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Research Article

Determination of Some Heavy Metals in Oil Sunflower Seeds Grown in the North of Turkey

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Abstract

This study aims to determine some heavy metal contents (boron, aluminum, manganese, iron, cobalt, nickel, copper, zinc, cadmium, and lead) of eighteen sunflower seeds obtained from six regions in the Middle Black Sea Region where sunflower is grown. The ICP-MS device was used to determine the heavy metal concentrations in the study, and cadmium, and lead amounts in the samples examined at the end of the study were found in the range of 0-0.06 $\mu g\ kg^{-1}$ and 0-1.07 $\mu g\ kg^{-1}$, respectively. The highest heavy metal concentrations in all the examples were obtained as iron (13.14-61.04 $\mu g\ kg^{-1}$), zinc (34.11-54.12 $\mu g\ kg^{-1}$), copper (15.68-20.7 $\mu g\ kg^{-1}$), and manganese (12.72-20.20 $\mu g\ kg^{-1}$). These heavy metals were followed by boron (4.82-10.33 $\mu g\ kg^{-1}$), aluminum (0-13.12 $\mu g\ kg^{-1}$), and nickel (0.88-7.74 $\mu g\ kg^{-1}$). The lowest heavy metal concentration was cobalt (0.037-0.12 $\mu g\ kg^{-1}$). As a result, the heavy metal concentrations found in the sunflower seeds grown in the Middle Black Sea region were lower than the limit values threading to human health.

Keywords: Black Sea, Heavy Metals, *Helianthus Annuus* L., Oil Seed, Toxicity.

Türkiye'nin Kuzeyinde Yetiştirilen Yağlık Ayçiçeği Tohumlarında Bazı Ağır Metallerin Belirlenmesi

Öz

Bu çalışma, ayçiçeği yetiştiriciliği yapılan Orta Karadeniz Bölgesinde yer alan altı bölgeden temin edilen on sekiz ayçiçeği tohumunun bazı ağır metal içeriklerinin (bor, alüminyum, mangan, demir, kobalt, nikel, bakır, çinko, kadminyum and kurşun) belirlenmesini amaçlamaktadır. Çalışmada ağır metal konsantrasyonlarını belirlemek için ICP-MS cihazı kullanıldı ve araştırma sonucunda incelenen numunelerdeki kadminyum ve kurşun miktarları sırasıyla 0-0.06 $\mu g\ kg^{-1}$ ve 0-1.07 $\mu g\ kg^{-1}$ aralığında bulundu. Tüm örneklerde en yüksek element içeriği demir (13.14-61.04 $\mu g\ kg^{-1}$), çinko (34.11-54.12 $\mu g\ kg^{-1}$), bakır (15.68-20.7 $\mu g\ kg^{-1}$) ve mangandan (12.72-20.20 $\mu g\ kg^{-1}$) elde edilirken bu elementleri bor (4.82-10.33 $\mu g\ kg^{-1}$), alüminyum (0-13.12 $\mu g\ kg^{-1}$) ve nikel (0.88-7.74 $\mu g\ kg^{-1}$) elemetleri takip etmiştir. Sonuç olarak Orta Karadeniz bölgesinde yetiştirilen ayçiçeği tohumlarında bulunan ağır metal konsantrasyonları, insan sağlığını tehdit eden sınır değerlerin altında kalmıştır.

Anahtar Kelimeler: Ağır Metaller, *Helianthus annuus* L., Karadeniz, Toksisite, Yağlı Tohum.

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1. Introduction

Heavy metals accumulate in agricultural lands, groundwater resources, air, and foods, causing pollution of the ecosystem and threatening the life of all living organisms in the world (Benavides et al, 2005). The most important reasons for the heavy metals to spread ecosystem is activities such as mining, gases from the exhausts of motor vehicles, an increase in the industrial sector, excessive use of chemical fertilizers and pesticides (Samarghandi et al, 2007). Heavy metals are metals with relatively high density and have a toxic effect even at low rates. There are more than 60 heavy metals such as lead (Pb), cadmium (Cd), iron (Fe), cobalt (Co), copper (Cu), nickel (Ni), mercury (Hg), and zinc (Zn), and the most toxic heavy metals can be listed as Cd, Pb, and Hg. These heavy metals can affect the psychological structure of humans and lead to health problems (Kahvecioğlu et al, 2003; Jarup et al, 2003). The elemental content of heavy metals in the soil ranges from 1 to 100,000 µg kg^{-1}, and overdoses of heavy metals cause deterioration of soil structure, decrease in product yield and quality, and environmental pollution (Long et al, 2002). While cadmium and lead cause serious health problems for organisms, nickel has a carcinogenic effect, and these heavy metals are easily found in plants. Although nutrient uptake by plants is selective, heavy metals are taken up by plants in the environment and incorporated into the food chain. This status negatively affects human health because of toxic effects on organisms that feed with plants (Yıldız, 2001).

