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Heavy metal accumulation in *Portulaca oleracea* Linn.

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Abstract
In this research paper the distribution and accumulation of heavy metals in soil and various parts *Portulaca oleracea* Linn. are investigated. Objectives of this research paper was to study the physical parameters of soil samples; and to evaluate the presence of heavy metals, namely Arsenic, Cadmium, Lead and Copper in the soil and plant samples collected from two different wasteland areas of Mira road, Thane and Goregaon (west), Mumbai, designated as Site I and Site II. Atomic absorption spectroscopy was conducted for soil and plant samples collected from above mentioned sites. Soil analysis indicated that Site I was relatively more contaminated with heavy metals than Site II. Presence of all four heavy metals was detected in the leaf, stem and roots of the plant samples growing in these two wasteland area. It was found that *Portulaca oleracea* has the tendency to accumulate heavy metals in underground as well as the aboveground parts of the plant body. Heavy metal content was relatively more in the plant samples that were collected from Site I than Site II. *Portulaca oleracea* stem accumulated more heavy metals as compared to leaf and root. Mobility of heavy metals from root to stem and leaves appear to be high. Biological Accumulation Coefficient (BAC), Bioconcentration Factor (BCF), and Biological Transfer Coefficient (BCF) have been calculated; and accordingly it appears that *Portulaca oleracea* is a bioaccumulator of heavy metals, namely Arsenic, Cadmium, Lead and Copper. It is suggested that the mass cultivation of this nutritionally rich vegetable crop for human consumption and medicinal use should be carried in unpolluted crop fields.

Keywords: *Portulaca oleracea* Linn. heavy metals

Introduction
Soils pollution due to heavy metals has become a common problem across the globe. Ever increasing anthropogenic activities have resulted in accumulation of heavy metals in soil and plants. Plants do require a specific concentration of certain trace elements for their growth and development; however an excessive concentration is harmful to them in a number of ways [1]. There are few metals such as Arsenic, Cadmium, Lead, and Mercury which hardly play any positive role in plant growth. Instead research has shown that even in very low concentration, these elements impose adverse effects on plant growth and development[2] Plants facing such stress due to soil pollution have to adapt to them through physiological, biochemical, anatomical and morphological transformations in their systems [3]. In addition to this heavy metals make their way in to the food chain from soil and plants, and pose threat to the ecosystem on a larger perspective and to the human health specifically. Presence of heavy metal has been detected in a large number of leafy vegetables and crops [4, 5, 6]. In this research paper quantitative analysis of heavy metals, namely, Arsenic, Cadmium, Lead and Zinc has been made in *Portulaca oleracea* Linn. Using atomic absorption spectroscopy. Commonly known as purselane plant, it is a small, prostrate succulent herb from family Portulacaceae. *Portulaca oleracea* has high nutritious value. Vitamin A, vitamin C, total protein, calcium, iron, potassium, magnesium, and betacyanins content have been reported to be high in vegetative parts of purselane [7]. In mediterranean and tropical Asian countries including India it is used in soups, salads and as a leafy vegetable. Medicinally, it is a well acclaimed herb. Antioxidant properties have been studied thoroughly. It has a long history of being used as a folk medicine across the world. It exhibits antibacterial, antiseptic, antidiabetic, antioxidant, antispasmodic, diuretic, anti-scorbutic, wound-healing properties [8]. Secondary metabolites such as alkaloids, anthraquinone glycoside, cardiac glycoside, coumarins, flavonoids, polysaccharides, fatty acids, terpenoids, sterols, and omega-3- fatty acids are present in relatively good proportion. Omega-3- fatty acids help in preventing heart attacks and have a vital role in streangthening the immune system [9]. Notably *Portulaca oleracea* is a potential source of omega-3- fatty acid known to scientists. It is commonly found in fish, and purselane is the one of the plant species where omega-3- fatty acid is reported to be present in a considerably high concentration [9].

Since *Portulaca oleracea* rates high nutritionally and medicinally, it might emerge as a potential crop of demand in future. Though easy to cultivate, its mass scale cultivation in field as a vegetable and as a medicinal plant is seldom seen in India. It is usually raised as a garden plant for its yellow colored attractive flowers and is easily propagated by vegetative stem cuttings; and proliferates naturally by producing abundant seeds which have a short dormancy. Additionally it often grows as a weed in fields, roadside, and in wasteland area as it shows ability to withstand adverse factors, be it edaphic or climatic. Presence of heavy metals in purselane has been reported earlier from plants growing in area polluted with industrial pollution [10, 11].

The present research work was conducted with following Objectives

1. To study the physical parameters; and to evaluate the presence of heavy metal, namely Arsenic, Cadmium, Lead and Copper in the soil samples collected from wasteland areas
2. To evaluate the presence of above heavy metal in different parts of *Portulaca oleracea*, i.e., leaf, stem and root.
3. To assess tendency of *Portulaca oleracea* as a bioaccumulator of heavy metals by determining Bioconcentration Factor (BCF), Biological Accumulation Coefficient (BAC) and Biological Transfer Coefficient (BCF).

