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The Possibilities of Using Blue Spruce (*Picea pungens* Engelm) as a Biomonitor by Measuring the Recent Accumulation of *Mn* in Its Leaves

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ABSTRACT

Nowadays, air pollution has reached life-threatening levels in some cities, and worldwide, it has reached a level where millions of people lose their lives every year. Heavy metals (HMs), in particular, are among the significant components of air pollutants, as heavy metals are non-biodegradable and their concentration in the environment is constantly on the rise. They also tend to bio-accumulate. Therefore, identifying heavy metal concentrations in nature is of great importance in terms of identifying risky regions and risk levels. This study investigates the possibility of using the perennial Blue Spruce (*Picea pungens*) needles as a biomonitor and to measure the recent change in Mn concentrations in these organelles. As part of the study, the changes in the concentration of Mn levels according to the organelles ages and whether the sampled organelles were washed or unwashed were evaluated. The results of the study show that Mn concentration varies significantly depending on the organelle, its age, and whether its washed or unwashed.

Anahtar Kelimeler:
Mangan,
Ağır metal,
Biyomonitör,
Picea pungens Engelm,
Yapraklar.

ÖZ

Günümüzde hava kirliliği her yıl milyonlarca insanın sağlığını etkileyen en önemli çevre sorunlarından birisidir. Hava kirliliği etmenleri arasında ağır metaller biyobirikme eğiliminde olmaları, insan sağlığı açısından düşük konsantrasyonlarda bile toksik olmaları sebebiyle ayrı bir öneme sahiptir. Bundan dolayı ağır metallerin izlenmesi büyük önem taşımaktadır. Bu çalışmada da mavi ladin (*Picea pungens* Engelm) ibrelerinin yakın geçmişteki Mn konsantrasyonunun değişiminin izlenmesinde biyomonitor olarak kullanılabilme olanakları araştırılmıştır. Çalışma kapsamında Mn elementinin konsantrasyonunun, yıkanan ve yıkanmayan ibre, kabuk ve dal organlarında organ yaşına bağlı olarak değişimi değerlendirilmiştir. Çalışma sonuçları, Mn konsantrasyonunun organ, yıkanma ve organ yaşına bağlı olarak önemli ölçüde değiştiğini ortaya koymaktadır.

1. Introduction

Air pollution is one of the most important environmental problems in today's world. In addition to the continuous increase in the population across the globe, migration from rural to urban areas contributes heavily towards increasing pollution. Air pollution has become a problem that causes millions of people to die every year [1-18].

As mentioned previously, heavy metals play a dangerous part. While some heavy metals are beneficial to plants, (Fe, Cu, Zn, Mn, Mo) are essential for plant growth, (V, Co, Ni) stimulate plant growth), high concentrations of HMs have a toxic effect on both plants and other living things [19]. Therefore, monitoring HMs concentrations is extremely important.

When Mn, one of the most high-stress heavy metals, reaches people through the food chain, signs of toxicity are observed primarily in the respiratory system and in the brain. Symptoms of manganese intoxication include hallucinations, exhaustion, insomnia, weakness, amnesia, and nerve damage. Mn can also cause Parkinson's disease, lung embolism and bronchitis, while exposure to Mn toxicity in men may cause impotence [20].

Landscape plants that are most exposed to air pollution are the best indicator of this type of pollution. They show the progress of heavy metal concentration in the air by accumulating heavy metal pollution caused by fossil fuels especially in traffic intensive areas in their trunks, leaves and needles [8-12,14,16,21-22]. Therefore, instead of directly detecting heavy metal pollution, bioindicators or biomonitors are frequently used to measure pollution levels [16,22-34].

In this study, the possibility of using blue spruce (*Picea pungens* Engelm) needles as a biomonitor for monitoring the change of recent Mn concentration was investigated. Within the scope of the study, the change of the concentration of the Mn element in the wash and non-wash pointer, shell and branch organs depending on the age of the organ was evaluated.

2. Material and Method

The study was carried out on the side branches of a *Picea pungens* (Blue Spruce) tree from the city center of Ankara. The samples were taken by cutting the side branches of the Picea pungens tree, which is commonly used in landscaping, and brought to the laboratory. The branches were then cut and classified according to their age.

The classified samples were divided into two groups and washing was carried out in a group. In the washing process, the needle, shell and branches were first washed with plenty of water, then 1/3 of a large glass jar was filled with water and the pieces were thrown into the jar. The jar was rinsed with vigorous shaking for several minutes, and the process was repeated at least three times until the water was clear. After the water has started to maintain its clarity, this process was repeated three times with pure water to completely remove particulate matter adhering to the organs. Washed samples were spread on towel paper and lightly pressed again with the help of towel papers to remove excess water.

After washing a part of the organs, the needle, branch and shell parts were separated from each other. The shell samples were taken from the main part on the lateral branch and the branch samples from the lateral branches on the lateral branch. The bark samples were taken out of the branch by stripping and the branches were taken together with the more thin branches and the wood and the bark were not separated.