Sunflower is an important oil plant in terms of crude oil production with 40-50% fat content (Öztürk et al, 2008). Since it is among the most nutritionally valuable oils among vegetable oils (69% unsaturated fatty acids and 11% saturated fatty acids), it is widely used in meals, frying and margarine production. The pulp formed after oil production is used as animal feed thanks to its high protein content. It is also used as raw material in the paint, plastic, soap and cosmetic industries. Sunflower seed is a valuable source of nutrients because it is rich in vitamin E and linoleic acid, which lowers cholesterol levels (Franco et al, 2018).

In recent years, the increase in technological activities due to the increase in population causes the environment and food to be contaminated. It is seen that heavy metals are among the most important causes of food pollution that threaten human health (Türközü & Ganlıer, 2014). Since heavy metals in the atmosphere are very dangerous, these elements and their effects should be monitored. Plant species such as sunflower (Helianthus annuus L) can store these elements in their roots and bodies (Kötschau et al, 2014). Sunflower (Helianthus annuus L.), which has a high tolerance to heavy metals, is used to clean of the soil in areas where heavy metals are concentrated due to the excessive adsorption of plant nutrients from the soil (Jadia & Fulekar, 2008; Pilon-Smits, 2005). Studies have shown that low concentrations of Cd, Pb and Ni stimulate root and shoot elongation of sunflower plants, while high concentrations inhibit germination, root and shoot elongation (Jadia & Fulekar, 2008). Excessive heavy metal accumulation in the environment negatively affects the development factors such as germination, root, body development, enzyme activity in seeds, protein synthesis, oil yield, and product yield (Zengin & Munzuroğlu, 2006). Studies show that oil sunflower, which grows in areas with high environmental pollution, has high levels of copper and zinc in its roots, stems, leaves, and seeds (Şabudak et al, 2007).

Scientific studies on determination of heavy metal concentrations in sunflower growing regions of our country are not sufficient. In this study, it was tried to determine the heavy metal content of seed samples obtained from the Middle Black Sea Region, which is one of the important regions in oil sunflower cultivation.

2. Material and Method

2.1. Material

Three different seed samples were taken from Samsun (Havza, Vezirköprü, Bafra), Amasya (Merzifon), Tokat (Turhal) and Çorum centers where oil sunflower cultivation was carried out, and the points where the seeds were taken are shown in Figure 1.

