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Purifying the Effects of Cadmium in Soil by *Amaranthus chlorostachys* on the Amount of Chlorophyll a and b

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ABSTRACT

The use of chemical and industrial materials has caused environmental pollution. These pollutants are including heavy metals like cadmium can be noted that pollutants have dangers for many organisms, including plants.
In this study, in order to inform the advantage *Amaranthus chlorostachys* puring in soils contaminated with cadmium, Concentrations of 0, 5, 20, 40, 60 and 100 mg /kg of cadmium on plant growth parameters including plant fresh and dry weight and chlorophyll a and b that were reviewed. The results show a significant difference of cadmium accumulation in shoots and roots were treated with other treatments and the trend was increasing ($p< 0.05$). decreased Fresh weight in all treatments and dry weight at concentrations of 40, 60 and 100 mg/ kg was a significant difference with control($p<0.05$). But the amount of chlorophyll a and b, no significant differences between treatments were observed. The results show the robustness of the plant's ability to attract and cadmium accumulation and its ideal for phytoremediation.
Keywords: *Amaranthus chlorostachys* , cadmium, chlorophyll a and b, phytoremediation, fresh and dry weight.

INTRODUCTION

Today, due to rapid population growth and generate more waste and increasing demand for organic agricultural products, fertilizers and organic fertilizers such as sewage sludge and phosphate fertilizers to Being rich is considered , Unaware of these fertilizers are contain large amounts of heavy metals, particularly lead and cadmium. Cadmium is one of the most toxic contaminations of the environment that sources of pollution are such as mining, electroplating, leather and other materials into the environment. The element concentrations in non-contaminated soils is typically less than 0.5 mg/ kg (22) and its allowable level in the plant is 0.1 mg/ kg plant weight. Cadmium can cause to be the efficiency of the plant and severely endangers the health of plants and animals (8). The risks for animals are including anemia disease, liver disease and brain disease (24). Although cadmium is not essential for plant growth but the plants are easily absorbed through the roots (22). The most important factor in the uptake of cadmium by plants is PH that whatever medium is more acidic is absorbed cadmium by the roots of is more.

Root before from other tissues damage from uptake of cadmium caused in most plants it sees cadmium more accumulates in the roots and less to be transferred leaves (19). The first studies on the adverse effect of cadmium on plant photosynthesis is reduced (13), which slipped through photosynthesis, the organization chloroplasts and oxide stress (24). Reduced synthesis of chlorophyll and photosynthesis, reducing plant biomass are the following (17). The main symptoms of cadmium uptake by plant chlorosis, leaves become tube and root growth inhibition that due to its direct effect on cell division and longitudinal growth has been reported (7). According to studies, chlorosis is the results of iron deficiency, phosphorus and transported manganese. Preventing of the absorption iron III reductase is cadmium and lead to iron II deficiency can seriously reduce photosynthesis.

Antioxidants caused crop loss due to cadmium, they are tasteless. Less absorbed by the plants is due to competitive antagonism that has elements of other negative effects of cadmium in the soil (24). Damage caused by this toxic metal absorption by plants and reduced leaf area, decreased cell wall elasticity and reduces the space between the plant cell, protein synthesis and enzyme activity is prohibited. Cadmium in reduction biochemical processes in older leaves than young leaves is effective

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(18) .with Heavy metal absorption and accumulation in plants, plant defense system is activated and free many radicals are produced But may continue to increase and this will lead to saturation of the junction of radicals by antioxidants (1). Cadmium accumulation in cells with reduced water supply and reducing sugars in the leaves of plants so This is probably an adaptive mechanism to protect plants against osmotic potential toxicity of cadmium is absorbed in addition to The role of sugars in the regulation of osmotic pressure, the plant can be saved with soluble sugars in their carbohydrate to maintain optimal Basic cell metabolism to be in better condition (20).

