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Determination of some Heavy Metals in Soil and Guava Plant at Rosetta Egypt

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Abstract

The uptake of heavy metals is the main topic of this study. Find out how much lead, cadmium, and other heavy elements are in the soil and guava trees in Rosetta. Therefore, this study's goal is to ascertain the concentration of heavy metals in the guava's fruits, leaves, stems, and roots as well as in the soil cultivar Psidium guajava L. The research was conducted in Rosetta, Egypt. Atomic absorption spectroscopy was used to determine the presence of heavy metals in soil and plant parts. It was found that the soil was poor in copper and the concentration of heavy metals in the soil was generally low. It did not reach the level of toxicity. Cadmium was found in the leaves of the plant. Nickel was also found in all plant parts examined and its percentage varied from 1.2 to 22.4 mg/kg. Agricultural soil contains a percentage of lead. Lead was found in the roots of plants, while manganese was found in all its parts. Copper, iron and zinc have also been found in all parts of the guava plant. In conclusion, the concentrations of heavy metals in both soils and Rosetta guava were so low that they did not cause toxicity to the plants and did not exceed the critical limit.

Keywords: Heavy metals, soil, guava, plant, Rosetta

Introduction

Metals with a high atomic weight and a density greater than 5 g/cm3 are naturally classified as heavy metals [4]. Globally, think tanks have increased their attention to environmental toxicity above standard maximum residue limits (MRL) (Tóth G.,et al 2015) The combination of environmental and health issues caused by cadmium (Cd), lead (Pb), copper (Cu), and zinc (Zn) is alarming (.Zhang X., et al. 2019 & Su C. et al. 2014)There are numerous sources of heavy metals, including mining, agriculture, and industry. The sources used in agriculture can be divided into four categories: wastewater, livestock manure, pesticides, and fertilization Li Z. et al. 2014) the threat of environmental heavy metal pollution has been rising quickly recently and causing chaos, particularly in the agriculture industry.

The key point in growing plants is how to regulate the relationship between the soil and Plant Environment: This research focuses on the uptake of radionuclides. Determine the content of Lead, Cadmium and some heavy elements in guava trees and soil in Rosetta.

The scientific community has long regarded heavy metal pollution of agricultural areas as a serious concern. Farmland typically has low levels of heavy metals. However, because of their poisonous nature and cumulative behavior, they have the potential to seriously affect human health at every stage of the food chain in addition to crops (Das et al., 1997; Melamed et al., 2003). The fact that heavy metal pollution persists in the soil for a very long time is one of the key issues. However, it may always be decreased by relocating the contamination to a different location, eliminating it from crops, or using phytoremediation (McLaughlin et al., 2000). Because heavy metals can have direct hazardous effects on species and provide indirect risks to human health, they have been recognized as damaging to the environment.

Guava plants are grown near mines and in workplaces to extract heavy metals. They are also grown next to roads exposed to exhaust, which may cause contamination with heavy metals and lead to the presence of some of these elements. Therefore, this study is useful in evaluating heavy metal pollution resulting from agricultural activities and environmental factors causing the pollution. Determining the concentration of heavy metals in the soil and various portions of the guava plant (fruit) was the goal of the experiment.

Materials And Methods

The Study Area

The study was conducted in the Rosetta area on the guava plant (Psidium guajava) the soil of this farm consists mainly of sandy loam. Most soils in the study area contain large amounts of sand **Table (1**).

Heavy metal extraction from plant samples

Plant samples of the Psidium variety were taken from three guava blocks. Three guavas were chosen at random to be sampled. Samples of the fruit, leaves, and roots were taken from every plant (three plants per block). There were three fruits taken from every guava plant. After being cleaned with distilled water and wiped down with a clean cloth, the samples were sliced into small pieces using a knife, the leaves were divided, and the root sections received the same treatment as the fruits and leaves. Fruits, leaves, and roots were dried at 70 °C in an oven until their weight stabilized before being cut (AOAC, 1984). After that, it is ground in a mortar. After weighing one gram of each sample into a conical flask, ten milliliters of HNO3 were added.

