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Bioaccumulation of lead and Chrome in Celery plant (*Apium graveolens L.*)

[1]Jaafar B. Algburi, [2]Furqan Yahya Jawad Sharba, [3]Murtdha Mohammed Taher, [1]Bashar Fadhl Neamah, [1*]Mohammed Jawad Al-Haidarey

[1] Department of Ecology and Pollution, Faculty of Science, University of Kufa, Najaf, Iraq

[2] Department of Biology, Faculty of Education for Girls, University of Kufa, Najaf, Iraq

[3] Education Directorate of Najaf Province, Iraq

*Corresponding author:
mohammedj.alhayderi@uokufa.edu.iq

Abstract

Celery is one of the most important table plants in the world, this plant tends to collect many minerals from the surrounding environment, and one of these minerals is lead and chrome, which they considered toxic metals if they accumulate in this plant and accordingly three different areas were chosen for the cultivation of this plant. It was divided into areas contaminated with lead and chromium, which were close to the cement factory street and Bahr al-Najaf area polluted with sewage water and its air polluted by the smoke of bricks. The celery leaves and the soil planted in this sites were collected in December of the year 2020, for three replicates from each region, they were digested and the concentration of lead and chromium were detected.

The results showed that the concentration of studied elements in the soil and plants of Bahr Al-Najaf < Al Ma'mal Street < Al Bu Hadari, and this difference was significant (< 0.05). Also, the results showed that the biological concentration of these elements were large in Bahr Al-Najaf area compared to Al-Ma'mal Street and Al-Bu Hadari area. Accordingly, the study recommends not to plant crops in polluted areas and the necessity of chalking the concentration of these elements of the soil and the surrounding environments of the plants before starting cultivation.

Keywords

Bioaccumulation, Celery, Chrome, Heavy metals, Lead,

Imprint

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Celery is known as one of the types of plants belonging to the Apiaceae family, which includes many plants, such as: parsley, parsnip, and root vegetables, and it is one of the most important vegetables in the Iraqi table and is usually eaten raw (1).

Because plant biomass is naturally renewable, unlike fossil fuels like coal, oil, and natural gas, it is regarded as a renewable source of energy. After coal and oil, biomass is the third most important source of energy, accounting for around 14% of the world's total energy supply (2).

In the past several decades, with the rapid urban, agricultural, and industrial development and the increase in dependence on it, the activities of fertilization with chemicals, irrigation with sewage water, mining and the large number of wheels in Iraq have led to the pollution of agricultural soil with heavy metals, especially in areas near roads and industrial areas (3). Heavy metals are high atomic mass (>5 g cm-3) such as (Hg, Pb, Cd, Ni, Cd, Cr... etc) that can cause toxicity problem. On the other hand, some heavy metals may have a toxic effect on living organisms while being used cumulatively. Heavy metals may accumulate in agricultural soils and plants due to the irrigation of wastewater over time. This is one of the most serious environmental problems because there are concerns about food safety and possible health risks (4).

Heavy metal pollution is one of the forms of environmental pollution resulting from industrial or agricultural human activity. In recent years, scientists have been interested in studying heavy metals in terms of their presence in the environment and their biological effects and their relationship to human health. Food is one of the main sources of human exposure to these elements, so many studies have been interested in developing methods appropriate to determine the extent of food contamination with these elements (5). Crops and vegetables that are cultivated in soil that is contaminated with heavy metals have a higher buildup of heavy metals than crops and vegetables that are grown in soil that is not contaminated. Although some studies showed that the concentration of Pb in soil ranged between (42.91-106.31) mg/kg (6). The majority of the critical minerals that our bodies require come from water and food, which are also the primary vectors via which many harmful metals enter our bodies. Compared to fruit and cereals crops, vegetables leafy acquire heavy metals more readily in their edible parts. Vegetables collect heavy metals and store them in edible and inedible sections in high enough concentrations to induce clinical issues in human and animals that eat them (7).