Another group of plants that produce proteins called phytoclatyn are included of solfidryll groups; cadmium cations are trapped and there by reduce the damage due to toxic (6). use of plants to extract heavy metals have much and Little reduction in their biomass or reactions have less to maintain or reduce the amount of chlorophyll photosynthesis to stress show the protection is important for Environmental (23). Today's most research on how to increase the uptake of cadmium in soil and plants is done But the effects of cadmium on plant physiology and plant affected and the response does not provide much information (9). The accumulation of this element in the upper layers of soil and avoid being absorbed by plants and its destructive effects on the expression, in this study was to assess the effect of cadmium on *Amaranthus chlorostachys* so These indicators include changes in the rate of growth of the plant chlorophyll fresh and dry weight and a and b that is Signs of resistance or susceptibility to the toxicity of this plant And cadmium uptake was examined by the resistance of the soil the plant can be refined And environmental protection will And other organisms were also protected from the dangers of this toxic element.

MATERIALS AND METHODS

The research on the plant *Amaranthus chlorostachys* was done. Planted in 21 pots, each containing 7 kg of soil was contaminated with $cachl_2$ were used. Cadmium concentrations of the contaminated soil in the pots were included 0 (control), 5, 20, 40, 60 and 100 mg / kg and for treatment 3 was repeated. The interaction of soil and heavy metal, a reaction period of 30 days was recorded, the number of seeds per pot, depending on the type and size of the pot plants were planted after thinning the plants were added to 4-leaf plants and one plant per pot remained. Pots in the greenhouse temperature were 25 degrees Celsius.

During growth, water once every 48 hours according to FC was calculated for each pot of drip irrigation to drought stress was not created for the plant to stress the plant and not create any drainage water from irrigation was returned to the pot. Pre-planting soil PH of 7.5, EC and 6.7 dS/m, the amount of organic matter in the 1.2%, sandy clay loam soil texture and initial cadmium concentration of 1.232 mg /kg of the soil. Irrigation water PH 7.4, EC and 1.2 ds /m and cadmium concentration is 0.013 mg / lit respectively. After the growth period (4 month) plants were harvested by scissors from the crown and shoots and roots of each treatment was transferred to the laboratory for testing to be separated. Methods that were used for the tests are as follows:

Measure the concentration of cadmium ions in the plant:

Ions measured in root and shoot tissue was performed using the atomic absorption method (soltani *et al.,* 2006). The purpose of the 0.5 g tissue dry for 24 hours in 10 ml of concentrated nitric acid was placed in the plant tissue is well digested in acid, The solution for the removal of acid fumes and hot after heating it has a volume of 50 ml Dissolved cadmium concentrations were measured by atomic absorption. To determine ion concentrations, before measured the sample, standard solution was injected at 6 ml/ min to the device and the standard curve was plotted by a special software system And concentration of the unknown solution was determined with this software.

Measurements of fresh and dry weight root and shoot plant:

Measured for fresh weight, root and separated shoot plant of each sample by the scale weight was weigh. The specimens were in the oven at 70 ° C for 48 hours after drying were re-weighed as dry weight of roots and shoots were determined separately by each treatment.

Measuring the amount of chlorophyll in leaves of wild tumbleweed:

Using chlorophyll concentration (14) was measured. For this action 0.1 g of leaf tissue than the median weight for each treatment and the pigments were extracted by acetone 80%. Then the samples on filter paper, was flat with the volume of the solution to 25 ml of acetone and the absorption at wavelengths of 663 and 646 nm was read by spectrophotometer. The amount of chlorophyll a and b and total chlorophyll via of the following formulas, mg / gr fresh weight was calculated:

$C_a = 12.25\ A_{663} - 2.798\ A_{645}$

$C_b = 21.50\ A_{645} - 5.10\ A_{663}$

$C_T = C_a + C_b$

For measuring absorption and accumulation of cadmium by atomic absorption spectrometry and measuring the fresh and dry weight of plant shoots and roots and Method for measuring chlorophyll a and b according to Lichtenthaler and wellbun micrograms of chlorophyll in per gram fresh leaf, the middle leaves of each plant was used. The experiments applied accidentally and with 3 repeats for any treatments and all of the statically accounting are done with SPSS software and ANOVA with using LSD test and design of diagrams by means of Excel software.

RESULTS

Table 1: comparision the effects of different concentrations of cadmium on growth index in *Amaranthus chlorostachys* by LSDexam in probab level 5%.

