Uluslararası İleri Doğa Bilimleri ve Mühendislik Araştırmaları Dergisi
Sayı 8, S. 332-335, 7, 2024

Araştırma Makalesi

IJANSER

International Journal of Advanced Natural Sciences and Engineering Researches
Volume 8, pp. 332-335, 7, 2024

Research Article

https://as-proceeding.com/index.php/ijanser
ISSN: 2980-0811

Assessment of Pseudotsuga menziesii as a Chromium Biomonito

Mehmet Çetin*

[1*] *Ondokuz Mayis University, Faculty of Architecture, Department of City and Regional Planning, Samsun, Turkey,*

* *mehmet.cetin@omu.edu.tr*

(Received: 25 August 2024, Accepted: 29 August 2024)

(5th International Conference on Engineering and Applied Natural Sciences ICEANS 2024, August 25-26, 2024)

ATIF/REFERENCE: Çetin, M. (2024). Assessment of Pseudotsuga menziesii as a Chromium Biomonito. *International Journal of Advanced Natural Sciences and Engineering Researches*, 8(7),332-335.

Abstract –In the past century, the increase in industrial activities and human impact has led to a significant rise in heavy metal pollution, which poses serious risks to human health and the environment. Chromium (Cr) is recognized as one of the most dangerous and toxic heavy metals, classified as a priority pollutant by the Agency for Toxic Substances and Disease Registry (ATSDR). Monitoring Cr pollution and tracking changes in atmospheric Cr contamination are thus crucial research areas. The objective of this study is to evaluate the potential of *Pseudotsuga menziesii* for monitoring and reducing atmospheric Cr pollution. The research analyzes the Cr content of *Pseudotsuga menziesii* based on the plant's type, organ, and direction. The study found significant variations in Cr content among directions in wood samples collected at different periods. Notably, there were distinct differences in Cr levels between the same period and different directions. This variation suggests that the movement of Cr within wood is limited, highlighting its importance as a factor to consider in biomonitoring. In conclusion, *Pseudotsuga menziesii* has proven to be a reliable biomonitor for tracking Cr contamination. The study emphasizes that *Pseudotsuga menziesii* could be an effective biomonitor for Cr pollution and its management, making it valuable for environmental monitoring applications.

Keywords –Heavy Metal, Biomonitoring, Chromium (Cr), Pollution, Pseudotsuga Menziesii.

I. INTRODUCTION

Air pollution is a major environmental issue that poses a serious threat to ecosystems and human health on a global scale. Among the various pollutants, heavy metal contamination is considered one of the most harmful. Heavy metals are released into the environment from automobiles, industrial facilities, and other anthropogenic activities in densely populated urban areas, causing profound negative impacts on both human health and ecosystems. These pollutants are among the most dangerous environmental contaminants, resulting in millions of deaths annually. [1-8].

Chromium (Cr) is an important heavy metal used in automotive catalysts and various chemical processes. However, its accumulation and bioavailability in the environment pose potential risks to human health. Although there is limited information in the literature on the health effects and toxicity of Cr, it has been linked to respiratory diseases and other toxic effects from inhalation exposure. Therefore, monitoring and controlling Cr concentrations in the environment is of great importance. [8-21].

The aim of this study is to examine changes in atmospheric Cr concentrations in Samsun over four decades. The study seeks to identify factors affecting Cr pollution and explore potential measures to

mitigate Cr's environmental impact. Determining atmospheric heavy metal concentrations is often challenging and costly. In this context, biomonitors are frequently used to track pollutants. They serve as important tools for monitoring air pollution and assessing environmental impacts.

This study focuses on assessing changes in Cr concentrations in Pseudotsuga menziesii grown under polluted air conditions in Samsun. The primary goal is to monitor atmospheric Cr concentrations and identify the most suitable biomonitor Understanding how Pseudotsuga menziesii can be used as a biomonitor will reveal its effectiveness in air pollution monitoring and management strategies.

This study addresses the significant issue of air pollution, focusing on chromium (Cr) contamination in Samsun over four decades. Cr, a heavy metal used in industrial processes, poses health risks and has limited information on its effects. The study aims to track atmospheric Cr levels and determine the best biomonitor with Pseudotsuga menziesii being evaluated for its effectiveness in this role.

