Determination of Heavy Metal Contents in Some Medicinal Plants from Region of Oran from Algeria

Mohamed rabie Mokred
University of Oran
Talbi mohamed
University of Oran
Nadia kambouche
kambouche@yahoo.fr
University of Oran
Ahlem Berrabah
University of Oran
Salima bellahouel
University of Oran

Research Article

Keywords: medicinal plant, dosage, heavy metals, atomic absorption

Posted Date: March 16th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-2653339/v1

Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at Current Nutrition & Food Science on June 1st, 2024. See the published version at https://doi.org/10.2174/1573401319666230622101559.

Abstract

Some of the heavy metals found in our environment are toxic; once absorbed by plants, they build up in tissues and are phased out. Other heavy metals are trace elements that are necessary for human health, but can be toxic in excessive concentrations.

The purpose of this study is both to confirm the necessary metals' recognized medicinal virtues and to raise awareness of the presence of harmful non-essential metals that could harm humans and the environment.

This study depicts a profile of existence of heavy metals (Zn, Cu, Cd, Pb, Fe) in some important herbal plants used in some parts of the country as a food condiment like (*Moringa oleifera*, Artemesia *campestis*, *Nigella sativa*, *Asparagus stipularis*, *Sesamum indicum*, *Ruta montana*, *Rhamnus alaternus* , *Pistacia lentiscus* using atomic absorption spectrophotometer. Heavy metals in these herbal plants were in the range of 0.38-0.56ppm of Zn, 0.00-0.69 ppm of Cu, 0.13-0.16 ppm of Cd, 0.26-0.52 ppm of Pb, 1.10-8.89 ppm of Fe. Of the eight medicinal plants/products examined, the prescribed limits were respected.

For each plant, mineralize a test sample of 2 grams of powder. Each mineral is analyzed by injection. For each element, a calibration curve is generated. – Assay with atomic absorption devices (lead, copper, cadmium, nickel, manganese). The results are expressed in mg/L for different species. The highest value is: lead. Copper content is present in various extracts and is considered a good source. The zinc contained in *Moringa* is very valuable. The presence of iron in the species *Rhamnus alaternus* confirms its use in traditional medicine as an antianemic.

Introduction

Heavy metal refers to any elements that have a relatively high density and is toxic at low concentrations and examples of heavy metals include mercury, chromium, arsenic, cadmium, thallium and lead and possess some level of toxicity (Adepoju-Bello et al. 2012). They are naturally present in our environment and widely used in industry. Generally emitted in the form of very fine particles, they are transported by the wind and disseminate in soils and aquatic environments (Haldar and Ghosh 2020), contaminating flora and fauna, and thus end up in the food chain (Yang et al. 2022).

Some heavy metals are essential and necessary for the human body (Uddin et al. 2012). However, they become toxic and can damage vital body organs like brain, liver and heart even in small amounts. (Tapos Kormoker et al. 2022) (Chai et al. 2021).

It is found that plants not only contain toxic secondary metabolites, but they are also contaminated with environmental pollutants specially heavy metals, which can lead to serious health problems (Hina et al., 2011) (WHO 2007).

This article aims to provide the heavy metal content in eight plants used in traditional medicine in Algeria. Heavy metals were determined using atomic absorption spectroscopy (AAS).

Materials And Methods

Material vegetal:

The plants material are identified and validated with the help of Prof. Dr. Hadjadj-Aoul.S (Botany Department, Oran1, Algeria). They are cleaned, washed with tap water and dried in the shade. Then it was weighed, coarsely ground, and collected in clean bags.

The labeling of the samples is mentioned as in the Table 1. The concentrations are shown on mg/l.

Chemicals

The reagents used for the wet digestion of the samples were analytical quality fischer Scientific nitric acid (HNO3) and 70% perchloric acid (HCLO4). Prepare solutions using deionized water. All glassware is thoroughly washed and rinsed before use (Haldar and Ghosh).