	Cadmium concentration(ppm)					
	0	5	20	40	60	**100**
Root cadmium	7.67±0.44 ^{a}	14.92±0.9 ^{b}	54.61±9.19 ^{b}	62.64±2.87 ^{d}	88.15±4.91 ^{e}	**133.54±3.50** ^{f}
Aerial sections cadmium	0.289±0.96 ^{a}	6.26±0.90 ^{a}	43.15±3.40 ^{c}	53.15±4.30 ^{b}	72.21±3.13 ^{c}	**96.62±3.57** ^{d}
Wet planet weight	100.4±1.82 ^{a}	95.75±0.95 ^{b}	80.05±2.05 ^{bc}	73.77±1.72 ^{d}	71.85±2.09 ^{cde}	**38.30±29.78** ^{bcde}
Dry planet weight	9.30±0.85 ^{a}	7.60±0.69 ^{a}	7.19±1.30 ^{ab}	5.05±0.59 ^{bc}	5.73±1.05 ^{bc}	**6.16±0.58** ^{d}
Chlorophyll a	15.96±5.86 ^{a}	15.65±0.90 ^{a}	14.07±1.29 ^{a}	13.64±3.85 ^{a}	13.76±3.89 ^{a}	**14.47±2.99** ^{a}
Chlorophyll b	12.19±2.83 ^{a}	11.30±2.59 ^{a}	10.46±2.25 ^{a}	10.45±0.73 ^{a}	9.70±5.49 ^{a}	**9.50±2.17** ^{a}
Total Chlorophyll (a+b)	**28.16±3.51** ^{a}	**26.95±2.33** ^{ab}	**24.35±1.95** ^{ac}	**24.19±1.40** ^{acd}	**23.34±1.90** ^{bcd}	**23.26±2.70** ^{bcd}

Means with the same letter in each column are not sunificantly different at 5% level of probability.

Amount of Uptake and accumulation of cadmium in shoot and root plant control concentrations were compared as in Table 1 is observed with increasing concentrations of cadmium uptake and accumulation in plants increases amount of cadmium absorbed by the roots in all treatments compared with the control shows a significant difference, The amount of cadmium accumulated in shoots in all treatments except the control treatment, compared with 5 mg/kg, there is a significant difference ($p< 0.05$). Increase the absorption and accumulation of cadmium in shoots and roots were similar to each other but the cadmium accumulation in roots significantly is higher than shoots in all treatments (Figure 1). With survey data on fresh weight of plants treated with cadmium compared with control plants, as can be seen in Table 1 Cadmium concentration in plants decreased with increasing weight, which is significant compared with control plants ($p<0.05$) that Weight loss, more plants, but concentration is 100 mg/ kg more. Comparing the dry weight of plants in different treatments and control were also treated with a similar trend only in treatments 40 and 60 and 100 mg/ kg was significantly different than control. Finally, the dry weight of 33.7% is lower than for weight control was showed that the percentage of 61.88% and this shows that the decreasing trend with increasing concentration of cadmium in soil is less dry than the wet weight (Figure 2). Data analysis showed the content of chlorophyll a and b with the increase in cadmium levels of chlorophyll a and b can be reduced But is not significantly different between control and treatment plants in all treatments the amount of chlorophyll a and chlorophyll b But both are almost the same trend of changes with increasing concentration of cadmium showing in the soil. Studies show that increasing the concentration of cadmium in soil However, the decrease of total chlorophyll than control plants in treatments with very little change has And treatments except for 60 and 100 mg /kg was slightly more And significantly different than control plants in other treatments have not seen significant differences with control plants (Figure 3).