The samples were then left to dry for 15 days and were then dried in an oven at 45°C for one week. The dried samples were ground into powder and weighed 0.5 g and were placed in tubes designed for a microwave. 10 ml of 65% HNO3 was added to the samples. The prepared samples were then burned at 280 PSI in the microwave device and 20 minutes at 180 ºC. The tubes were removed from the microwave after the processes were completed and were allowed to cool. Cooled samples were added to 50 ml by adding deionized water. The prepared samples were read on the ICP-OES device at appropriate wavelengths after filtering through the filter paper. The data obtained were analyzed by using SPSS package program and variance analysis was applied to the data. The values were statistically analyzed by using Duncan test. The obtained data were simplified and interpreted.

3. Result and Discussion

The change in organ based on organ age was determined and the mean values on organ basis and F value obtained as a result of variance analysis, error rate and the groupings formed as a result of Duncan test are given in Table 1.

Table 1. Changes in Mn (ppm)

Age	Organ						F values	Error
	Needle		Bark		Branch			
	+	-	+	-	+	-		
1	43,46 c	34,28 a	40,89 b	83,35 f	54,01 e	50,70 d	16469,8	,000
2	40,26 b	88,80 f	23,71 a	58,92 e	41,67 c	49,51 d	35872,0	,000
3	39,01 a	50,19 c	52,10 d	63,90 e	47,50 b	66,93 f	4550,8	,000
4	74,93 e	168,8 f	21,72 a	39,96 b	57,77 d	46,76 c	333947,3	,000
5	50,40 c	80,46 e	18,61 a	59,87 d	50,58 c	48,51 b	41436,3	,000
6	54,65 c	97,01 e	35,78 a	80,20 d	50,30 b	54,75 c	20638,4	,000
7	88,14 d	117,2 e	73,71 b	77,61 c	128,05 f	46,86 a	14907,5	,000

When the values of the table are examined, it is seen that the change in Mn concentration of organ in all ages is statistically significant at 99.9% confidence level. When the mean values and the groupings formed as a result of the Duncan test are examined, the difference between the washed and unwashed samples is noteworthy. The values obtained in the samples washed in the shell are lower than the values obtained in the unwashed samples. In addition, when compared to the branch and shell samples, the values obtained are generally higher in the washed samples and the values obtained in the shell in the unwashed samples.

The change in the concentration of Mn according to organ was determined according to the age of the organ and the mean values on the basis of the organ and the F value obtained as a result of the analysis of variance, the error rate and the groupings formed as a result of Duncan test are given in Table 2.

Table 2. Change of Mn (ppm) Element by Year

Age	Organ					
	Needle		Bark		Branch	
	+	-	+	-	+	-
1	43,46 c	34,28 a	40,89 e	83,35g	54,01 d	50,70 d
2	40,26 b	88,80 d	23,71 c	58,92 b	41,67 a	49,51 c
3	39,01 a	50,19 b	52,10 f	63,90 d	47,50 b	66,93 f
4	74,93 f	168,84 g	21,72 b	39,96 a	57,77 e	46,76 a
5	50,40 d	80,46 c	18,61 a	59,87 c	50,58 c	48,51 b
6	54,65 e	97,01 e	35,78 d	80,20 f	50,30 c	54,75 e
7	88,14 g	117,24 f	73,71 g	77,61 e	128,05 f	46,86 a
F Values	14089,13	54421,35	52024,3	10057,90	24263,7	7765,5
Error	,000	,000	,000	,000	,000	,000

When the values of the table are analyzed, it is observable that the change of Mn concentration in all organs due to organ age is statistically significant at 99.9% confidence level. When the changes in the age of the organ are examined, it can be said that there is a general shot depending on the age. The change in bark and wood can be described as irregular. It is observed that the change in the Mn concentration on a year-on-year basis is generally horizontal, especially when there is no significant change in the branches. The Mn concentration in the unwashed branches ranged from 47.76 ppm to 66.93 ppm, while the Mn concentration in the washed branches ranged from 41.67 ppm to 54.01 ppm, except for the seven-year-old hands. However, the change in the hands is sometimes more than five times. The change of Mn concentration in terms of organ and organ age is given graphically (Figure 1).

