Determination of Heavy Metals Level in *Senna Obtusifolia* Growing on Dumpsite and Its Health Effect in Yola Metropolis

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Abstract
Senna obtusifolia is a plant species with a wealth of medicinal properties. However, its growth on farmland, polluted dumpsites and poses a risk to human health. This research study is aim at determination of heavy metals and will also highlighted the level of concentration of heavy metals in Senna obtusifolia growing on dumpsites and its health effect in Yola Metropolis. The Senna obtusifolia samples will be collected from different locations on the dumpsite. The samples will be dried and ground into a fine powder and the heavy metals will be extracted from the samples using hydrochloric acid digestion or other extraction procedures. The concentration of heavy metals in the samples will be measure using analytical techniques, such as atomic absorption spectrometry or inductively coupled plasma mass spectrometry. The analysis of the result revealed the following: *Cadmium (Cd), Lead (Pb), and Iron (Fe) were not detected (ND) in either the farm land or the dump site, indicating no contamination from these potentially harmful metals. Zinc (Zn) concentrations were similar in both locations, with 0.20 mg/kg in the farm land and 0.23 mg/kg in the dump site. These values are low and within safe, natural levels for soil. Copper (Cu) concentrations were also low, with 0.18 mg/kg in the farm land and 0.22 mg/kg in the dump site, suggesting no copper contamination. the results show that both the farm land and dump site have minimal heavy metal contamination, with levels of the metals tested being very low and not posing any immediate environmental or health risks.*

Introduction

Heavy metals are members of a loosely defined subset of elements that exhibit metallic properties. It mainly includes the transition metals, some metalloid lanthanides, and actinide. They occur naturally in the ecosystem with large variations in concentrations (Mohsen and Salisu, 2008). Some of the metallic elements are toxic and have high density, specific gravity or atomic weight. Heavy metals occur naturally in the soil from the pedogenetic processes of weathering of parent materials at levels that are regarded as trace (<1000 mg/kg) and rarely toxic (Pierzynski et al., 2000; Kabata-Pendias & Pendias, 2001). The geochemical cycle of metals by man resulted / caused most soils environments to have accumulated one or more of the heavy metals above defined background values high enough to cause risks to human health, plants, animals, ecosystems, or other media (D' Amore et al., 2005). Many of these metals undergo methylation, as a result of bioaccumulation where bacteria absorb these elements and convert them from a metallic state into a toxic organ metallic state, by incorporating with an organic component, these metals become readily available to the first tropic level of the food chain and eventually lead to biological magnification throughout the system (Laura & Susan, 2009).

Senna obtusifolia, also known as Chinese senna or sicklepod, is an annual plant that belongs to the family Fabaceae. The plant is native to the tropical regions of the Americas. It is an important herb in traditional medicine and can be used to treat a range of ailments, from constipation to skin diseases.

Senna obtusifolia contains various medicinal compounds, such as naphthoquinones, anthraquinones, and flavonoids. These compounds have been shown to have anti-inflammatory, antioxidant, and antitumor properties. The plant is also known for its laxative effects and can be used to treat constipation.

Senna obtusifolia is a short-lived (annual or biennial) shrub growing to up to 2.5 m tall, but usually less than 2 m in height. The lower stems often sprawl along the ground in open areas.

Plants produce numerous, branched, sprawling stems that are 1.5-2 m long. These stems are usually softly hairy (pubescent) when young, but become mostly hairless (glabrescent) with age. The foliage has a slightly rank odour.

The compound (pinnate) leaves are alternately arranged along the stems and are borne on relatively short stalks (petioles) 15-20 mm long. They have two or three pairs of leaflets (17-65 mm long and 10-40 mm wide), with those further from the leaf stalk usually being larger. The leaflets are egg-shaped in outline with the narrower end attached to the stalk (obovate) and have rounded tips (obtuse apices). Their surfaces may be either hairless (glabrous) or sparsely hairy (pubescent) and the entire margins are usually edged with tiny hairs (cilia). There is a small elongated structure (gland) 1-3 mm long located on the main leaf axis (rachis) between the lowest pair of leaflets (occasionally also between the second pair of leaflets as well).

The yellow flowers (10-15 mm across) are borne on stalks (pedicels) 7-28 mm long. These flowers usually occur in pairs in the leaf forks (axils) and are mostly located near the tips of the branches. They have five green sepals (5.5-9.5 mm long) and five yellow or pale yellow petals (8-15 mm long). Each flower also has seven fertile stamens with anthers (3-5 mm long) that have a short narrow projection (beak) on one end.