Standard preparation:

The standard solutions of all heavy metals studied were prepared at five to six different concentrations, and the calibration curves were obtained by diluting standard stock solutions to a concentration of 1000 ppm.

Analysis method

The samples to be examined are first disintegrated using a wet pulping process. Briefly, approximately 0.2 g of sample was placed in a 100 mL volumetric flask and approximately 4 mL of HNO3 was added. Add the solution and let stand for a few hours, then gently heat on a water bath until the red smoke in the flask has completely ceased. Allow the flask to cool to room temperature, then add approximately 4 mL of perchloric acid, then reheat the flask on a water bath to evaporate, except for a small portion, then filter through Whattman filter paper to bring the volume to 100 mL using distilled water (Akram et al. 2015; Bhat et al. 2010) .

Instrumentation

Determination of heavy metals in all medicinal plants using atomic absorption spectrometry (Shimadzu) (Hina et al. 2011). Hollow cathode lamps of Cu, Cd, Pb, Zn and Fe (Shimadzu) were used as the radiation source and the fuel was air acetylene. All samples and standards were run in duplicate.

Results

The labeling of the samples is mentioned as in the Table 1. The concentrations are shown on mg/l.

Table 1
Abbreviations used for labelling samples

Labeling	Sample
Ms	*Moringa oleifera* seed
Aspc	*Asparagus stipularis* complet
Artc	*Artemesia campestris* complet
RMl	*Ruta montana* leaf
RMst	*Ruta montana* stem
Nis	*Nigella sativa* seed
Sess	*Sesamum indicum* seed
Lenl	*Pistacia lentiscus* leaf
Lenst+	*Pistacia lentiscus* upper stem
Lenst-	*Pistacia lentiscus* lower stem
RHst	*Rhamnus alaternus* stem
RHl	*Rhamnus alaternus* leaf

Metal Dosage

The results of the analyzes of the various metals in the parts of our studied plant species are presented in the form of histograms (Figs. 1–5). The Fig. 6 above groups all the metals of the plants under study

Discussion

ZINC (Zn)

Given these results, we found that zinc was present in all parts of the plant and varied from (0.38 to 2.5) mg/L.

Moringa, Nigella, sesame and *asparagus* have the highest zinc content (2.5-1.9-1.8) mg/L, and *Ruta Montana* leaves contain more zinc than stems, probably because the plant's metal accumulates zinc in the leaves. Or it has the leaf uptake capacity of metal plants, the upper stem of *Pistacia Lentiscus* has values close to the leaves but lower compared to its lower stems close to the root, which is not the case for *Rhamnu*s leaves and stems of mugwort The same amount of zinc was accumulated in the whole plant *Artemisia*, but their average concentration was 0.5 mg/L.

COPPER (Cu)

These results show that copper is not present in every species, it varies between 0 and 0.6 mg/L.

Sesame seeds are known to be rich in oligo-elements and have an expected high copper content of 0.69 mg/L. The *Rhamnus Alatenus* strain had a copper content of 0.48 mg/L, followed by asparagus, *moringa* and *nigella*, respectively, with a low copper concentration, which was very important to us, however, due to the fact that the stems of *Rhamnus Alatenus* compared to the leaves There is a great value where the copper concentration is zero, which indicates that no transfer has occurred between sections or that the leaves have excreted the accumulated copper.

CADMIUM (Cd)

The results from the analyzes of our samples concerning cadmium showed that the latter is present in all our plant parts at low concentrations and varies from 0.13 to 0.16 mg/L.

The concentrations of cadmium are very close to each other and very low mg/L, a value higher than this average would have been alarming because cadmium is a very toxic metal not only for the plant itself but also for the humans and the environment.

LEAD (Pb)

Following the analyzes of the samples concerning lead, it was noted that this metal is present in all our plant parts and varies from 0.26 to 0.52 mg/L as a maximum value.

