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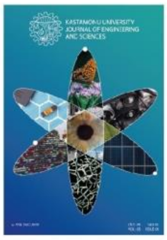

Change of B and Ag concentrations due to traffic density in some plants growing in Samsun city center

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Abstract: Increasing population and industrialization have brought air pollution, air pollution has increased to a level that threatens human health in some cities and has become one of the most important agenda topics of today. In the city, many pollutants arise from exhaust gases, car wheels, vehicles, and vehicle wear. Because heavy metals can remain in nature for a long time without deterioration and their concentration in the environment is constantly increasing. Therefore, the determination of heavy metal concentration is of great importance in terms of determining the risky areas and risk level. Biomonitors are the most important indicators that show the change in the concentration of heavy metal pollution in the atmosphere. In this study, it was tried to determine the changes in the concentrations of B and Ag elements based on organ washing and traffic density in *Euonymus japonica* (Ej), *Juniperus sabina* (Js), and *Buxus sempervirens* (Bs), which can be used to monitor traffic-induced heavy metal concentration. Leaf and branch samples were collected from the individuals of the plant species that are the subject of the study, grown in areas with heavy traffic, low density, and no traffic, washing process was carried out in some of the samples, and heavy metal analyzes were made in the prepared samples, and the concentrations of B and Ag elements were determined. It was determined that different species accumulate heavy metals at different levels, and the changes in the concentrations of the elements vary depending on the organ and traffic density on the species basis.

Keywords: Heavy metal, Biomonitor, Traffic, B, Ag

Öz: Artan nüfus ve sanayileşme, hava kirliliğini de beraberinde getirmiş, hava kirliliği bazı şehirlerde insan sağlığını tehdit edecek düzeyde artmış ve günümüzün en önemli gündem konularından birisi haline gelmiştir. Kent içerisinde egzoz gazları, araba tekerleri, araçlar ve araç aşınmalarından kaynaklanan pek çok kirletici madde ortaya çıkmaktadır. Bunlar arasında özellikle ağır metaller büyük öneme sahiptir. Zira ağır metaller doğada bozulmadan uzun süre kalabilmekte ve çevredeki konsantrasyonu da sürekli artmaktadır. Ayrıca biyobirikme eğilimindedir. Bundan dolayı ağır metal konsantrasyonunun belirlenmesi, riskli bölgelerin ve risk düzeyinin tespit edilmesi açısından büyük öneme sahiptir. Ağır metal kirliliğinin atmosferdeki konsantrasyonunun değişimini gösteren en önemli belirteçler biyomonitörlerdir. Bu çalışmada da trafik kaynaklı ağır metal konsantrasyonunun izlenmesinde kullanılabilen *Eonymus japonica* (Ej), *Juniperus sabina* (Js) ve *Buxus sempervirens* (Bs) türlerinde B ve Ag elementlerin konsantrasyonlarının organ bazında yıkama durumu ve trafik yoğunluğuna bağlı değişimi belirlenmeye çalışılmıştır. Çalışma kapsamında çalışmaya konu bitki türlerinin, trafiğin yoğun olduğu, az yoğun olduğu ve trafiğin bulunmadığı alanlarda yetişen bireylerinden yaprak ve dal örnekleri toplanmış, örneklerin bir kısmında yıkama işlemi gerçekleştirilmiş ve hazırlanan örneklerde ağır metal analizleri yapılarak B ve Ag elementlerinin konsantrasyonları belirlenmiştir. Çalışma sonucunda farklı türlerin ağır metalleri farklı düzeyde biriktirdiği, elementlerin konsantrasyonlarındaki değişimin de tür bazında organ ve trafik yoğunluğuna bağlı olarak değişiklik gösterdiği belirlenmiştir.

Anahtar Kelimeler: Ağır metal, Biyomonitor, Trafik, B, Ag

1. Introduction

In addition to the increase in the world population in recent years, the gradual increase in the population living in urban centers has brought along many problems [1-25]. In this process, as a result of traffic and other anthropogenic activities, especially in urban centers, various elements, many of which are dangerous for life, are found in soil [26-30], water [31-38] and air [39-56] concentrations in various organs of animals [57] and plants [58-73] growing in these environments are constantly increasing. As a result, nature is destroyed and indirectly problems such as global climate change arise [3, 6, 8, 43, 71, 74-77].