The fruit is a slender, are strongly curved downwards (sickle-shaped), pod (6-18 cm long and 2-6 mm wide) that is almost round (cylindrical) in cross-section (sometimes slightly flattened or four-angled) and curved downwards and resembles a sickle in shape. The pods turn brownish-green as they mature and are slightly indented between each of the numerous seeds (faintly septate). The seeds (3-6 mm long) are dark brown in colour, shiny in appearance, and either diamond-shaped (rhomboid) or irregular in shape.

Problem Statement

The senna obtusifolia plants are rich in polyphenol and anthraquinone contents and are reported to have several medicinal uses. In Nigeria, senna obtusifolia is an annual plant widely distributed through the northern region (Wickens, 1976). The leaves are used as source of food which is eaten by most of the people of that region. Dirar et al. (1985), in their biochemical and micro- biological studies, considered the fermented leaves of the plants ‘’ as a meat substitute for its relatively high-quality protein content. In traditional medicine, ‘the fermented leaves’ is used for the treatment of jaundice (El Ghazali 1987). It is also used as a bioindicator in plant for assess soil pollution levels. However, due to the high awareness of the public regarding the detrimental effects of heavy metals on health and environment, several countries have implemented regulations to control and monitor the permissible levels of heavy metals discharged in effluent. Based on the United States Environmental Proctection Agency (EPA), the permissible cadmium (Cd), lead (Pb), zinc (Zn) and chromium (Cr) content within were 0.01 mg/L, 0.05 mg/L, 5 mg/L and 0.05 mg/L, respectively (yayintas et al., 2007).

Heavy metals is major component of contaminants in the ecosystem, which present a different challenge than other organic contaminants owing to their non-biodegradability (Jan,et al., 2015). In Humans, adverse health consequences are inevitable due to accumulation of heavy metals overload in the body from continued exposure. Intriguingly, exposure to heavy metals particles, even at levels below what is previously known to be nontoxic, can have serious health effects as a result of the dynamic interaction between these species and many cellular processes that define life. A sustainable effort at curtailing incidences of exposure and outcomes of environmental pollution by heavy metals is the use of living organisms such as microorganisms and plants, which have been shown to have the capacity for heavy metal load reduction in the environment through bioaccumulation (which refers to the increase in the level of xenobiotics in an organism overtime when compared to the level of the xenobiotic in the environment (Gupta et al., 2013).

Senna obtusifolia growing on dumpsite can pose a health risk to humans, particularly to those who consumed the plant. This study is aimed at determination of heavy metals levels in senna obtusifolia growing on dumpsite in Yola metropolis that have enabled to protect human health and prevent heavy metals.

Objectives of the Study

The specific objectives are to:

1. Identify the heavy metal in *senna obtusifolia*
2. Determine the heavy metal levels in *senna obtusifolia*
3. Analyse the health risk of heavy metal in *senna obtusifolia* on a dumpsite in Yola Metropolis

Research Questions

The study was guided by the following research questions:

1. What are the heavy metal in *senna obtusifolia*?
2. What are the level of heavy metal in *senna obtusifolia*?
3. What is the health risk of heavy metal in *senna obtusifolia* on a dumpsite in Yola metropolis?

Literature Review

Heavy metals are natural constituents of the earth's crust, but indiscriminate human activities have drastically altered their geochemical cycles and biochemical balance. This results in accumulation of metals in plant parts having secondary metabolites, which is responsible for a particular pharmacological activity. Prolonged exposure to heavy metals such as cadmium, copper, lead, nickel, and zinc can cause deleterious health effects in humans. Molecular understanding of plant metal accumulation has numerous biotechnological implications also, the long term effects of which might not be yet known. (Singh et., al 2011)

Environmental contamination by heavy metals such as lead (Pb) or cadmium (Cd) is of significant concern. These metals cannot be destroyed by degradation, and thus remediation of contaminated medium requires outright removal or clean up (Henry, 2018.