The results obtained for the concentration of lead in the plants are higher than expected, which indicates the seriousness of the pollution of the soils where their pickings were carried out and also alarms on the fact that these plants having lead are consumable. Nevertheless these values are below the daily consumption threshold.

Indeed *Artemesia*, *Asparagus*, *Moringa* and *Nigella* contain more lead (0.46–0.52) mg/L, the *Ruta Montana* leaf contains more lead than the stem knowing that generally the lead remains accumulated in the root, This result may correspond to foliar absorption of lead indicating the presence of lead in the environment such as in soils.

IRON (Fe)

According to the results shown above, iron is the element that is essentially present in all of our plant parts, and its concentration ranges from 1.1 mg/L at the lowest value to 8.89 mg/L at the highest value.

This investigation allowed us to confirm the medicinal function of this plant, which is used by the Algerian community as an anti-anemic plant. The *Rhamnus Alaternus* leaf and stem contain the greatest iron, with a concentration of 8 mg/L. The presence of iron in the species *Rhamnus alaternus* confirms its use in traditional medicine as antianemic (Nekkaa et al. 2021).

The leaf of *Pistacia lentiscus* has twice the concentration of iron as the stem (respectively 2.5-1.6-4.5 mg/L), which is also the case for *Ruta montana*, where the leaf has much more iron than the stem (respectively 4.6, 1.7 mg/L). The lower stem of *Pistacia lentiscus* has more iron than the superior stem.

Disucussion

The Fig. 6 above groups all the metals of the plants under study. The resulting concentrations do not exceed the danger threshold according to the WHO (World Health Organization %J WHO 2007).

Our results show that Sesame seeds are known to be rich in oligo-elements and have an expected high copper. It is considered as an essential element for human health at low concentration (Waggoner et al. 1999).

It turns out that iron is a metal found in abundance in all parts of plants, we also note that for plants the presence and amount of metals vary from stem to leaf, sesame contains a balanced metal. Lead, even in small amounts, is a concern for soil conditions in Algeria. Zinc is one of the major essential elements required by the human system (Izah et al. 2016). Zinc plays several functions in the human body, such as proper thyroid function, blood clotting, wound healing, maintenance of good vision (Chasapis et al. 2012; Izah et al. 2016; Salako et al. 2016). It's important to note that zinc (which has recently been over exploited for its anti-Covid properties) (Wessels et al. 2020; Wessels et al. 2021) is abundantly found in *Moringa*, Sesame and Nigella, and these plants may become new sources of this vital element during this health crisis.

Conclusion

As we have seen in our study, medicinal plants generally have an ability to absorb and tolerate heavy metals to a certain point, where they can exhibit toxicity; here comes the limit to their consumption set by the WHO.

80% of the world's population use medicinal plants according to the WHO, some for lack of hospital resources or financial problems, others consider that natural products present less risk than the chemicals used in modern medicine or used as a supplement with a synthetic drug.

And for this it is essential to find out about the area and the conditions of collection if they are for human consumption (pick the plants in sites far from industrial areas; establish the history of the sites where the medicinal plants are picked; control the medicinal plants...).

Declarations

Acknowledgments

The authors gratefully acknowledge the financial support of this work by the Algerian Ministry of Higher Education and Scientific Research (MESRS) and Directorate of Scientific Research and Technological Development (DGRSDT).

Author's Contributions : All the authors conducted the research process; specifcally, they performed the sample extractions and prepared the study. Finally, B. L and K, B, N, acquired the fnancial support for the project leading to this publication. All the authors have read and agreed to the published version of the manuscript.

Funding Not applicable.

Data Availability Not applicable.

Declarations Ethics Approval Not applicable.

Consent to Participate Not applicable.

Consent for Publication Not applicable.

Conflict of Interest The authors declare that they have no known competing fnancial interests or personal relationships that could appear to infuence the reported work.