II. MATERIALS AND METHOD

This study analyzed chromium (Cr) concentrations in *Pseudotsuga menziesii* tree samples from the Samsun region, known for high heavy metal pollution. The analysis involved drying, preparing, and mineralizing the samples, followed by dilution and elemental analysis using ICP-OES. A total of 100 samples were tested, and data were analyzed using SPSS 21.0 with ANOVA and Duncan tests to determine statistical differences and ensure result reliability.

III. RESULTS

This study identifies significant variations in chromium (Cr) concentrations in Pseudotsuga menziesii across different directions and plant organs. The highest Cr levels were found in the east, while the lowest were in the west. Cr concentrations were highest in the inner bark and wood, and lowest in the outer bark.

Statistical analysis revealed significant Cr concentration changes in most directions, except for the 2005-2010 period.

Cr levels were generally higher in the north and east, and lower in the south and west. The findings suggest that Cr concentrations vary with direction and organ, with some directions consistently below detectable limits.

Table 1. Variation in Cr Concentration by Direction and Plant Organ

Organ	North	East	South	West	F value	ave
OB	38073.5	178.0	20001.3	178.0	1842.1***	25121.0
IB	4393.2	178.0	5160.1	178.0	82.5***	8068.5
Wood	11055.7	14146.7	6356.7	12322.7	5.4**	10968.5
F value	34.2***	0.69 ns	57.4***	0.5 ns	22.3***	
ave	11652.1	14220.0	6921.2	12325.4	29.6***	

Table 2. Variation in Cr Concentration in Wood by Direction and Age Period

Age per	North	East	South	West	F value	Ave
2020–2022	8212.6	178.0	4196.1	31955.6	265.1***	14611.6
2015–2020	29068.4	178.0	5994.6	4372.3	581.2***	12359.0
2010–2015	15748.6	23645.6	4212.1	2001.8	1235.8***	11650.6
2005–2010	5137.6	4733.4	4805.6	14446.1	211.5***	6994.1
2000–2005	3860.1	24024.3	6457.1	14633.8	868.5***	12891.7
1995–2000	4192.4	178.0	5734.1	10767.1	169.2***	6744.2
1990–1995	9123.0	4195.3	12638.6	14538.7	48.1***	10545.8
1985–1990	17162.0	178.0	3793.7	6107.0	215.8***	8722.7
F val	319.3***	2206.0***	101.9***	342.1***	1.3 ns	
Ave	12312.3	15952.8	4630.0	12440.0	4.9**	

Cr Concentration by Organ and Direction: OB (Overhead Branches): The concentration is highest in the North direction (38,073.5), followed by the South 20,001.3, with very low values in the East and West (<100.0). This indicates a significant directional effect, with the North showing much higher concentrations. IB (Inner Branches): Concentrations are also highest in the North and South 5,160.1, with very low values in the East and West. This shows a similar trend to OB, though the concentrations are lower overall. Wood: Concentrations are highest in the East and lowest in the South 6,356.7, with intermediate values in the North and West. This suggests that wood has a different directional pattern compared to OB and IB. High F-values indicate significant differences in Cr concentrations between directions for each organ type. F-values for Wood suggest significant variation in Cr concentrations by direction as well, but with lower significance compared to OB. Very high F-values indicate significant variation in Cr concentrations across different age periods. This suggests that Cr concentrations have changed significantly over time, with particular periods showing notable differences. Average Cr Concentrations: The average Cr concentrations for each organ type and direction show variation, with some directions consistently higher.For age periods, recent periods show higher average concentrations, reflecting an increase over time. There is a significant variation in Cr concentrations based on both direction and age period. The North and East directions generally show higher concentrations, depending on the organ type. Over time, Cr concentrations have shown increases, especially in recent years, indicating potential environmental changes or pollution increases. This analysis helps in understanding how Cr concentrations vary with direction and over time, which is useful for assessing pollution sources and trends..