Bioremediation entails the use of living organisms for the recovery or cleanup of a contaminated medium (soil, sediment, sludge or water) and is defined by Phillips as any process that uses living organisms (microorganisms, fungi, green plant or enzymes) to return a medium altered by a contaminant to its original condition (Phillips, 2019). Despite this broad definition, bioremediation usually refers specifically to the use of microorganisms for the clean up of a contaminated medium (Chaney, 2018). The use of green plants to clean up contaminated sites is referred to as phytoremediation and is considered a form of bioremediation. The process of phytoremediation is an emerging green technology for the cleanup of toxic chemicals in soil, sediment, ground water, surface water, and air (Karigar & Rao, 2018). The use of metal-accumulating plants to remove heavy metals and other compounds was first introduced in 1983, but the concept has been implemented for the past 300 years on wastewater discharges The technique relies heavily on the use of plant interactions in the contaminated site to mitigate the toxic effects of pollutants (Azubuike et. al., 2016). The complex chemical, physical and biological interactions that take place within the medium adjacent to plant roots allow for cleanup of contaminated sites through a number of phytoremediation mechanisms. The phytoremediation mechanism most commonly employed for the treatment of heavy metal-contaminated soil involves the use of green plants to absorb, concentrate and precipitate contaminants from the soil into the above ground parts of the plant (phytoextraction). One of the major advantages of this remediation approach is that some precious metals can bioaccumulate in plants and be recovered after remediation, a process known as phytomining. With ever increasing global metal contamination, plant remediation provides efficient, cost effective and ecologically sound approaches for sequestration and removal through leaves, stem and roots (Bu-Olayan & Thomas 2009). The success of the phytoextraction process, whereby pollutants are effectively removed from soil, is dependent on an adequate yield of plants and/or the efficient transfer of contaminants from the roots of the plants into their aerial parts (Evangelou et. al., 2019). The discovery of plant species capable of accumulating 100 times more metals (hyperaccumulators) than other non-accumulating plants in the same medium demonstrates that plants have significant potential to remove metals from contaminated soil and thus bioremediation is considered a green alternative to the problem of heavy metal pollution.

Methodology

Study Area

First, the Senna obtusifolia samples was collected from different locations on the dumpsite and farmland in Yola metropolis.

Sample Preparation and Analysis

The samples were dried and ground into a fine powder. Next, heavy metals are extracted from the samples using hydrochloric acid, nitric acid and hydrofluoric acid in digestion of heavy metal. Finally, the concentration of heavy metals in the samples was measure using analytical techniques, using atomic absorption spectrometry.

Result and Discussion

The result in table 1.0 shows the concentrations of the various elements (Cd, Zn, Fe, Pb, Cu) in both the **farm land** and **dump site**. The values are in **mg/kg** (milligrams per kilogram), which represent the mass of each element per kilogram of the sample.

Table 1.0: The Result showing concentrations of the various elements (Cd, Zn, Fe, Pb, Cu) in both the **farm land** and **dump site**

Element / Sample	Cd (mg/kg)	Zn (mg/kg)	Fe (mg/kg)	Pb (mg/kg)	Cu (mg/kg)
Farm land	ND	0.20	0.21	ND	0.18
Dump Site	ND	0.23	0.30	ND	0.22

Cadmium (Cd):

- **Farm Land**: ND (Not Detected)
- **Dump Site**: ND (Not Detected)

Interpretation:

- **Cadmium** is a highly toxic metal that can accumulate in soil and water, and it is harmful to plants, animals, and humans, even at low concentrations. Cadmium is often associated with industrial pollution, especially from sources like batteries, fertilizers, and industrial discharges.

- The fact that **cadmium is not detected** in either the farm land or the dump site suggests that there is no apparent contamination by cadmium in these areas. This is a good sign for the health of both the soil and the ecosystem, as it reduces the risk of long-term contamination by this heavy metal.

Zinc (Zn):

- **Farm Land**: 0.20 mg/kg
- **Dump Site**: 0.23 mg/kg

Interpretation:

- **Zinc** is an essential micronutrient for plants and animals, including humans. However, in high concentrations, it can be toxic and impair plant growth or contaminate the food chain.
- Both the farm land and dump site show very similar zinc concentrations (0.20 mg/kg vs. 0.23 mg/kg). These values are relatively low and suggest that the levels of zinc in these areas are not of immediate concern. Normal concentrations in soil can range from 10 to 100 mg/kg, so these values are much lower than the typical threshold for toxicity, indicating that zinc levels are within safe, natural limits for both agricultural and environmental health.