References

1. Adepoju-Bello A A , Issa O. A , Oguntibeju O. O, Ayoola G. A, Adejumo O. O (2012) Analysis of some selected toxic metals in registered herbal products manufactured in Nigeria. Afr J Biotechnol 11:. https://doi.org/10.5897/AJB11.3961
2. Akram S, Najam R, Rizwani GH, Abbas SA (2015) Determination of heavy metal contents by atomic absorption spectroscopy (AAS) in some medicinal plants from Pakistani and Malaysian origin. Pak J Pharm Sci
3. Bhat R, Kiran K, Arun AB, Karim AA (2010) Determination of Mineral Composition and Heavy Metal Content of Some Nutraceutically Valued Plant Products. Food Anal Methods 3:181–187. https://doi.org/10.1007/s12161-009-9107-y
4. Chai M, Li R, Gong Y, et al (2021) Bioaccessibility-corrected health risk of heavy metal exposure via shellfish consumption in coastal region of China. Environmental Pollution 273:116529. https://doi.org/10.1016/j.envpol.2021.116529
5. Chasapis CT, Loutsidou AC, Spiliopoulou CA, Stefanidou ME (2012) Zinc and human health: an update. Arch Toxicol 86:521–534. https://doi.org/10.1007/s00204-011-0775-1
6. Haldar S, Ghosh A (2020) Microbial and plant-assisted heavy metal remediation in aquatic ecosystems: a comprehensive review. 3 Biotech 10:205. https://doi.org/10.1007/s13205-020-02195-4
7. Hina B, Rizwani GH, Naseem S (2011) DETERMINATION OF TOXIC METALS IN SOME HERBAL DRUGS THROUGH ATOMIC ABSORPTION SPECTROSCOPY. Pak J Pharm Sci
8. Izah SC, Chakrabarty N, Srivastav AL (2016) A Review on Heavy Metal Concentration in Potable Water Sources in Nigeria: Human Health Effects and Mitigating Measures. Expo Health 8:285–304.

https://doi.org/10.1007/s12403-016-0195-9

9. Nekkaa A, Benaissa A, Mutelet F, Canabady-Rochelle L (2021) Rhamnus alaternus Plant: Extraction of Bioactive Fractions and Evaluation of Their Pharmacological and Phytochemical Properties. Antioxidants 10:300. https://doi.org/10.3390/antiox10020300
10. Salako S, Adekoyeni O, Adegbite A, Hammed T (2016) Determination of Metals Content of Alcohol and Non-alcoholic Canned Drinks Consumed at Idiroko Border Town Ogun State Nigeria. BJAST 12:1–8. https://doi.org/10.9734/BJAST/2016/19163
11. Kormoker T, Proshad R, Islam MS, et al (2022) Presence of toxic metals in rice with human health hazards in Tangail district of Bangladesh. International Journal of Environmental Health Research 32:40–60. https://doi.org/10.1080/09603123.2020.1724271
12. Uddin, A. H., Khalid, R. S., and Abbas, S. A. (2012) Determination of heavy metal concentration of different traditional medicine formulations available at the east coast region of Malaysia. Afr. J. Pharm. Pharmacol. 6:20: 1487-1491. http://doi.org/irep.iium.edu.my/id/eprint/25016
13. Waggoner DJ, Bartnikas TB, Gitlin JD (1999) The Role of Copper in Neurodegenerative Disease. Neurobiology of Disease 6:221–230. https://doi.org/10.1006/nbdi.1999.0250
14. Wessels I, Fischer HJ, Rink L (2021) Dietary and Physiological Effects of Zinc on the Immune System. Annu Rev Nutr 41:133–175. https://doi.org/10.1146/annurev-nutr-122019-120635
15. Wessels I, Rolles B, Rink L (2020) The Potential Impact of Zinc Supplementation on COVID-19 Pathogenesis. Front Immunol 11:1712. https://doi.org/10.3389/fimmu.2020.01712
16. WHO guidelines for assessing quality of herbal medicines with reference to contaminants and residues. Geneva: World Health Organization; 2007 (https://apps.who.int/iris/handle/10665/43510, accessed 17 March 2021).
17. Yang L, Wu P, Yang W (2022) Characteristics, Health Risk Assessment, and Transfer Model of Heavy Metals in the Soil—Food Chain in Cultivated Land in Karst. Foods 11:2802. https://doi.org/10.3390/foods11182802