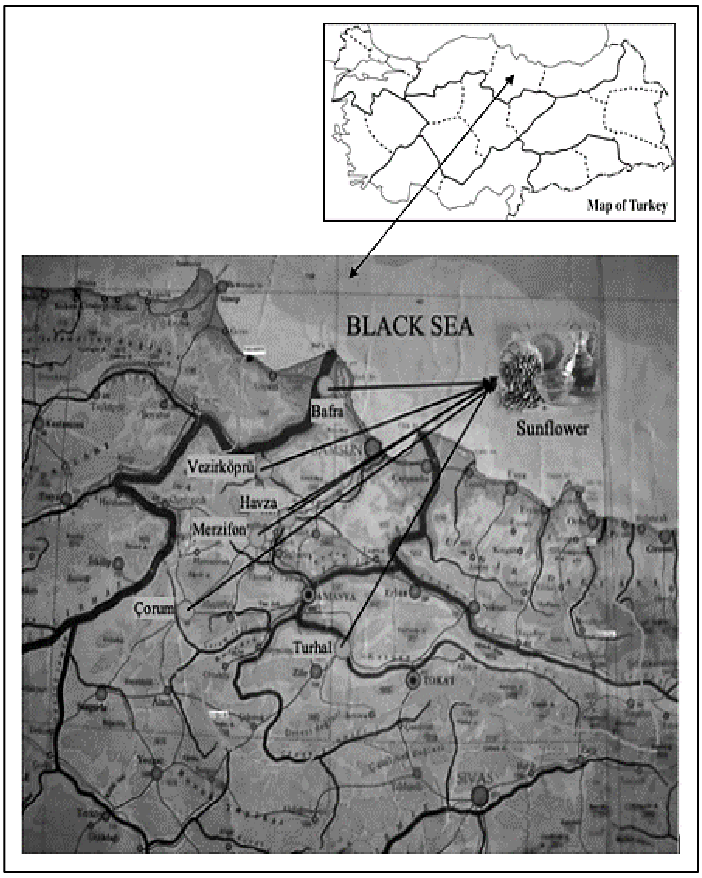

Figure 1. Oil sunflower seed samples taken in the Middle Black Sea Region

2.2. Method

Analyzes were performed in Bayburt University Central Research Laboratory. To determine the heavy metal, 0.2 g of each sample was taken into the bottle. 9 ml HNO_3 (65%, Merck) and 1 ml H_2O_2 (30%, Merck) were added to the incinerator. The burning process was performed at 200°C in Ethos Easy (Advanced Microwave Diyestion System-Milestone) device and allowed to cool for 30 minutes at room temperature. Extracts were filtered with 0.45 µm PTFE filters and stored at +4°C in a laboratory environment until ICP-MS analyses (Inductively Coupled Plasma Mass Spectrometer). Analyses were performed in 50 ml polyethylene tubes. Each sunflower sample was analyzed in triplicate. Standard solutions of B, Al, Mn, Fe, Co, Ni, Cu, Zn, Cd and Pb were prepared by diluting 1000 mg L-1 stock solution stored in polyethylene prior to analyses. Finally, the concentrations of B, Al, Mn, Fe, Co, Ni, Cu, Zn, Cd and Pb in the seed samples were measured with the ICP-MS device.

3. Results and Discussion

The contents of mean heavy metals of each sunflower seed are given in Figure 2 and Figure 3. The amounts of Cd, Co and Pb were determined to be in the range of 0-0.06 μg kg^{-1}, 0.04-0.13 μg kg^{-1} and 0-1.07 μg kg^{-1}, respectively.

3.1. Heavy Metal Content

The highest concentrations obtained from the seed samples were found to be 13.14-61.04 μg kg^{-1} and 34.11-54.12 μg kg^{-1} for Fe and Zn elements, respectively. Cu, Mn, Al, B, Ni, and Co were found to be 15.68-20.71 μg kg^{-1}, 12.72-20.20 μg kg^{-1}, 0-13.12 μg kg^{-1}, 4.82-10.33 μg kg^{-1}, 0.88-7.74 μg kg^{-1} and 0.04-0.13 μg kg^{-1}, respectively.

The highest concentration of B was obtained from the Turhal region as 10.33 μg kg^{-1}. The highest concentrations of Al, Mn, Co, Fe, and Pb elements were obtained from the Havza region as 13.12 μg kg^{-1}, 20.20 μg kg^{-1}, 7.74 μg kg^{-1}, 61.04 μg kg^{-1}, 1.07 μg kg^{-1}, respectively. The highest concentrations of Ni Cu, Zn, and Cd elements were obtained from the Bafra region as 7.74 μg kg^{-1}, 20.71 μg kg^{-1}, 54.12 μg kg^{-1}, and 0.06 μg kg^{-1}, respectively. The lowest concentrations of Fe, B, and Ni elements were obtained from the Merzifon region as 13.14 μg kg^{-1}, 4.82 μg kg^{-1}, and 0.88 μg kg^{-1}, respectively. The lowest concentrations of Co element were obtained from the Bafra region as 0.04 μg kg^{-1}. The lowest concentrations of Mn and Zn elements were obtained from the Turhal region as 12.72 μg kg^{-1}, and 34.11 μg kg^{-1}, respectively. The lowest concentration of Cu element was obtained from the Vezirköprü region as 15.68 μg kg^{-1}. In addition, the concentrations of Cd in Merzifon, Turhal, and Çorum regions, the concentrations of Pb in Bafra and Vezirköprü regions, and the concentration of Al in the Bafra region were not found as seen in Figure 2 and Figure 3.