Iron (Fe):

- **Farm Land**: 0.21 mg/kg
- **Dump Site**: 0.30 mg/kg

Interpretation:

- **Iron** is another essential element for plant and animal life, and it is typically abundant in soil. Iron plays a vital role in processes like chlorophyll formation and is crucial for plant growth.
- The concentrations observed in both the farm land and dump site are very low (0.21 mg/kg and 0.30 mg/kg). Soil iron levels can vary widely, but these values seem quite low compared to the natural content of iron in soil, which can range from hundreds to thousands of mg/kg depending on soil type and geology. The low levels in both locations could indicate that these specific sites do not have an abundant iron presence, but they are not necessarily problematic since iron deficiency in soil is rare.

Lead (Pb):

- **Farm Land**: ND (Not Detected)
- **Dump Site**: ND (Not Detected)

Interpretation:

- **Lead** is a heavy metal that is highly toxic to both plants and animals, particularly in high concentrations. It can cause neurological damage in humans and animals, especially in children.
- The fact that **lead is not detected** in either the farm land or the dump site suggests that these areas are not contaminated with lead, which is a positive outcome. In areas with industrial or urban pollution, lead contamination is more common, especially from old paints, batteries, and gasoline residues. These results suggest that the sites are relatively free from such contamination.

Copper (Cu):

- **Farm Land**: 0.18 mg/kg
- **Dump Site**: 0.22 mg/kg

Interpretation:

- **Copper** is an essential nutrient for plants and animals, but it can be toxic in high concentrations. In agricultural soils, copper contamination can occur from the use of pesticides, fungicides, or contaminated irrigation water.
- The copper concentrations in both the farm land and dump site (0.18 mg/kg and 0.22 mg/kg) are relatively low and not likely to pose a risk. Typical background concentrations of copper in soil range from 2 to 100 mg/kg, so these levels are far below toxic thresholds. These results indicate that copper contamination is not a concern for either site.

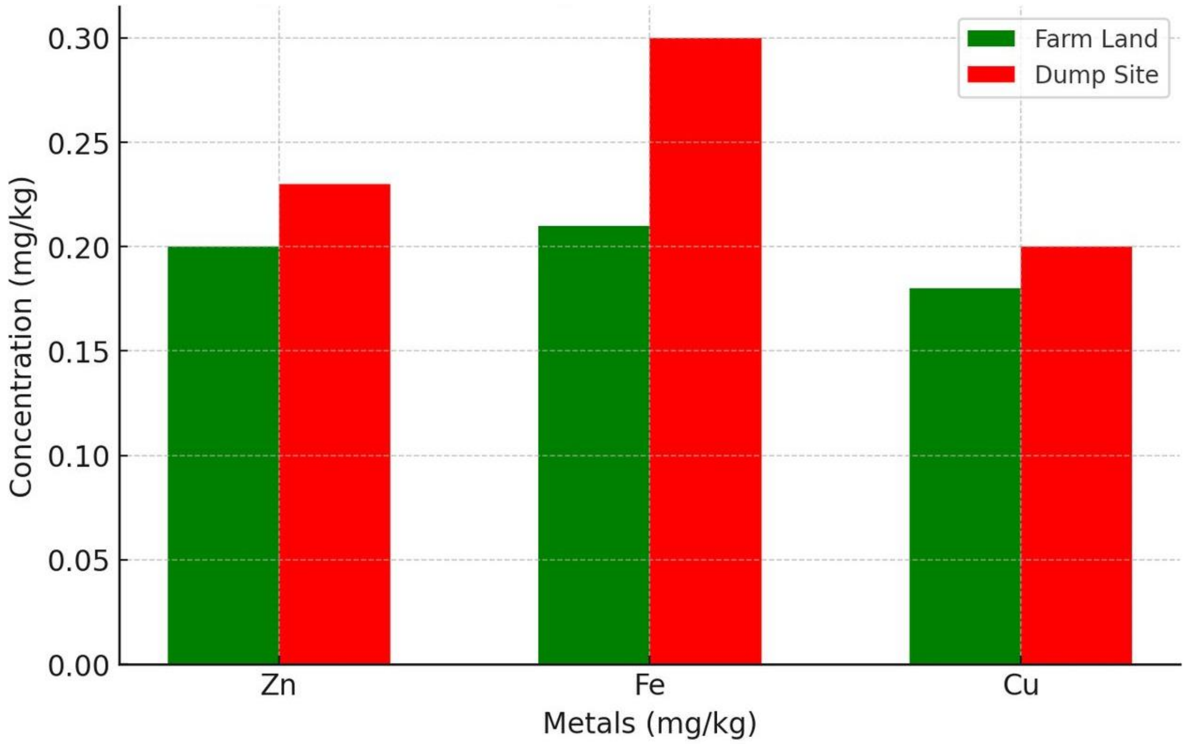

Figure 1.0: The bar chat showing the Comparison of Heavy Metal Concentration in ***Senna Obtusifolia***