Toxins are growing more common in our contemporary industrial society. Unfortunately, they end up in live organisms. Through food chains and food webs, all creatures in an environment are tightly interrelated. Bioaccumulation is the process that describes what happens when toxic substances make their way into an organism, where they can then build up and remain. As a result of the connection that exists throughout the food web, bioaccumulative toxins have the potential to spread throughout whole ecosystems. Heavy metals include chromium, mercury, tin, nickel, lead, cadmium, and cobalt, in addition to several important elements that are poisonous in excessive concentrations, including zinc, copper and iron. Heavy metals can be released into the environment through gold mining, element mining (which employs mercury element), industrial waste and electronic trash, putting humans and animals at danger. mercury, lead, nickel, Cadmium, and cobalt interfere with blood cell formation. the nervous system, circulatory, liver and kidneys, effected negatively by some heavy metals. Certain ones of them are known to be cause cancer as well as reproductive issues. Some species of plants are used by scientists to remove toxins as well as heavy metals from polluted soil, however this procedure is dangerous since other creatures may eat the plants, so transferring pollutants into to the food chain (8).

Lead and chromium are toxic metals, which led to the limitation of its applications in most countries after the discovery of its toxicity. Lead negatively affects biological bodies, where its effect is similar to neurotoxins in terms of the ability to damage the nervous system and disrupt the functional performance of some vital enzymes, causing neurological and motor disorders (9).

The buildup of lead in the body results in lead poisoning, Lead is a toxic heavy metal. The brain is the organ that is most sensitive to lead exposure. Poisoning symptoms include abdominal pain, headache, memory problems, irritability, infertility, constipation as well as tingling in the feet and hands. About ten percent of cases of mental retardation are caused by lead exposure, cases that are otherwise of unknown cause and can lead to behavioral problems. Lead poisoning leaves some permanent effects and may occur in severe cases, anemia, seizures, coma, or death. One can be exposed to lead through contaminated air, water, dust, food, or consumer products. (10)

Children are at greater risk because they are more likely to pick up objects from the ground and put them in their mouths, such as those containing lead paint, and absorb much more of the lead they eat than adults. Exposure at work is a common cause of lead poisoning in adults in certain occupations. Lead exposure risk. Diagnosis is usually made by measuring the level of lead in the blood. (11)

The US Centers for Disease Control has set the upper limit of the blood lead level for adults at 10 mcg/dL (10 mcg/100 g) and for children at 5 mcg/dL. Elevated lead can also be detected by detecting changes in red blood cells or thick streaks in children's bones as they appear on X-rays.

Lead poisoning can be prevented. This includes individual efforts such as removing leaded items from the home, workplace efforts such as improving ventilation and ongoing case monitoring, but also through national policies, such as passing laws banning the use of lead in products such as paint and gasoline, and laws that Provides cleaning of contaminated soil. Treatment mainly depends on removing the source of lead and using drugs that bind to the lead so that the body can get rid of it, known as chelation therapy.

Chelation therapy is recommended in children with blood lead levels greater than 40-45 mcg/dL. Drugs used include dimercaprol, EDTA, and Succimer. Lead is believed to have caused 853, 000 deaths in 2013 (12). It generally occurs in the developing world, especially among the poor, who are most at risk. Lead is believed to be responsible for 0.6% of the global disease burden. People have been mining and using lead for thousands of years. Lead poisoning has been described as early as 2000 BC, while the first efforts to reduce lead use date back at least to the 16th century. Concerns about low levels of exposure began in the 1970s with no safe minimum exposure for lead.

The current study was conducted with the aim of comparing the possibility of lead and chromium accumulation in one of the commonly grown vegetables in Iraq. Irrigation of vegetables with sewage water and near pollution sources is a very common practice in Iraq.

MATERIAL AND METHODS

For the purpose of achieving the objectives of the study, three sites were chosen, distributed in Bahr Al-Najaf, the Cement Factory Street in Kufa, and the Bu Hadari area as a reference site (Fig. 1), and three replicates were taken from the soil and from the celery plant in December of the year 2020.

The first site (Bahr al-Najaf) it is considered one of the areas where agricultural crops are irrigated based on a small stream branching from the Euphrates River and on the waste water of the old city in Najaf (3).

The second site (Al-Ma'mal Street), which is considered one of the areas contaminated with lead and chromium and some other vehicles due to its proximity to the road of trucks transporting cement and the large number of cars movement, as well as due to the dust falling from the activities of the cement factory (3).

The third site (Albu Hadari area), it is located an the Shatt Al-Kufa river (it's a branch of Euphrates River) and it is the least polluted and was considered as a reference site for the purpose of comparison.

