| October | 1994 | 48.1 |
| November | 1994 | 13.2 |
| December | 1994 | 66.7 |

The fact that there was a little more evidence of Pb and Ni in the control tree then had been expected, shows that Pb and Ni granules, very little of size, are carried over long distances by the ascending and circulating air. Similar evidence, which prove this result, was by Lagerwerf (1971).

Furthermore, it has been proved through the studies that these heavy metals (Pb and Ni) can be carried over up to 100 km per year, and ever hundreds of km away traces of them have been found. Another reason for the high values in the control tree is that Turgut Reis Street nevertheless has a little traffic circulation. That we carried out our study in the rainy months and that in these months there was evidence of high Pb and Ni concentration is because there is more traffic in the rainy months. Türkan (1982) and Bingöl (1992) came in his study to a similar result, which supports these findings. According to the results, there are different accumulation of Pb and Ni in different tissues in different months. This shows that the surface structures of the plant organs affect the ability of accumulating Pb and Ni. In examinations of bark with rough surfaced plant tissues, the highest amount of accumulation was found directly proportional to the tree's age. And in branch samples again directly proportional to the tree's age 2. degree accumulation was proved. Similar studies with ours have been carried out (Page et al., 1971; Bingöl, 1992; Fidora, 1972; Hampp, 1973; Türkan, 1982; Öztürk ve Türkan, 1982; Özörgücü ve Türkan, 1985; Başlar et al., 2003). Pb and Ni concentrations at branches and barks according to months are shown in Table 3-8. As it is known many motorized vehicles enter traffic every day in Turkey and cause the traffic to grow heavier day by day. Experts point out, that tetra ethyl lead and tetra methyl lead will continue to be use in gasoline as anti-knock material as long as no material of equal value can be found (Bingöl, 1992; Türkan, 1982). It is not difficult to predict that if it continues in this way, the amount of Pb and Ni accumulation in plants, which we tried to prove, will reach, in near future, the amount of some other countries. But in spite of all these, the use of unleaded gasoline has increased in recent years, especially in our country and in the U.S.A. Regarding the fact that approximately 200 ppm of lead can kill growing up small animals, it becomes clear how great the danger is. In our opinion, increase in this danger can be prevented, by certain measures against the accumulation and pollution of Pb and Ni in the most valuable creatures in our ecosystem the plants, which we tried, though in a limited extent, to exhibit.

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