Table (1) The soil's pH, O.M., and Texture Class from the Rosetta guava plantation

depth cm.	Particle size dis			Texture Class	O.%	pH	E.C dS/m	Ca CO3%
	Sand %	Silt %	Clay %					
0-25	82.3	12	5.7	sand loam	0.2	7.8	1.5	1.41
25-100	75.1	17	7.9	sand loam	0.5	7.5	1.1	0.52
0-25	80.1	10.2	9.7	loam	1	7.6	0.5	1.7
25-100	80.3	9.9	9.8	sand loam	1.3	7.7	1.3	1.22
0-25	70.4	13	16.6	sand loam	0.4	8	0.5	1.42
25-100	66.6	15.6	17.8	sand loam	0.3	7.9	0.66	2.01
0-25	70.6	15.6	13.8	sand loam	1.4	7.4	0.2	2.2
25-100	68.9	14.8	16.3	sand loam	1.5	7.3	0.24	1.9
0-25	68.2	15.7	16.1	sand loam	0.5	7.7	1.8	1.71
25-100	67.5	16	16.5	loam	0.3	7.6	1.5	1.02

Heavy Metals extraction from the Soil

Each block had five plots set aside for soil sampling. Samples of soil were taken at a depth of 0–25 cm (25–50), allowed to air dry, and then run through a 250 µm mesh. Prior to analysis, soil samples were crushed using a mortar. 50 milliliters of 1.0 M NH4CH3OO (pH 7) was added to Kartelli bottles containing ten grams of soil samples. After being shaken for 1.5 hours, the samples were centrifuged for 30 minutes at 3000 rpm filtered through 0.45 µm Millipore filter paper, and then reconstituted with 50 milliliters of distilled water. The samples were centrifuged and shaken again after being cleaned with 50 milliliters of distilled water, as previously mentioned.

Result

Content of Heavy Metals in Guava Fruits:

Table (2) The average amount of heavy metals in guava fruit is displayed (mg kg-1).

	pb	Fe	Cd	Cu	Ni	Mn	Zn
Guava block 1							
Fruit	2.55	0.38	0.03	17.34	1.2	0.38	12.51
Leaves	1.80	1.30	1.79	19.55	9.6	1.30	36.26
Stem	0.5	0.10	0.15	21.41	11.9	0.10	25.22
root	0.01	0.41	2.2	30.24	22.4	0.41	95.11
Guava block 2							
Fruit	1.66	0.39	0.11	19.99	1.2	0.46	15.35
Leaves	0.95	3.30	2.11	22.55	9.6	1.99	45.22
Stem	0.9	110	1.22	26.41	11.9	0.18	29.26
root	0.1	0.99	1.90	30.24	22.4	0.77	99.55
Guava block 3							
Fruit	3.22	0.05	0.76	16.6	1.4	0.92	11.42
Leaves	2.65	2.03	1.55	19.1	9.3	0.89	39.99
Stem	1.75	0.24	0.99	21.01	11.6	0.12	21.12
Root	0.05	0.03	1	33.21	22.1	0.56	87.22
WHO/ FAO	0.3	48	0.2	40	10	500	100

Safe values for copper, lead, and cadmium in fruit and vegetables recommended by the (WHO/FAO) are 40, 0.3, and 0.2 mg/kg, respectively

According to this study, the guava plant contains iron, manganese, zinc, copper, and nickel in all of its parts. Lead was found in the fruits of every plant in the study, while cadmium was only found in the leaves of the plants in the first and second groups Table (2). Iron, zinc, and copper are the primary phytonutrients that were found in guava plants. Plants need these nutrients for healthy growth and a variety of enzyme activities (Hopkins, 1999). The percentage of zinc and manganese in the leaves was also found to be higher than in the other plant parts examined in this investigation. These outcomes are in line with other research that has demonstrated the role of zinc as an enzyme activator in hormone synthesis (Hopkins, 1999; Marschner, 1986). It's interesting to note that the guava plant contains iron in every part (Table 2). This study demonstrated that iron is present throughout the guava plant. Iron is necessary for several enzyme functions, is a part of chlorophyll, and takes part in the photosystem's electron transfer process (Hopkins, 1999).

The role of nickel in plants is not entirely clear,, but it is required in small amounts (Hopkins, 1999). Nickel is also found in all plant parts, and Ni deficiency can reduce seedling vigor and cause leaf damage (Brown et al., 1987; Dalton et al., 1988). Nickel is found in all guava parts, leaves and roots. The nickel content of guava fruit may be due to bioaccumulation.

Lead has been detected in small amounts in guavas, and it should be noted that guavas are grown along a road that is close to heavy traffic, which can cause lead levels. Lead (Pb) is one of the most common heavy metal contaminants in soil and is considered very harmful to plants (Zeng et al., 2007). Lead can cause morphological, physiological, and biochemical issues in plants, but it serves no biological purpose in them (Zeng et al., 2007, Kumar et al., 2017). Lead uptake has been observed in several plants. The absorbed Pb accumulates in the roots and only a small part of it is transported to the aerial parts of the plant (Kumar et al., 2017).