Figures

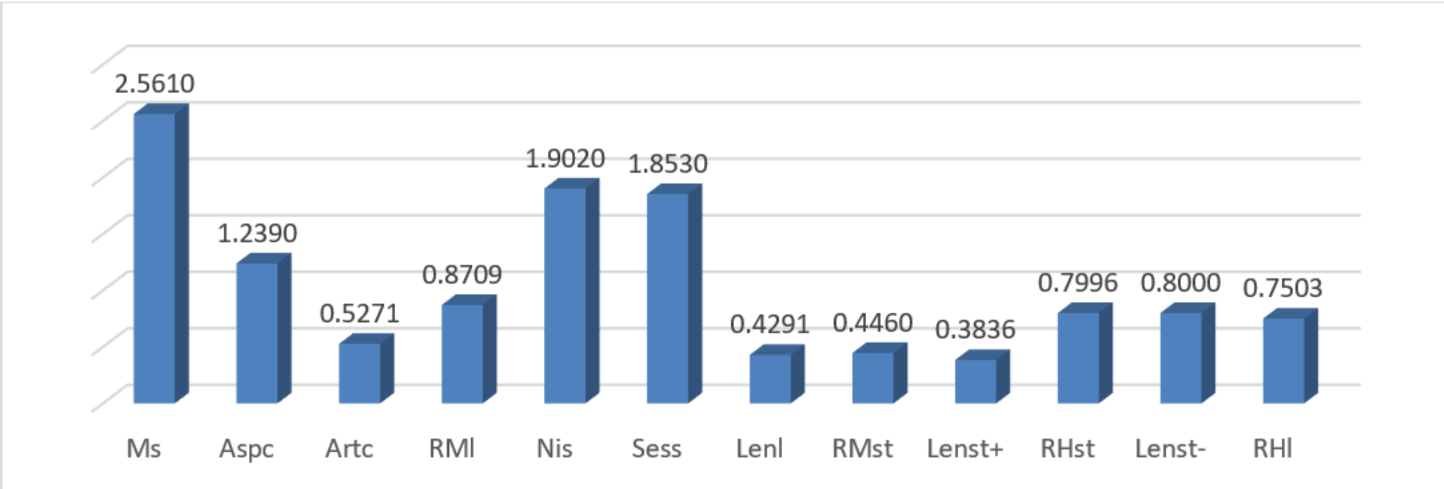

Figure 1

Zinc concentration in plant parts.