Air pollution is considered the most dangerous among environmental pollution [46, 52, 53, 54, 56, 61, 78]. Air pollution is one of the most important problems of today [46, 47-49, 52-56, 61, 74-76]. It is stated that approximately 7 million people in the world die every year due to air pollution-related reasons [46, 52-56, 79]. It is stated that even in Turkey, whose air is considered quite clean compared to many countries, 29 thousand people lost their lives due to air pollution in 2016 [56].

Among the components of air pollution, heavy metals have a special importance because they tend to bioaccumulate and can be toxic to human health even at low concentrations [80-82]. Studies show that almost all metals have a toxic effect when taken above a certain amount [83]. Since heavy metals are so important for human health, it is extremely important to determine the heavy metal concentration in the air and to monitor its change, to determine the risky areas and the risk level [42].

The change of heavy metal pollution in the atmosphere can be determined by direct and indirect methods. However, direct measurement of heavy metal pollution in the atmosphere; has disadvantages such as being expensive, not being able to determine the direct effect of atmospheric pollution on the ecosystem, and not providing data for the periods before the measurement time [59]. In addition, these methods usually require expensive measuring instruments and carry a higher risk of contamination compared to bioindicators. One of the most effective methods used to detect air pollution is bioindicators. In addition to being cheap and easy, this method can provide more reliable data on the periodic change of heavy metal concentration [39].

Landscape plants, which are most exposed to air pollution, are the best indicator of this pollution. It shows the course of the increase in the heavy metal concentration in the air over time by accumulating heavy metal pollution caused by fossil fuels on its stem, leaves, and needles, especially in areas with heavy traffic [34, 65, 84]. Therefore, instead of directly detecting heavy metal pollution, bioindicators or biomonitors are often used as an indicator of pollution [68, 69]. This study, it was aimed to determine the change of heavy metals B and Ag concentrations in some landscape plants grown in Samsun city center depending on plant type, plant organ, washing status, and traffic density.

2. Material and Method

Material

The study was carried out on samples collected from the city center of Samsun. Within the scope of the study, it is grown in areas with heavy traffic, low density, and no traffic (at least 100 m near there is no highway) and frequently used in landscaping; Samples were collected from plant species *Euonymus japonica* (Ej), *Juniperus sabina* (Js) and *Buxus sempervirens* (Bs). The samples were taken from the last year's shoot, that is, the one-year-old part, by cutting with pruning shears, and packaged, labeled, and brought to the laboratory.

Method

The samples brought to the laboratory after being collected and labeled were laid on cardboard and subjected to the separation process. Leaves and branches are separated, grouped, and labeled. Then half of the samples were separated and subjected to the washing process. In the washing process, firstly the samples were washed with tap water, then they were placed in a bottle, water was added, and the particulate matter adhering to the surface of the samples was tried to be removed by shaking rapidly. Afterward, the process was repeated by draining the dirty water and filling it with clean water. After the color of the water became clear, the same procedure was performed three times with distilled water, and the samples, which were taken out of the last bottle, were washed again with distilled water. Within the scope of the study, the samples that were washed were coded with (+) and the samples that were not washed were coded with (-) signs. Afterward, the samples were broken into pieces for easy drying and placed in glass petri dishes, and labeled again. The samples prepared in this way were kept for 15 days to become room-dry, and the laboratory was ventilated every day during this period. The air-dried samples were dried in an oven at 45°C for one week to dry them completely.

Statistical Analysis

The data obtained as a result of the study were entered into the excel program and evaluated with the help of the SPSS 22.0 statistical package program. Analysis of variance was applied to the data with the help of the SPSS program and homogeneous groups were obtained by applying the Duncan test to the data with $p<0.05$, that is, at least 95% confidence level differences. The obtained data were simplified, processed into tables, and interpreted.

3. Result

In the samples subject to the study, the variation of the B concentration in the areas where there is no traffic, where there is little or no traffic, analysis of variance and Duncan test was applied to the data, the average values obtained, the F value and significance level obtained as a result of the analysis of variance, and the homogeneous groups formed as a result of the Duncan test is given in Table 1.