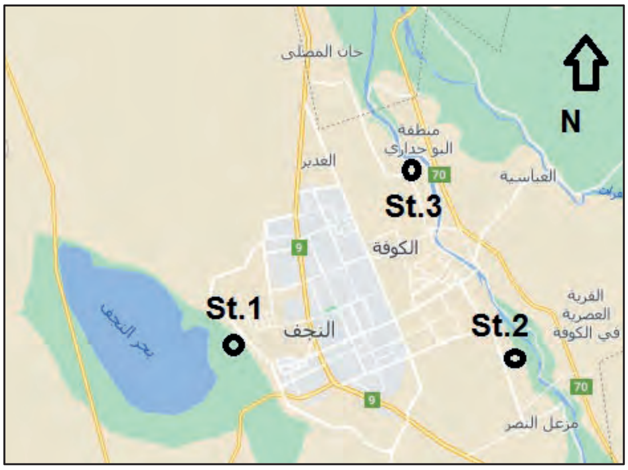

Fig. 1.The study sites in Iraq

Celery plants were collected manually (without using the usual cutting tools or scythe) to avoid the contamination, kept theme in plastic bags until reaching the laboratory. Also, samples of soil were collected from same area which plant grown, at a depth of 10 cm, where the root zone of this plant was located. Upon reaching the laboratory, the plant samples were washed using deionized water in the advanced environment laboratory in the Department of Ecology and Pollution at the Faculty of Science / University of Kufa, then dried using a laboratory oven at 60 degrees for 24 hours, then the leaves of the plant were crushed using a ceramic mortar and It was sieved using a 50 µm sieve, and then 1 gm of the powder was taken and digested using hydrochloric acid, perchloric acid and nitric acid using a digester. Atomic absorption (13). Also, Soil samples were dried using a laboratory oven at a temperature of 60 for 24 hours, then they were cleaned of impurities, gravel and large stones, then they were crushed using a ceramic mortar and sieved using a 50 µm sieve and then 1 gm of the powder was taken. It was digested using hydrochloric acid, perchloric acid, nitric acid and hydrofluoric acid using a digester. After the digestion process, the samples were sent to the Consulting College of Pharmacy laboratory for the purpose of measuring the concentration of lead in the sample using an atomic absorption device (13).

As for the statistical analysis, the IBM-SPSS statistics 24 program was relied upon to find the significant differences between the different variables and sites and to find correlations.

RESULTS

The results proved that the plants of the first site (Fig. 2, and 4) accumulated lead and chromium in greater quantities than the rest of the sites because of the high concentrations in the soil (Fig. 3, and 4 respectively). Also, the concentrations in the first location were higher than the second location, which in turn was higher than the third region.