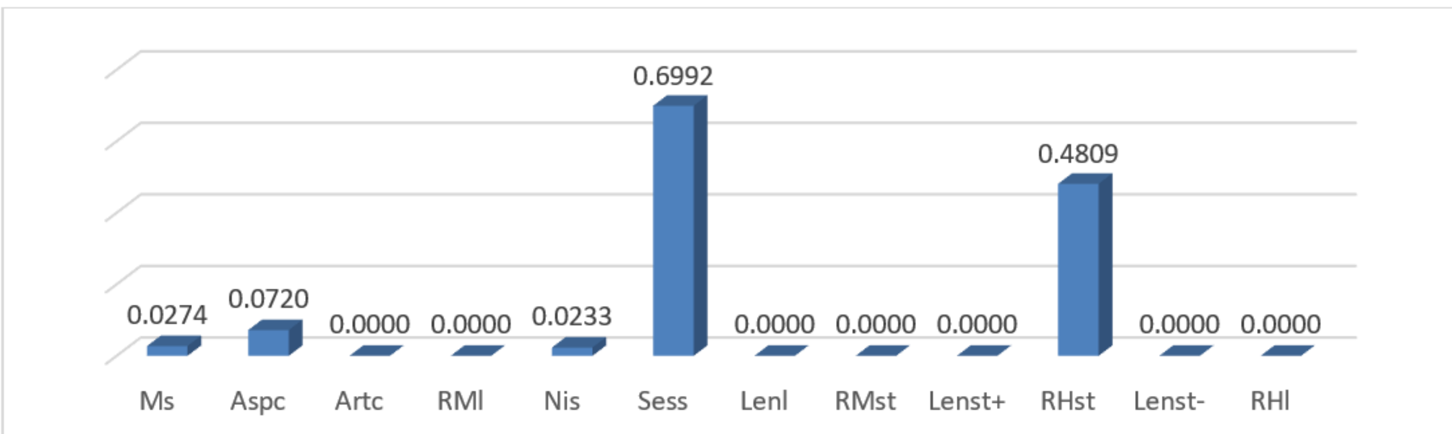

Figure 2

Copper concentration in plant parts

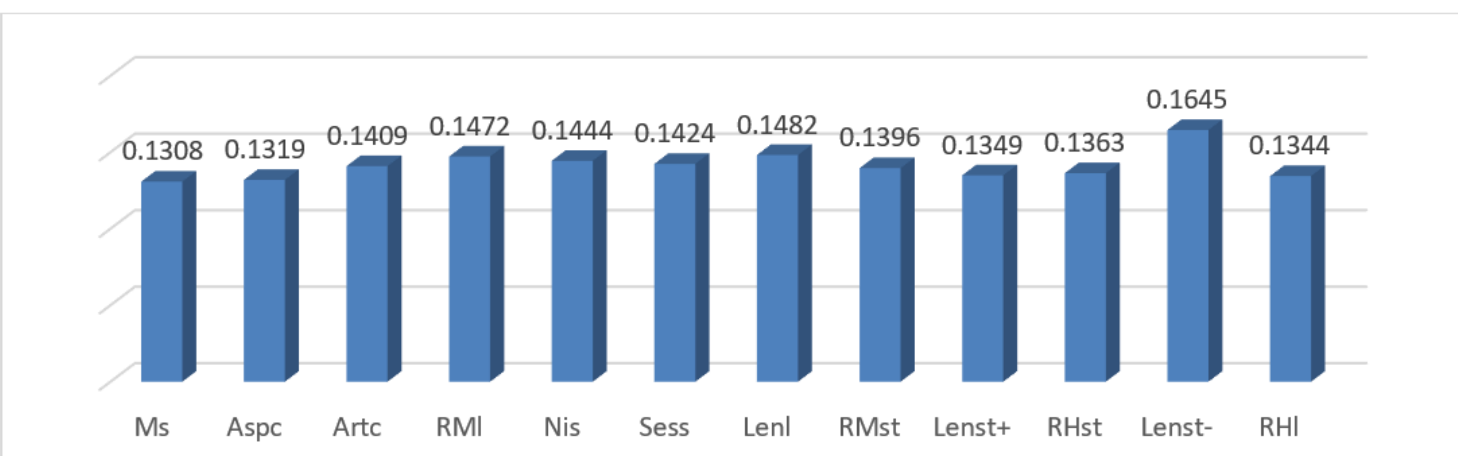

Figure 3

Cadmium concentration in plant parts.