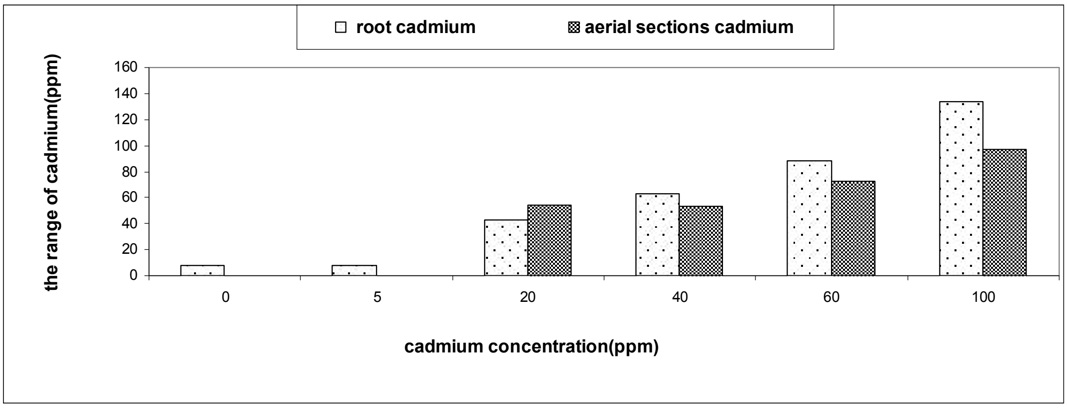

Figure 1: absorbtion range and cadmiume concentration in aerial organs and plant root of *Amaranthus chlorostachys* with increasing in its concentration in soil.