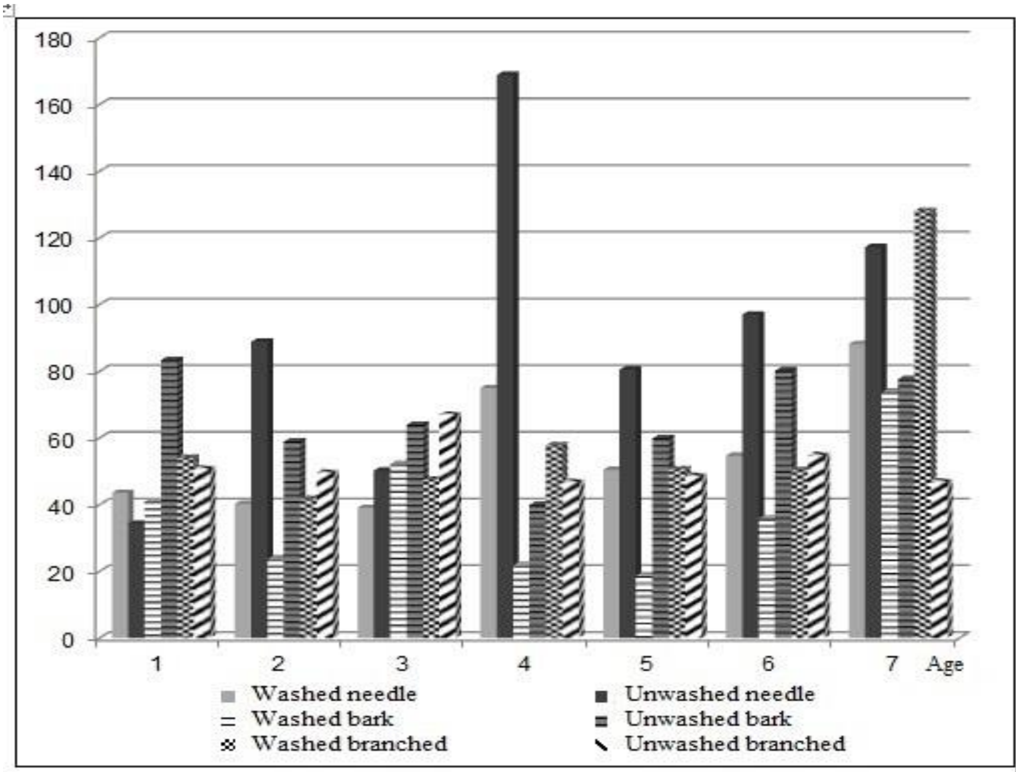

Figure 1. Graphic. Change of Mn concentration on organ and year basis

4. Conclusions

In the study, it was determined that the change of Mn concentration in all ages on organ basis was statistically significant at least at 95% confidence level. Variations in the element concentrations were evaluated according to the organ. In Mossi's study [35] , it was determined that the changes in the amount of elements in seven different types of leaves and branches, and that Cu, Ni, Pb, Cd and Ca concentrations were higher in the branches than in the leaves and Mn concentration was higher in the leaves than in the branches. Pınar [36] found that the difference between organs was 4.3 times in Cu, compared to leaf, seed and branch samples.

In heavy metal studies, the change of heavy metal concentrations depending on the organ is often the subject of studies. Mossi [35] leaf and branch, Turkyilmaz et al., [8-12] bark and wood, Erdem [37] and Sevik et al., [38] leaves, seeds and branches, Elfantazi et al. [39,40] Leaf and branch, Ozel [41] leaves, branches and fruits, Pınar [36] leaves, branches and seeds, Akarsu [42] have determined the differences between the inner shell, outer shell and the organs in the wood. There is not much work on leaf or needle age in studies to determine the heavy metal concentration up to now. In a study conducted on this subject Turkyilmaz et al., [8-12] *Pinus nigra*, *Pinus sylvestris*, *Abies bornmuelleriana* and *Picea pungens* species in one, two and three-year-old hands in the evaluation of changes in the concentration of some HMs in almost all values in relation to age, showed increased the amount of HMs. Similar results were obtained by Çobanoğlu [43] in his study on *Picea pungens*.

The change of HMs depending on the organ, the structure of the plant and organ as well as the structure of the HM, environmental conditions and all the interaction between them is a complex and yet not fully solved mechanism, and the information on this subject is limited [1-3, 13,14-18, 26, 31-33, 42, 44,45].

Zn, Mn, Cu and Mo are pivotal for the growth of the plants from the heavy metals reaching the plant root area, Co and Ni are required in some conditions. Al, V, As, Hg, Pb, Cd and Se are generally toxic [20]. Manganese toxicity in plants varies according to plant species. Manganese toxicity appears as brown spots on mature leaves in most plants. The areas where stains occur are fungus over time. It causes deformations of young leaves in plants such as beans and cotton. Changes in Mn concentration in different plant species have been investigated. Celik et al., [46] *Robinia pseudoacacia*, Cesur [47] in *Cupressus arizonica*, Turkyilmaz et al., [8-12] *Tilia tomentosa*, *Eleagnus angustifolia*, *Prunus cerasifera* and *Ailanthus altissima*, Çobanoğlu [43] determined the change of Mn concentration in *Picea pungens*. Mn has also been studied in other studies related to heavy metal [48-51]. Recent studies with Ozel et al., worked Oak in Krikkale, Uludag Fir, and oriental plane found some resuls of it [52-58].

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