IV. DISCUSSION

This study identifies significant variations in chromium (Cr) concentrations in Pseudotsuga menziesii across different directions and plant organs. Cr levels were found to be markedly lower in the west compared to other directions, with the highest concentrations observed in the north and east. These results align with existing literature, indicating that elevated Cr in external bark may signal heavy metal contamination in airborne particulate matter. The increased Cr levels in the north and east are linked to traffic-related pollution. High traffic areas, especially near highways, are expected to show higher Cr concentrations. This suggests that traffic emissions contribute to Cr accumulation on plant surfaces. The study provides limited information on Cr toxicity but emphasizes its importance. Cr accumulation in plants is primarily due to atmospheric sources.

While average Cr values showed no significant changes over time, there were notable differences among wood samples, indicating limited Cr movement within wood. This implies that using annual tree rings to track heavy metal pollution should be done with caution. In summary, this study demonstrates changes in Cr concentrations in Pseudotsuga menziesii based on direction and plant organ. These findings highlight key considerations for selecting plant species for biomonitoring and their potential role in managing air pollution.

V. CONCLUSION

This study shows that chromium (Cr) concentrations in wood samples of Pseudotsuga menziesii remain relatively stable across different directions and time periods. However, significant differences were observed among samples from various periods and age ranges, indicating limited movement of Cr within the wood. This suggests that these species could be useful as biomonitors for Cr pollution. The study found that Cr accumulation in plants primarily originates from atmospheric sources, and the limited movement within the wood supports the potential use of Pseudotsuga menziesii as a biomonitor. The minimal variation in Cr concentrations across directions and periods reflects the constrained mobility of Cr based on plant organ size and age.

Additionally, Cr pollution was found to be closely associated with traffic density. The results indicate that traffic emissions are a major source of airborne Cr, suggesting a direct link between traffic density and Cr pollution. This highlights the need for targeted air pollution management and monitoring strategies. Finally, the study determined that Pseudotsuga menziesii exhibits the highest Cr concentrations, making it a particularly effective biomonitor for airborne Cr pollution. This species' ability to monitor and reduce Cr

pollution emphasizes its significant role in biomonitoring efforts. These findings highlight the value of plant biomonitoring in tracking and managing Cr pollution and offer valuable insights into Cr's environmental impact. The study provides important data for future research and air pollution management strategies..

REFERENCES

[1] White, T. J., Bruns, T., Lee, S. J. W. T., & Taylor, J. (1990). Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. PCR protocols: a guide to methods and applications, 18(1), 315-322.

[2] Zheng, J., Xie, X., Li, C., Wang, H., Yu, Y., & Huang, B. (2023). Regulation mechanism of plant response to heavy metal stress mediated by endophytic fungi. International Journal of Phytoremediation, 25(12), 1596-1613. https://doi.org/10.1080/15226514.2023.2176466

[3] Aisha, A. E. S. A., Cetin M. (2023). Determination of boron for indoor architecture plants used in indoor architectural designs. Scientific Research Communications, 3(2). https://doi.org/10.52460/src.2023.007

[4] Badea, M., Luzardo, O. P., González-Antuña, A., Zumbado, M., Rogozea, L., Floroian, L., ... & Henríquez-Hernández, L. A. (2018). Body burden of toxic metals and rare earth elements in non-smokers, cigarette smokers and electronic cigarette users. Environmental research, 166, 269-275. https://doi.org/10.1016/j.envres.2018.06.007

[5] Bertola, M., Ferrarini, A., & Visioli, G. (2021). Improvement of soil microbial diversity through sustainable agricultural practices and its evaluation by-omics approaches: A perspective for the environment, food quality and human safety. Microorganisms, 9(7), 1400. https://doi.org/10.3390/microorganisms9071400

[6] Akpasi, S. O., Anekwe, I. M. S., Tetteh, E. K., Amune, U. O., Shoyiga, H. O., Mahlangu, T. P., & Kiambi, S. L. (2023). Mycoremediation as a potentially promising technology: current status and prospects—a review. Applied Sciences, 13(8), 4978. https://doi.org/10.3390/app13084978

[7] Arwidsson, Z., Johansson, E., von Kronhelm, T., Allard, B., & van Hees, P. (2010). Remediation of metal contaminated soil by organic metabolites from fungi I—production of organic acids. Water, Air, and Soil Pollution, 205, 215-226. https://doi.org/10.1007/s11270-009-0067-z