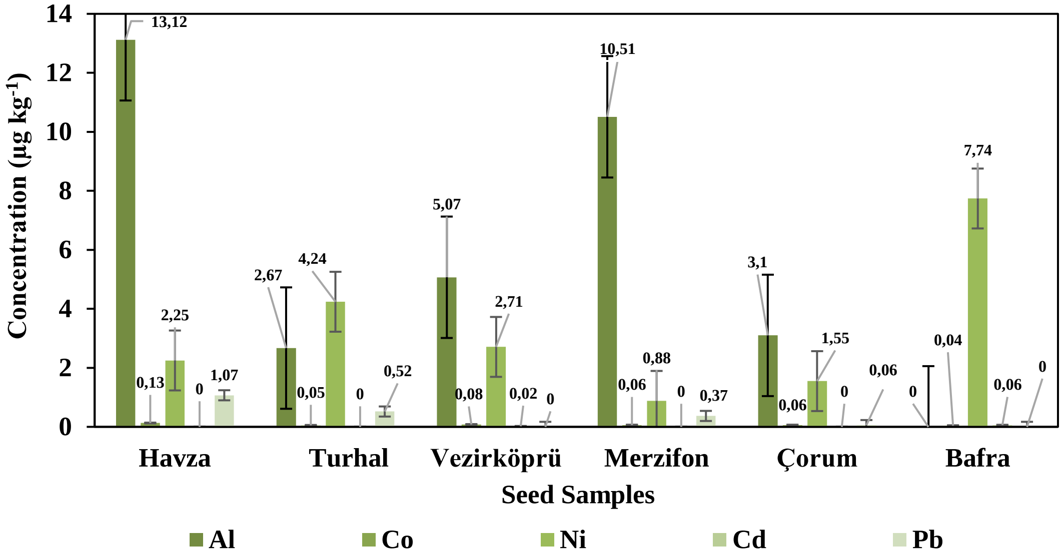

Figure 2. The concentrations of Co, Cd and Pb in oil sunflower seeds grown in the Middle Black Sea Region

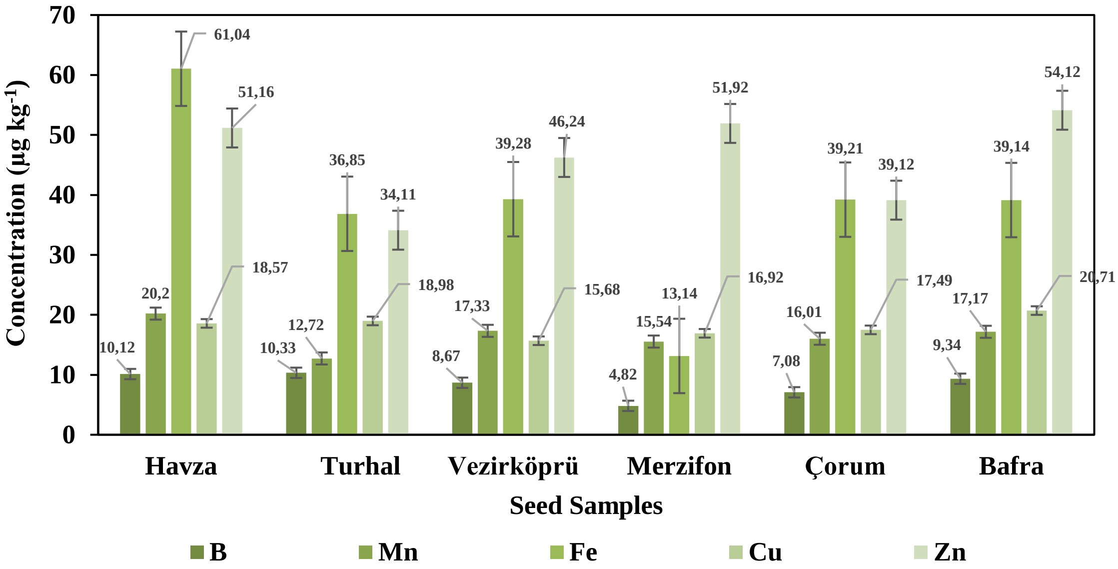

Figure 3. The concentration of B, Mn, Fe, Cu and Zn in oil sunflower seeds grown in the Middle Black Sea Region