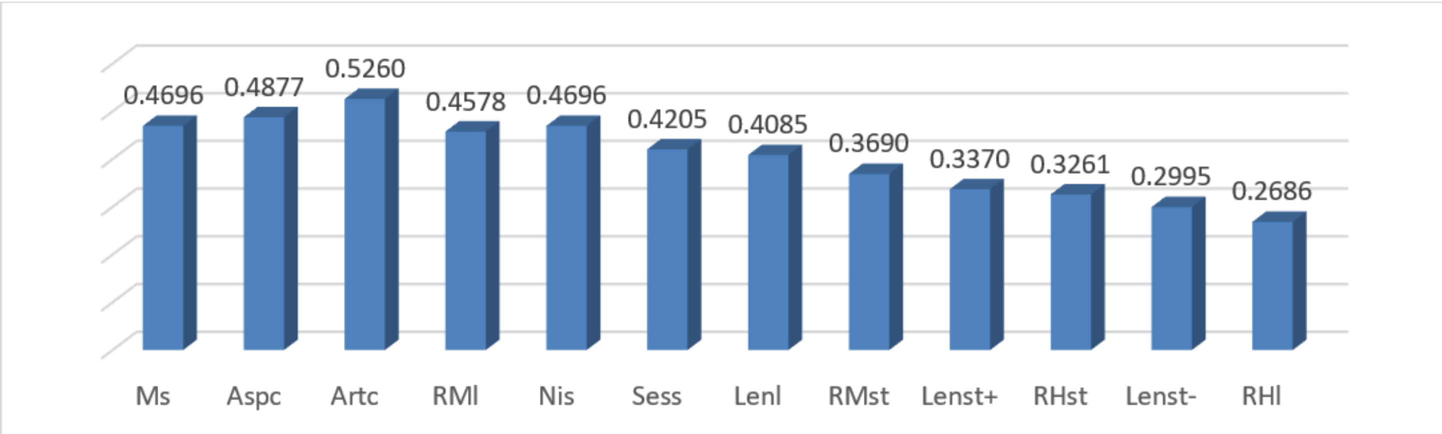

Figure 4

Lead concentration in plant parts

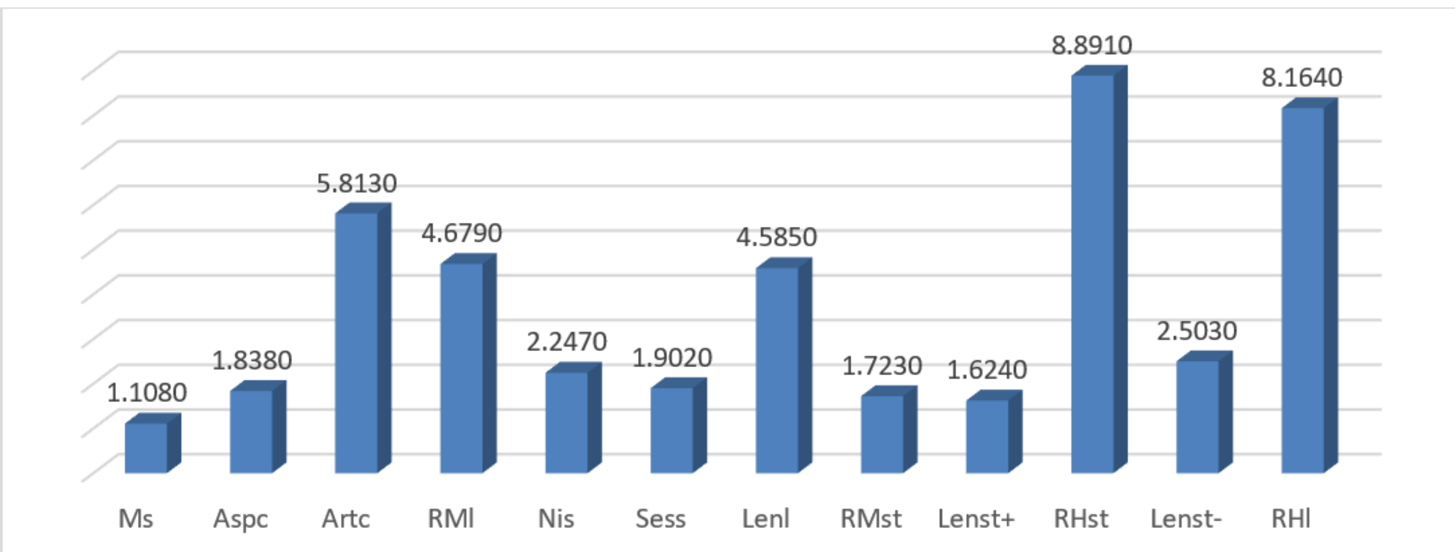