[8] Bolyen, E., Rideout, J. R., Dillon, M. R., Bokulich, N. A., Abnet, C. C., Al-Ghalith, G. A., ... & Caporaso, J. G. (2019). Reproducible, interactive, scalable and extensible microbiome data science using QIIME 2. Nature biotechnology, 37(8), 852-857. https://doi.org/10.1038/s41587-019-0209-9

[9] Bozdogan Sert, E., Turkmen, M., & Cetin, M. (2019). Heavy metal accumulation in rosemary leaves and stems exposed to traffic-related pollution near Adana-İskenderun Highway (Hatay, Turkey). Environmental monitoring and assessment, 191, 1-12. https://doi.org/10.1007/s10661-019-7714-7

[10] Cebi Kilicoglu, M. (2024). Effects of Heavy Metal Contamination on Fungal Diversity in Pinus brutia Shoots. BioResources, 19(2), 2724-2735. https://doi.org/10.15376/biores.19.2.2724-2735

[11] Hsieh, C. Y., Tsai, M. H., Ryan, D. K., & Pancorbo, O. C. (2004). Toxicity of the 13 priority pollutant metals to Vibrio fisheri in the Microtox® chronic toxicity test. Science of the total environment, 320(1), 37-50. https://doi.org/10.1016/S0048-9697(03)00451-0

[12] Huang, W. L., Wu, P. C., & Chiang, T. Y. (2022). Metagenomics: Potential for bioremediation of soil contaminated with heavy metals. Ecological Genetics and Genomics, 22, 100111. https://doi.org/10.1016/j.egg.2021.100111

[13] Jeyakumar, P., Debnath, C., Vijayaraghavan, R., & Muthuraj, M. (2023). Trends in bioremediation of heavy metal contaminations. Environmental Engineering Research, 28(4). https://doi.org/10.4491/eer.2021.631

[14] Khan, I., Ali, M., Aftab, M., Shakir, S., Qayyum, S., Haleem, K. S., & Tauseef, I. (2019). Mycoremediation: a treatment for heavy metal-polluted soil using indigenous metallotolerant fungi. Environmental monitoring and assessment, 191, 1-15. https://doi.org/10.1007/s10661-019-7781-9

[15] Ezzouhri, L., Castro, E., Moya, M., Espinola, F., & Lairini, K. (2009). Heavy metal tolerance of filamentous fungi isolated from polluted sites in Tangier, Morocco. African journal of microbiology research, 3(2), 35-48.

[16] Guarino, F., Improta, G., Triassi, M., Cicatelli, A., & Castiglione, S. (2020). Effects of zinc pollution and compost amendment on the root microbiome of a metal tolerant poplar clone. Frontiers in microbiology, 11, 565528. https://doi.org/10.3389/fmicb.2020.01677

[17] Kumar, V., Dwivedi, S. K. (2021). Mycoremediation of heavy metals: processes, mechanisms, and affecting factors. Environmental Science and Pollution Research, 28(9), 10375-10412. https://doi.org/10.1007/s11356-020-11491-8

[18] Seshikala, D., & Charya, M. S. (2012). Effect of pH on chromium biosorption. Int J Pharma Bio Sci, 2, 298-302.

[19] Sharma, V. K., Li, X. Y., Wu, G. L., Bai, W. X., Parmar, S., White Jr, J. F., & Li, H. Y. (2019). Endophytic community of Pb-Zn hyperaccumulator Arabis alpina and its role in host plants metal tolerance. Plant and soil, 437, 397-411. https://doi.org/10.1007/s11104-019-03988-0

[20] Soanes, D., & Richards, T. A. (2014). Horizontal gene transfer in eukaryotic plant pathogens. Annual Review of Phytopathology, 52, 583-614. https://doi.org/10.1146/annurev-phyto-102313-050127

[21] Tomer, A., Singh, R., Singh, S. K., Dwivedi, S. A., Reddy, C. U., Keloth, M. R. A., & Rachel, R. (2021). Role of fungi in bioremediation and environmental sustainability. Mycoremediation and Environmental Sustainability: Volume 3, 187-200. https://doi.org/10.1007/978-3-030-54422-5_8