While some metals are necessary for life, others are extremely dangerous. For example, copper is necessary for some organs such as hair and bone, and even low levels of lead element is very dangerous for human health (Dökmeci & Dökmeci, 2005; Selinus et al, 2005). According to La Pera et al. (2002) stated that heavy metal content in vegetable oils may result from soil, fertilizers, or highway and industrial sites around the land. For this reason, the importance of following heavy metal analyzes in the regions where oil sunflower is grown is once again understood. In a study on the effects of heavy metals on oil crops, the concentrations of Pb, Cu, Zn, and Cd found in sunflower were determined as 0.2-0.7 µg kg^{-1}, 5.9-6.6 µg kg^{-1}, 21.7-41.9 µg kg^{-1}, and 0.09-0.23 µg kg^{-1}, respectively (Angelova et al, 2004a). While Cu and Zn element contents were lower than our results, Pb and Cd element contents were similar to our results. It is reported in the literature that the concentrations of Cu, Zn, Cd, and Pb elements in sunflower seeds reach high values (Kastori et al, 1998; Chizzola, 1998). According to another study examining sunflower seeds with high heavy metal concentrations, the concentrations of Cu, Fe, Mn, Zn, Cd and Pb in sunflower seeds were 21.9-23.4 µg kg^{-1}, 59.8-66.4 µg kg^{-1}, 20.2-23.9 µg kg^{-1}, 73.1-112 µg kg^{-1}, 130-239 µg kg^{-1}, and 167-219 µg kg^{-1}, respectively (Madejón et al, 2003). While these results are higher than the concentrations of Cd and Zn elements given in our results, Cu and Ni element values are similar (Lombi et al, 1998). In the literature, the concentrations of Fe, Mn, Zn, and Cu elements in sunflower were found in the range of 100-200 µg kg^{-1}, 50-100 µg kg^{-1}, 50-70 µg kg^{-1} and 10-20 µg kg^{-1}, respectively (Plank et al, 1995). In our study, while Fe, Mn and Zn elements are high, Cu element is similar. The levels of Fe, Zn, Cu and Mn concentrations in sunflower samples taken from the northern region of Turkey are below the values given above (Angelova et al, 2004b).

4. Conclusions and Recommendations

Sunflower oil seeds are in the first place in terms of vegetable oil production and use in Turkey. Therefore, detecting and evaluating the heavy metal content in sunflower seeds can be considered beneficial in terms of food safety and human health. Determination of heavy metal and trace element content obtained from sunflower seed oil grown in Turkey, will allow monitoring of the health and quality of oil production. In our study, Cd and Pb contents in sunflower seeds are in trace amounts, and according to the results obtained from some studies, the content of elements B, Al, Mn, Fe, Co, Ni, Cu, and Zn is below the critical level. However, since sunflowers draw excessive amounts of elements from the soil, more studies are needed in the regions in terms of heavy metal pollution.

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References

Angelova, V., Ivanova, R., & Ivanov, K. (2004b). Heavy Metal Accumulation and Distribution in Oil Crops. Communıcatıons in Soil Science and Plant Analysis, 35(17-18): 2551-2566. DOI:10.1081/CSS-200030368

Angelova, V., Ivanova, R., Delibaltova, V., & Ivanov, K. (2004a). Bio-accumulation and distribution of heavy metals in fibre crops (flax, cotton and hemp). Industrial Crops and Products, 19: 197-205. DOI:10.1016/j.indcrop.2003.10.001

Benavides, M.P., Gallego, S.M., & Tomaro, M.L. (2005). Cadmium toxicity in plants. Brazilian. Journal of Plant Physiology, 17: 21-34. DOI:10.1590/S1677-04202005000100003

Chizzola, R. (1998). Aufnahme und Verteilung von Cadmium in Sonnenblume. Kâmille und Johanniskraut. - Z. Arznei- & Gewürzpfl, 3: 91-95.

Dökmeci, İ., & Dökmeci, A.H. (2005). Toxicology Diagnosis and treatment with poisoning. 4nd ed. İstanbul, Turkey: Nobel Medical Bookstore, p 675

Franco, R., Iseppi, L., & Taverna, M. (2018). Sunflower oil functional properties for specialty food. Nutrition & Food Science International Journal, 5: 4-7. DOI: 10.19080/NFSIJ.2018.05.555668

Jadia, C., & H. Fulekar, M. (2008). Phytoremediation: The application of vermicompost to remove zinc, cadmium, copper, nickel and lead by sunflower plant. Environmental Engineering and Management Journal, 7(5): 547-558.DOI:10.30638/eemj.2008.078

Jadia, C.D., & Fulekar, M.H. (2008). Phytoremediation: the application of vermicompost to remove zinc, cadmium, copper, nickel and lead by sunflower plant. Envir. Eng. and Management J, 7(5): 547-558. DOI:10.30638/.eemj.2008.078

Jarup, L. (2003). Hazards of heavy metal contamination. Br Med Bull, 68:167-82. DOI:org/10.1093/bmb/ldg032

Kahvecioğlu, Ö., Kartal, G., Güven, A., & Timur, S. (2003). Environmental Effects of Metals-I. TMMOB Chamber of Metallurgical Engineers Metalurji Magazine, 136: 47-53.