Figure 5

Iron concentration in plant parts

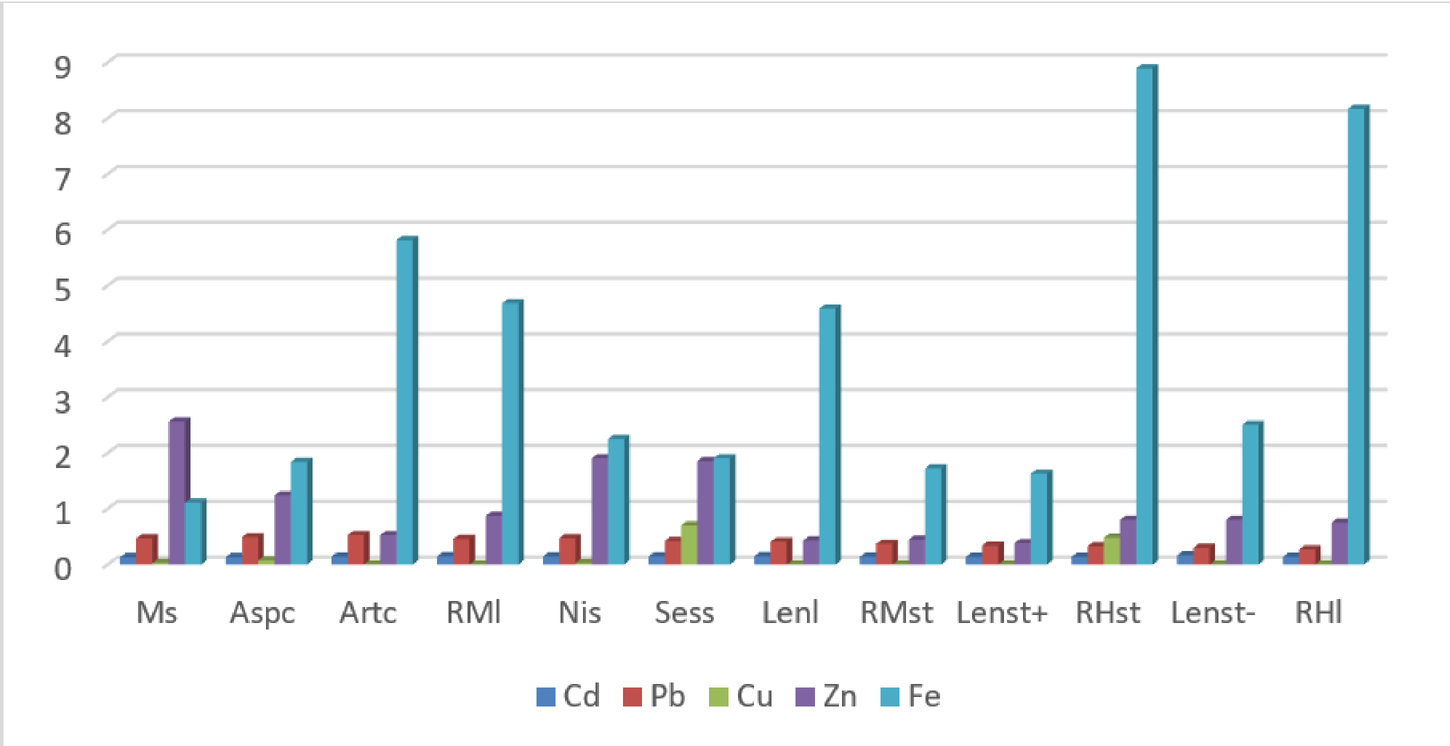

Figure 6

Quantity of metals in plant parts