Table 1. Variation of B (ppm) concentration depending on species, organ, and washing condition

Species	Organ	Washing	TRYOK	TRAZ	TRCOK	F Value
Ej	leaf	+	23,78 gB	21,65 hA	32,48 hC	2151,1***
		-	30,80 hC	23,97 iA	25,96 gB	702,5***
	Branch	+	23,68 gB	35,34 jC	15,46 fA	5201,2***
		-	30,35 hC	9,85 eA	12,17 dB	15161,8***
Js	leaf	+	10,97 dA	10,46 fA	14,17 eB	90,6***
		-	17,51 eC	4,53 cAB	14,77 ef	12422,1***
	Branch	+	5,34 bB	1,74 aA	6,62 bC	226,4***
		-	8,27 cB	3,55 bA	10,06 cC	779,1***
Bs	leaf	+	67,58 iC	48,96 lA	51,97 jB	1234,5***
		-	69,95 jC	46,40 kA	47,28 iB	3761,8***
	Branch	+	18,71 fC	12,84 gB	9,97 cA	107,1***
		-	3,48 aB	7,75 dC	1,57 aA	1736,6***
	F Value		13286***	10541***	4630***	

***: p<0,001; **: p<0,01

When the results of the analysis of variance are examined, it is seen that the traffic density in all organs subject to the study and the change in B concentration based on organs in all traffic densities is statistically significant at the 99.9% confidence level. When the average values are examined; The B concentration is between 3.48 ppm and 69.95 ppm in the area where there is no traffic; between 1.74 ppm and 48.96 ppm in low traffic areas; and it is seen that it varies between 1.57 ppm and 51.97 ppm in areas with heavy traffic. It is very difficult to say that there is a linear relationship between traffic density and B concentration.

In the samples subject to the study, the Ag concentration was not trafficked; the change was determined in the areas where it is less dense and dense. Analysis of variance and Duncan test were applied to the data, mean values obtained; F value and significance level obtained as a result of variance analysis, and homogeneous groups formed as a result of Duncan test are given in Table 2.

Table 2. Variation of Ag concentration depending on traffic density based on species, organ, and washing

Species	Organ	Washing	TRYOK	TRAZ	TRCOK	F Value
Ej	leaf	+	719,0 eA	1113,3 bB	604,6 cdA	39,6***
		-	723,3 eB	255,3 aA	306,3 abcA	23,0***
	Branch	+	148,0 aA	2374,3 cdC	414,3 abcdB	274,9***
		-	351,6 abcA	2237,6 cB	2103,3 eB	32,022**
Js	leaf	+	209,3 abc	228,3 a	199,6 ab	0,337 ns
		-	607,0 deA	1051,0 bB	716,0 dA	16,095**
	Branch	+	415,3 bcdA	2613,0 deB	319,6 abcA	243,2***
		-	181,3 abA	2739,6 eB	2239,3 eB	69,8***
Bs	leaf	+	230,3 abc	188,0 a	333,0 abc	1,801 ns
		-	431,6 cd	516,3 a	511,0 bcd	1,892 ns
	Branch	+	1989,0 fB	2683,6 deC	161,6 aA	926,7***
		-	2795,6 g	2174,0 c	2303,6 e	4,391 ns
	F Value		126,5***	86,6***	69,8***	

***: p<0,001; **: p<0,01

According to the results of the analysis of variance regarding the change in Ag concentration, the change in Ag concentration based on organs is statistically significant in all traffic densities. However, the change of Ag concentration in washed Js leaves, Bs leaves and unwashed Bs rafts depending on traffic density is not statistically significant. When the Duncan test results are examined; Ag concentration is between 148.0 ppb and 2795.6 ppb in the area where there is no traffic; between 188.0 ppb and 2739.6 ppb in low traffic areas; and it is seen that it varies between 161.6 ppb and 2303.6 ppb in areas with heavy traffic. It is noteworthy that, in general, the highest concentrations were obtained in the Bs branches.

4. Discussion and Conclusion

Within the scope of the study, the change of B and Ag elements depending on the traffic density based on species, organ, and washing status was determined. Although many studies have been carried out on heavy metals to date, many studies have been carried out on elements such as Pb, Cd, Ni, Co, Cr [66, 67], and the elements subject to the study have been largely neglected. However, it is stated that when all heavy metals are taken above a certain rate, they can be harmful to health, and especially heavy metals taken by inhalation can be much more harmful.