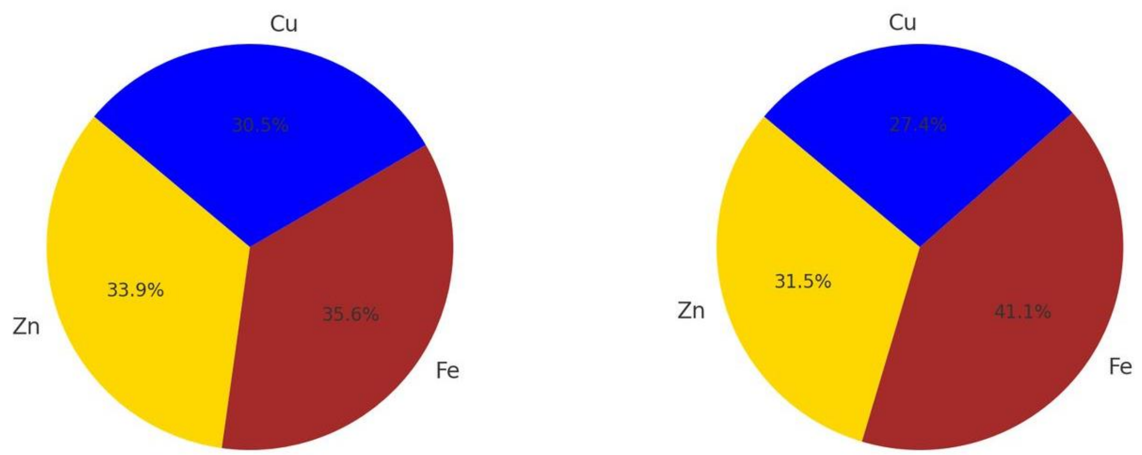

Figure 2.0: The pie chat showing the metal distribution in farm land and dump site

Discussion:

- **Farm Land vs. Dump Site**: The concentrations of metals in the farm land and dump site are quite similar. There are no detected levels of cadmium or lead in either location, and the concentrations of zinc, iron, and copper are also very low and unlikely to cause harm. This suggests that both areas have relatively low levels of metal contamination, which is good from an environmental and agricultural perspective.
- **Environmental Impact**: Both locations show minimal signs of contamination with the elements measured. This is beneficial for ecosystem health, as high concentrations of these metals (particularly cadmium, lead, or copper) can lead to soil degradation, poor plant growth, or long-term toxicity in the food chain. Given the low levels of these metals, it's unlikely that they would pose a significant environmental or health risk.
- **Potential Concerns**: Although the concentrations here do not seem problematic, future monitoring is always recommended, especially in areas like the dump site, where other contaminants may be present that were not measured in this study.

Conclusion:

The data suggests that both the farm land and the dump site are not significantly contaminated with the heavy metals tested (Cd, Zn, Fe, Pb, Cu). While the dump site might be expected to show higher levels of contamination due to waste accumulation, the results show similar, low levels in comparison to the farm land. The low presence of potentially harmful elements like cadmium and lead is a positive outcome, reducing concern for environmental and public health risks in these locations.

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References

Azubuike, C. C., Chikere, C. B., & Okpokwasili, G. C. (2016). Bioremediation techniques–bioremediation of soil pollutants. In *Recent Advancements in Bioremediation of Metal Contaminants* (pp. 54-71). IGI Global.

Bu-Olayan, A. H., & Thomas, B. V. (2009). Translocation and bioaccumulation of trace metals

Cadavid, D., Mellion, M., Hupperts, R., Edwards, K. R., Calabresi, P. A., Drulović, J., ... & cardiovascular disease-A systematic review. Environmental Health Perspective.115, 472–482

Chaney, Toghraie, D., Karami, A., Afrand, M., & Karimipour, A. (2018). Effects of geometric Chemistry (12):1161-1208 https://doi.org/10.2174/0929867053764635classification based on site of application: principles, advantages, limitations and prospects. *World Journal of Microbiology and Biotechnology*, *32*, 1-18.