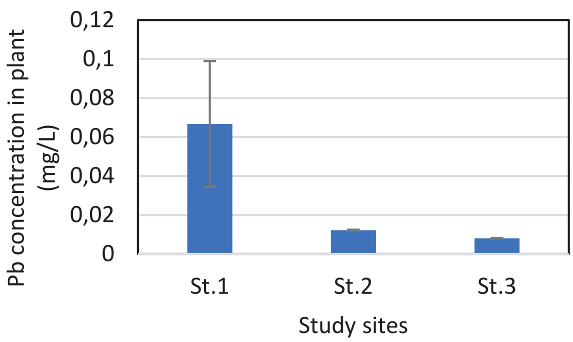

Figure 2 Concentration of lead in celery leaves study

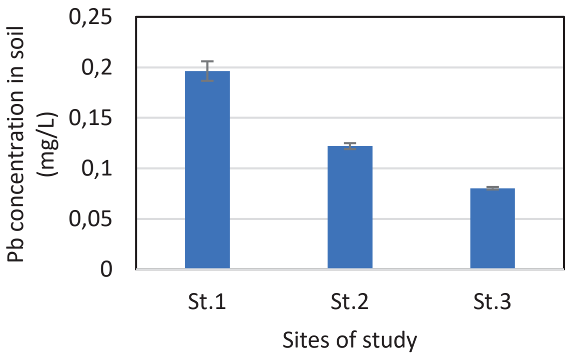

Figure 3 Concentration of lead in soil

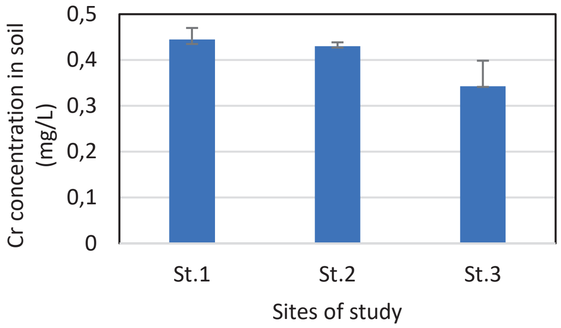

Figure 4 Concentration of chromium in celery leaves

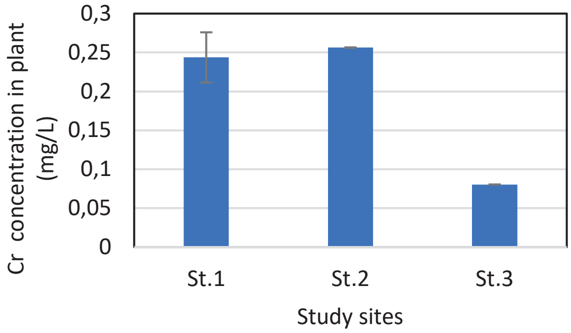

Figure 5 Concentration of chromium in soil

The statistical analysis (Table 1) showed that there are significant differences between lead and chromium concentrations in the different study sites. Also, there were a significant correlation between these metals (r=0.78, p-value < 0.05), and that mean they are from the same sources.

DISCUSSION

There are a few ways in which toxins may make their way into the food chain: absorbed via the skin, inhalation by lung, and swallowed also, plants can acquire poisons directly from the soil. For bioaccumulation to happen, a chemical should be able to dissolve in fat, mobile, long time lived, be biologically active, and be able to be taken in by biota. Toxins can build up in the fatty tissues of herbivores because the plants they eat may be polluted. When a carnivore consumes a large quantity of herbivores that are also loaded with toxins, the carnivore's body will become more saturated with those poisons. In the food chain, this process of biomagnification keeps going (14).

So it is the process of cells accumulating and accumulating some substances inside them from the surrounding environment so that the concentration of the substance inside the cell becomes higher than the concentration in the surrounding environment, and most of the accumulated substances are minerals, but cells may collect other substances, and cells can accumulate substances inside by several means, including the secretion of substances The chelation of minerals from the surrounding environment and their introduction into the cell (15).

The purpose of cells accumulating materials inside them for purposes related to the metabolic processes that they carry out or help them to cope with the

Table 1

The statistical analysis of bioaccumulation of lead and chromium in studied plant and soil.

ANOVA	The statistical analysis of bioaccumulation of lead In studied plants					
Source of Variation	SS	df	MS	F	P-value	F cit
Between Groups	0.0207	2	0.0104	199.	< 0.001	5.1433
Within Groups	0.0003	6	< 0.0001			
Total	0.02103	8				
ANOVA	The statistical analysis of bioaccumulation of lead In soil					
Between Groups	0.0064	2	0.0032	6.1571	0.0352	5.1433
Within Groups	0.0031	6	0.00052			
Total	0.0096	8				
ANOVA	The statistical analysis of bioaccumulation of chromium In studied plants					
Between Groups	0.059	2	0.029	11.05	0.0097	5.143
Within Groups	0.016	6	0.003			
Total	0.074	8				
ANOVA	The statistical analysis of chromium in soil					
Between Groups	0.018	2	0.009	4.762	0.058	5.143
Within Groups	0.0115	6	0.002			
Total	0.0298	8				

surrounding conditions, and they are within specific controls, materials are transported by transport devices specific to each substance. The charged particles are opposite to the release of molecules equivalent to them outside the cytoplasm. For example, the entry of positive ions corresponds to the release of protons or any other positive ions outside the cell (15).

The results of the current study agree with many previous studies in the ability of this plant to accumulate heavy metals such as lead, iron, chromium and other metals (16).

CONCLUSIONS

Although celery is a useful vegetable for human, planting it in polluted places may cause bioaccumulation of lead and chromium in plants and causing health problems. The soils of the study area in Bahr Al-Najaf and Al-Mamal Street were contaminated with lead and chromium elements, and there were a significant differences in studied metal concentrations in the studied areas.

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