Copper is essential for plant growth, plays a role in many enzyme processes and is key to the formation of chlorophyll. Copper (Cu) is a trace element that plants need in very small amounts. The normal range in the growth medium is 0.05-0.5 ppm, while the normal range in most tissues is 3-10 ppm. Although copper deficiency or toxicity is rare, it is best to avoid both conditions as both can have negative effects on crop growth and quality. (Ed Bloodnick, 2023) Copper activates some enzymes in plants, is also necessary in the process of photosynthesis and necessary for plant respiration. Copper is immobile, which means that the symptoms of its deficiency appear in the new leaves. Also, if the pH of the growing medium is high, it can lead to copper deficiency because it is less available to the plants. High levels of copper can compete with the plant and absorption of iron and sometimes zinc. Copper, like most micronutrients, is more available when the pH of the growth medium is low

Cadmium (Cd) is a minor trace element in plants and is ubiquitous in the environment. Human activities such as waste disposal, mining, metal production and the use of synthetic phosphate fertilizers increase the concentration of cadmium in the environment and are carcinogenic to human health. (Fasih Ullah Haider et al 2020). Cadmium was found in trace amounts in guava leaves.

Overall, the study showed that the various parts of the guava plant studied did not contain toxic metals such as lead and cadmium, except for the leaves and fruits. It is worth noting that these plants are planted next to the factory, which leads to their contamination with some heavy elements, but according to FAO, they do not reach toxicity.

Heavy Metals in the Soil:

Most of the soil in the study area contains sandy loam. All soil samples recorded less than 2% organic matter and pH values ranged from 7.0 to 8.0, indicating that the soil was alkaline. Heavy metals are found in soil samples over a very wide concentration range. The highest total amount of copper was found in all soil samples (Table 3).The results of this study showed that all parts of the guava plant contain relatively high levels of iron. Merian (1991) reported that insoluble iron, primarily ferric hydroxide, is found in the soil before it is assimilated by plants.

Table (3) Heavy metals in soil sample

	pb	Fe	Cd	Cu	Ni	Mn	Zn
Guava1 block 1							
0-25	41	19.39	0.7	50	66	0.61	200
25-50	39	18.99	1.2	65	59	0.55	181
Guava1 block 2							
0-25	55	8.51	2.3	72	52	0.47	88
25-50	25	7.74	1.6	43	43	0.35	95
Guava2 block 3							
0-25	60	8.26	1.0	90	38	0.56	132
25-50	49	7.81	1.4	62	50	0.61	150
WHO/FAO Standard	112	2.80	0.2	36	-	-	50

All manganese values ranged from 0.10 to 1.30 mg kg-1 and this metal was found to accumulate in guava leaves. Mn uptake by guava plants was a consequence of soil pH conditions (7-8) (Andriano 1986) claims that the uptake of manganese by plants is higher in low acid soils compared to very acid or alkaline soils. The zinc content varied from 0.88 to 2.00 mg kg-1. As with manganese, zinc accumulates in guava fruits and leaves.

Given that soil organic matter can lower zinc bioavailability, these soils' low organic matter content and slight sandiness may have helped plants absorb zinc more readily (Andriano, 1986).

The soil's cadmium content was minimal and varied between 0.7-1.2 mg/kg. The leaf's low cadmium content could be an indication of its limited availability of cadmium in the soil. It is estimated that lead accounts for approximately 10% of all heavy metal pollution. Pb-affected soil contains 400-800 mg kg-1 lead, while in industrial areas it can reach 1000 mg kg-1 soil (Pourrut et al., 2011).

Copper was found in all parts of the soil and in guavas. The concentration of copper in the study area compared to other agricultural regions was significantly lower (Ismail et al., 2005). Leaching into the soil (0–25 cm), where the samples were taken, could be the cause of this. There have been reports of increased copper leaching in sandy soils with low levels of organic matter (Andriano, 1986; Merian, 1991). Therefore, copper deficiency in guavas is due to copper deficiency in the soil. In general, guava plants tend to accumulate heavy metals, which are also important nutrients for the plant. No statistically.

A noteworthy association was noted between heavy metals in soil and guavas. The potential for guavas to accumulate heavy metals could be the cause of this. These minerals were most likely absorbed via the evapotranspiration mechanism. However, these findings suggest that some heavy metal concentrations in guavas or the soil of this farm may be elevated by emissions from nearby factories and roads, as well as by plantations. Thus, it is advised to conduct soil tests prior to planting in order to ascertain the elemental proportions and attempt to adjust them before putting in the plants.

Conclusion

According to this study, the majority of the heavy metals present in the different portions of the guava plants under investigation were also phytonutrients necessary for various procedures to achieve optimal plant growth. Toxic metals such as lead and cadmium have been discovered in guava plants. But it was less than the critical limit according to the World Health Organization.

Environmental efforts must be made to keep the concentration of heavy metals below the critical limit Agricultural areas must be studied and the necessary land analyzes must be conducted to determine the most appropriate ways to treat these areas from pollution in order to preserve the environment and human health.

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