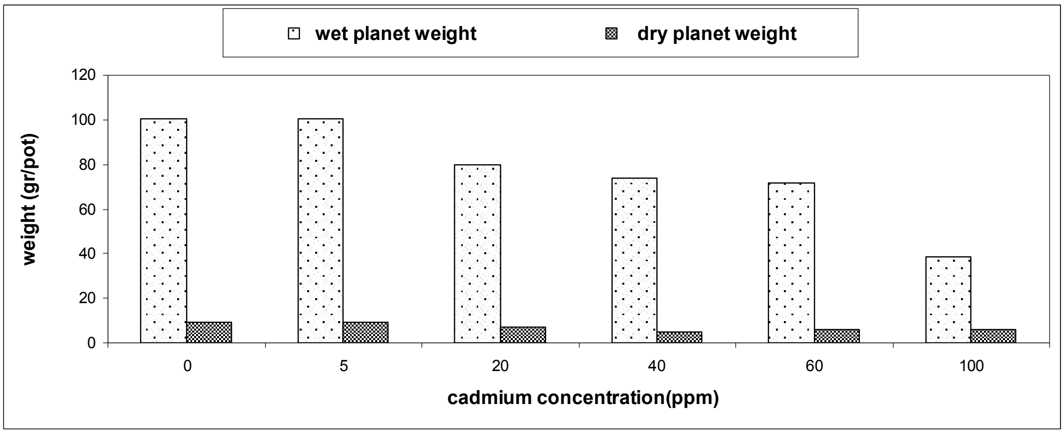

Figure 2: cadmium effect in wet and dry weight in *Amaranthus chlorostachys.*

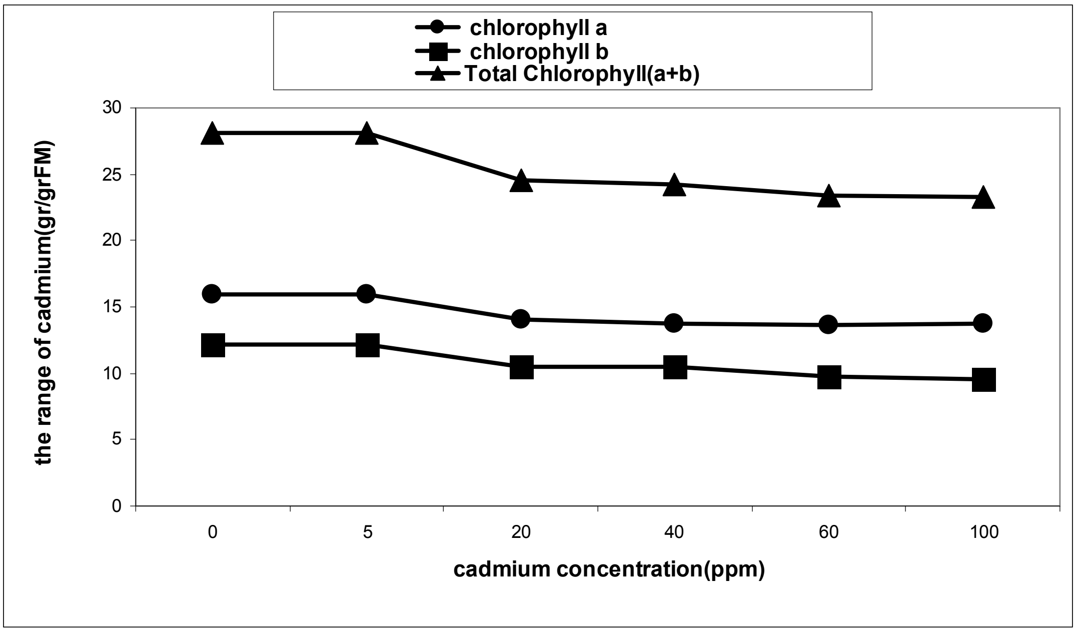

Figure 3: cadmium effect in a,b and total chlorophyll in *Amaranthus chlorostachys*.

Conclusion

Studies on spinach and lettuce show that equal concentrations of zinc, copper, nickel and cadmium accumulation in acidic soil in order to increase plant (15). The toxicity caused by cadmium depends on the extent to which the plant has access that the transfer of cadmium from soil to plant the ability to live within the existing system is defined (12). There is Reported positive relationship between elevated levels of cadmium in soils irrigated with sewage sludge and cadmium uptake by wheat and lettuce (9). The study found that the maximum absorption of cadmium in roots and shoots is concentration of 100 mg/ kg that the highest concentration was used in this study and the absorption increase with increasing concentration of cadmium in the soil is evident in Table 1 and Figure 1. With the mobility of metal ions in plant roots than shoots in these elements has been reported (3). Studies show that the accumulation of cadmium in sugar beet roots and shoots are 5 to 10 times more than it has been reported 50 times for soy (11).

Our results are consistent with previous studies and between roots and shoots in all treatments, there are significant differences compared with controls ($p<0.05$). Cadmium stress in plants with impaired respiration and reduced growth that ultimately would reduce the biomass, Researchers found to decrease in plant is fresh and dry weight due to impaired absorption of nutrients and water (4). Our results in weight loss by increasing the concentration of cadmium in the soil for all treatments were significantly different between the control And also in dry weight concentrations of 40, 60 and 100 mg/ kg showed a significant difference However, the dry weight was less than the weight which can be caused by resistance to the plant uptake of cadmium Mainly because the results of toxicity and pollution response of plants to measure changes in dry weight.

Many physiological processes such as photosynthesis and sensitivity to heavy metals such as cadmium have been shown in higher plants (22). In Experiments were conducted on the Beans is saw cadmium for uptake of Co_2 through the openings prevent from the photosynthetic activity (17). Chlorophyll content can be reduced because of the destructive enzymes and chlorophyll decrease in carbon fixation is particularly high concentrations of cadmium contamination (20).

In this study, our results with those of the most interesting plants cultivated in soil contaminated have been different with cadmium. Although the results of cadmium concentration in the culture medium increased with the reduction of total chlorophyll and chlorophyll a and b are But this decline is so small that no significant differences were observed in treated than in control Only two concentrations 60 and 100 mg /kg on amount of total chlorophyll to the control have significant difference that differences was still very small and negligible And given that the most obvious sign of plants with cadmium toxicity in leaf chlorosis is observed Concentrations in leaves (16), but we obviously did not see that this time the chlorosis of the plant's resistance against the toxicity of cadmium (24). The main component of this metal in plant tolerance to toxicity of heavy metals in plants and that this resistance is seen as the preferred storage in vacuoles, and epidermal cell types Where photosynthesis takes minimal damage can be stopped.

Zhou and Wang (2005) concluded that the selection of appropriate species and the ability to regulate light absorption of cadmium increased the accumulation is important without No serious damage to plants (10) The results of our analysis of data from the dry weight and chlorophyll a and b and total chlorophyll in the plant In comparison with other plants can be tested to make clear that this plant is related to plants that are resistant to cadmium pollution And the ability to absorb and accumulate toxic amounts of this element is appropriate without particular problem And given that this plant is a weed, but if used for refining of cadmium-contaminated soils In addition to good results are obtained in terms of cost and waste of useful plants , much damage does not enter to economy the area of environmental protection And for that It have roots of a wide and spread has been refined in an appropriate level And not so much of its amount can be refined relatively good levels.

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