D'amour, D., & Oandasan, I. (2005). Interprofessionality as the field of interprofessional

Dirar, H. A., Harper, D. B., and Collins, M. A. (1985). Bio- chemical and microbiological Eastern Nuba Mountains. Khar- toum University Press.

El Ghazali, G. E. (1987). Medicinal Plants of the Sudan. Part II. Medicinal Plants of the from an old smeltery pollution site: Effects on plant growth and medicinal properties. Science of the Total Environment 508: 514-521.

Gupta, N., Gaurav., S.S., Kumar, A. (2013). Molecular Basis of Aluminium Toxicity in

Henry, L. Younossi, Z., Anstee, Q. M., Marietti, M., Hardy, T., Eslam, M., ... & Bugianesi, E. http://dx.doi.org/10.3390/ijms161226183

Human Health: MechanisticInsight into Toxicity and Counter Defense Systemof

Antioxidants. International Journal of Molecular Sciences,16: 29592–29630;

in desert plants of Kuwait Governorates. *Research Journal of Environmental Sciences*, *3*(5), 581-587.

irrigated with waste water in share return and toxicological implication. American–Eurasian Journal of Agricultural environmental science, 4, 86-92

Jan, A.T Azam, M., Siddiqui, K., Ali, A., Choi, I and Haq, Q.M.R (2015). Heavy Metals and

Kabata-Pendias, A. (2001). Trace metals in soils-a current issue in Poland. *Acta Universitatis*

Karigar., Rao Nyika, J. M. (2018). The use of microorganism-derived enzymes for

Laura DK and Susan H, 2009. Early kidney damage in population exposed to cadmium and metal pollution with environmental physicochemical parameters in wastewater of Kocabas Stream (Biga, Canakkale, Turkey) by ICP – AES. Environmental Monitoring and Assessment, 127(1-3): 389-397.

Mohsen B and Salisu S, 2008. Investigation of metals accumulation in some vegetables

Navas-Acien, A.; Guallar, E.; Silbergeld, E.K.; Rothenberg, S.J. (2007) Pb exposure and Niazi NK, Singh B, and van der Zee SEATM, 2015. The synergistic effects of food waste

Odoemelam SA, Asiribo OE, Dauda KT, and Ojo S, 2017. Heavy metal contamination of other metals. Journal of Environmental Health Perspective, 117, 181-184.

overview. *Indian journal of pharmacology*, *43*(3), 246.

parameters on the performance of solar chimney power plants. *Energy*, *162*, 1052-1061.

Phillips, B. (2019). The shifting border between perception and cognition. *Noûs*, *53*(2), 316-

Pierzynski, G. M. (2000). Methods of phosphorus analysis for soils, sediments, residuals, and waters. Plants: A Review. American Journal of Plant Science 4: 21–37.

practice and interprofessional education: An emerging concept. *Journal of interprofessional care*, *19*(sup1), 8-20.

Singh, R., Gautam, N., Mishra, A., & Gupta, R. (2011). Heavy metals and living systems: An soils and plants on a Nigerian solid waste dumpsite: Implications for public health. Journal of Health and Pollution 7(13): 79-87.

Tchounwou, P. B., Yedjou, C. G., Patlolla, A. K., and Sutton, D. J. (2012). Heavy metals toxicity and the environment. EXS 101, 133–164.http://dx.doi.org/10.1007/978-3-7643-8340-4_6,

Valko M, Morris H, MTD C. (2005) Metals, toxicity and oxidative stress. Current Medicinal

Wickens, G. E. (1976). Jebel Marra. Her Majesty's Stationery OfÆce, London *Wratislaviensis. Prace Botaniczne*, *79*, 13-20.

Yayintas, O. T., YiLmaz, S., Turkoglu, M., & Dilgin, Y. (2007). Determination of heavy

Zhang X, Li Z, Chen H, and Liu X, 2015. Heavy metal accumulation in medicinal plants Zielinski, T. (2019). Safety and efficacy of opicinumab in patients with relapsing multiple sclerosis (SYNERGY): a randomised, placebo-controlled, phase 2 trial. *The Lancet Neurology*, *18*(9), 845-856.