The results of the study show that the changes in both heavy metals based on organs are at a statistically significant level at all traffic densities, and there can be great differences in heavy metal concentrations between species and organs. In the studies carried out to date, it has been revealed that the heavy metal concentration varies significantly based on species, and it has been stated that the changes based on species can be tens of times [85, 86]. The change of heavy metal concentrations based on organs has also been the subject of many studies, and in these studies, it has been revealed that the heavy metal accumulation potentials of different organs of different species differ significantly [87].

The significant variation in heavy metal concentrations on both species and organ basis is primarily related to the anatomical structure of the plant organ [88]. Heavy metal accumulation in organs; The physical and chemical properties of metals vary depending on factors such as forms, the morphology of organs, surface area, surface texture, exposure time to heavy metals, environmental conditions, and gas exchange [60]. In addition, heavy metal accumulation in plant organs varies greatly depending on the plant habitus [62]. Plant habitus is formed under the mutual interaction of plant genetics [45, 89-91] and environmental conditions [73, 92-94]. Therefore, environmental conditions that affect plant life conditions also greatly affect heavy metal accumulation in plant organs [59]. Within the scope of the study, it was determined that there could be a significant difference between the washed and unwashed samples. It is reported that heavy metals can adhere to various particles in the atmosphere after leaving their source, and thus most of the metals coexist with the particles in the atmosphere [83]. Particulate matter (PM) contains a complex mixture of various heavy metals in the atmosphere, many of which are harmful. Therefore, particulate matter contaminated with heavy metals can cause serious problems in terms of human and environmental health [63]. Therefore, many studies have been conducted on PM [95]. Another factor evaluated within the scope of the study is traffic density. It is stated that one of the most important sources of heavy metal pollution is traffic activities [42]. In many studies, it has been determined that heavy metal concentrations in plant organs vary significantly depending on traffic density [88]. In this study, it is very difficult to say that there is a linear relationship between the concentrations of the elements in the study and the traffic density. This result can be interpreted as the elements in the study are not emitted from traffic-related pollutants. Traffic is one of the important sources of heavy metal pollution, and there are many sources, especially industrial activities [40, 41].

Studies carried out to date have shown that the diffusion of heavy metals in the atmosphere and their entry into the plant body is a very complex mechanism [59]. The mutual interaction of plants with heavy metals and therefore heavy metal accumulation in the plant is closely related to plant metabolism [96]. Therefore, the stress level of the plant [97-99], plant origin [61, 63, 65], hormone applications [90, 91, 100] and genetic structure [101] affect heavy metal absorption and thus heavy metal concentration in plants [60]. Some of researches with landscape architecture mentioned the planning and management for selecting plants [102-129]. These research explained the landscape plants for use.

As a result, the change of heavy metal concentration in plants is the result of a complex mechanism depending on the interaction of many factors. However, this mechanism has not been fully resolved. Information on the uptake of heavy metals from aboveground organs is very limited [96].

5. Recommendations

One of the most important problems of today is air pollution. Air pollution has gained special importance with the increase in the level of awareness on this issue as well as the population density in the city centers, and many studies have been carried out on the importance of this issue and the solution of the problem. Among the solution proposals, increasing green areas is seen as one of the most effective methods. Because plants can significantly reduce air pollution.

However, the effects of different species on different pollution factors are at different levels. Although a large number of plant species have been studied in studies carried out so far, these studies are not yet at a sufficient level. There is no information about the potential of many plant species to accumulate heavy metals. However, as in this study, it has been determined that there are great differences between the heavy metal accumulation potential of plant species in many studies. Therefore, it is necessary to use the species that are not included in the studies in similar studies and to identify plants that can be more effective in monitoring and reducing heavy metal pollution. Therefore, it can be suggested that similar studies be continued by diversifying.

The importance of heavy metals in terms of human health is known and there are many studies on this subject. However, studies mostly focus on elements such as Pb, Ni, Cr, Co, Cd. However, it is necessary to intensify studies and identify risky areas on elements such as B, Ag, Ga, As, which can be extremely harmful to human health, but have not been given much importance and studied so far.

Competing Interest / Conflict of Interest

The author declare that they have no competing interests

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