Kastori, R., Plesnicar, M., Sakac, Z., Pankovic D., & ArsenijevicMaksimovic,I. (1998). Effect of lead excess on sunflower growth and photosynthesis. Journal of Plant Nutrition, 21:75-85.

Kötschau, A., Büchel, G., Einax, J.W., Von Tümpling, W., & Merten, D. (2014). Sunflower (Helianthus annuus L.): phytoextraction capacity for heavy metals on a mining-influenced area in Thuringia, Germany. Environmental earth sciences, 72: 2023-2031. DOI:10.1007/s12665-014-3111-2

La Pera, L., Lo Coco, F., Mavrogeni, E., Giuffrida, D., & Dugo, G. (2002). Determination of copper (II), lead (II), cadmium (II) and zinc (II) in virgin olive oils produced in Sicily and apulia by derivative potentiometric stripping analysis. Italian Journal Food Science, 14(4): 389-399.

Lombi, E., H Gerzabek, M., & Horak, O. (1998). Mobility of heavy metals in soil and their uptake by sunflowers grown at different contamination levels. Agronomic 18(5-6): 361-371. DOI:10.1051/agro:19980503

Long, X.X., Yang X.E., & Ni, W.Z. (2002). Current Status and Perspective on Phytoremediation of Heavy Metal Polluted Soils. Journal of Applied Ecology, 13: 757-762. DOI:10.1631/jzus.B0710633

Madejón, P., Murillo, J.M., Marañón, T., Cabrera, F., & Soriano, M.A. (2003). Trace element and nutrient accumulation in sunflower plants two years after the Aznalcóllar mine spill. Science of the Total Environment, 307(1-3): 239–257. DOI: 10.1016/S0048-9697(02)00609-5

Öztürk, Ö., Akınerdem, F., Bayraktar, N., & Ada, R. (2008). Determination of Yield and Important Agricultural Characteristics of Some Hybrid Sunflower Varieties in Konya Watery Conditions. S.Ü. Journal of Agricultural Faculty, 22 (45): 11-20.

Pilon-Smits, E. (2005). Phytoremediation. Annual Review Plant Biolgy, 5:15-39. DOI:org/10.1146/annurev.arplant.56.032604.144214

Plank, C.O., Granberry, D.M., & Phatak, S. (1995). Plant Analysis. Handbook for Georgia, Agricultural & Environmental Services Laboratories.

Şabudak, T., Şeren, İ., Kaykıoğlu, İ., & Dinçer, A.R. (2007). Determination of Copper, Zinc and Lead Contents in Sunflower Plants. Journal Enviromental Protection and Ecolocy, 8: 101-106.

Samarghandi, M.R., Nouri, J., Mesdaghinia, A.R., Mahvi, A.H., Nasseri, S., & Vaezi, F. (2007). Efficiency Removal of Phenol, Lead and Cadmium by Means of UV/TiO2/H2O2 Processes. International Journal of Environmental Science and Technology, 4: 19-25. DOI:10.1007/BF03325957

Selinus, O., Alloway, B., Centeno, J.A., Finkelman, R.B. Fuge, R., Lindh, U., & Smedley, P. (2005). Essentials of Medical Geology.Burlington, MA: Elsevier Academic Press, p 832

Türközü, D., & Ganlıer, N. (2014). Heavy Metal Contamination in Foods: Contamination Sources, Health Risks and National/International Standards. Electronic Journal of Food Technology, 9(10): 29-46.

Yıldız, N. (2001). Methods of Determination of Some Heavy Metals (Zn, Cu, Cd, Pb, Co and Ni) in Soil Pollutants. Atatürk University Agricultural Faculty Magazine, 32(2): 207-213.

Zengin, F.K., & Munzuroğlu, Ö. (2006). Ayçiçeği Fidelerinin Toplam Çözülebilir Protein, Prolin ve Klorofil Miktarları Üzerine Cıva Klorürün Etkileri, Fırat Üniversitesi Fen ve Mühensilik Bilimi Dergisi, 18: 25-30.