Material and Method

Sample collection

Sample of *Portulaca oleracea* were collected from Mira Road **(**east) area of Thane district, from a land area near Penkar Pada, designated as Site I; and Wasteland area of Goregaon (west), near S.V. Road, designated as Site II. Samples were collected by uprooting the whole plant. Along with plant samples, soil samples were also collected including the top layer and six inches beneath. Plant samples were washed in the laboratory to remove the traces of dust particles and dried initially at room temperature for 4 – 6 hours. Leaf stem and root were separated; loosely packed in normal blotting paper and then dried at 55ºC in the hot air oven to remove the traces of moisture. Leaves were dried for 24 hours, whereas stem and roots were dried for 72 hours so that moisture is completely removed. Dry samples were powdered using pestle and mortal and packaged and stored in desiccators for further analysis.

Heavy metal analysis

1. Plant samples

0.5 gm sample of each, stem, leaves and roots was taken and subjected to digestion in a kjedhal flask in 5 ml of nitric acid (65%) and 1 ml of perchloric acid (70-72%) as per the method of Wang & Zhou [12]. The digestion was carried at 60ºC for 6 to 10 hours till the solution became completely transparent. Clear solution obtained thereafter was brought to room temperature and transferred to 50 ml calibrated flask. It was then diluted by raising the volume up to the mark with distilled water [13]. Heavy metal content for As, Cd, Pb, and Cu, was measured with the help of Atomic Absorption Spectrophotometer.

2. Soil sample

Soil samples collected from the same site were brought to the laboratory in polythene bags. Samples were subjected to drying first at room temperature and then at 50ºC to remove trace of moisture and sieved in a 2 mm mesh size. Thereafter, 0.5 gm soil sample was measured and subjected to digestion in a kjedhal flask in 5 ml of nitric acid (65%) and 1 ml of perchloric acid (70-72%) as described by Wang & Zhou [12]. The soil samples were digested at 60-70ºC for four days till the solution became completely transparent. This solution was thereafter brought to room temperature and transferred to 50 ml calibrated flask. Distilled water was added to make the final volume to 50 ml [13]. Quantitative estimations of heavy metals, namely, As, Cd, Pb, Cu, were made with the help of Atomic Absorption Spectrophotometer.

Soil analysis for physical factors

To analyze the soil samples for physical factors, such as soil pH, a solution of 1:9 soils: water ratio was taken. For measuring pH, the instrument was initially calibrated with buffer solutions of pH 4, 7 and 9. Soil texture was determined by sieve method. On the basis of percentage of sand, silt and clay, textural class of each sample was determined with the help of standard textural class triangular [14].

Biological accumulation coefficient (BAC)

It was calculated taking the concentration of heavy metals in plant shoots and dividing this by the heavy metal concentration in soil, as per the method given by Zu *et al*. [15] which is given below:

BAC = heavy metal concentration in shoot / heavy metal concentration in soil.

Biological transfer coefficient (BTC)

It was calculated as the ratio of heavy metal concentration in plant stem to that in plant root as per the method given by Zu *et al*. [15] which is given below:

BTC = heavy metal concentration in shoot / heavy metal concentration in root

Bio-concentation factor (BCF) - It was calculated as ratio of concentration of heavy metal in plant roots to that of soil, as per the method given by Yoon *et al*. [16].

BCF = heavy metal concentration root / heavy metal concentration in soil

Results

Soil analysis

Soil sample collected from two sited was analyzed for physical parameters namely soil moisture, soil pH, soil organic matter and soil texture (Table 1). Soil moisture was recorded to be 5.3% and 18.4%; and organic matter content was found to be 4.3% and 16.8% in samples of Site I and Site II respectively. Soil pH was in alkaline range as shown in Table 1. Soil texture was recorded to be sandy loam in both the sampling sites. Heavy metal content was higher in Site I soil sample as compared to Site II soil sample. In both the sites, the level of arsenic was found to be highest (193 mg/kg and 154 mg/kg), followed by lead (178.8 mg/kg and 144.7 mg/kg), cadmium (144 mg/kg and 137 mg/kg) and copper (109 mg/kg and 94.2 mg/kg). It appears that site I is relatively more polluted with heavy metals as compared to Site II.

Table 1: Analysis of physical factors and heavy metals in soil samples collected from two wasteland sites.

S. No.	Soil Parameter	Site I (Mira Road, Thane)	Site II (Goregaon, west)
1.	Soil Moisture	5.3%	18.4%
2.	Soil pH	8.4	7.6
3.	Soil Organic matter	4.3%	16.8%
4.	Soil Texture	Sandy loam	Sandy loam
5.	Arsenic	193 mg/kg	154 mg/kg
6.	Cadmium	144 mg/kg	137 mg/kg
7.	Lead	178.8 mg/kg	144.7 mg/kg
8.	Copper	109 mg/kg	94.2 mg/kg

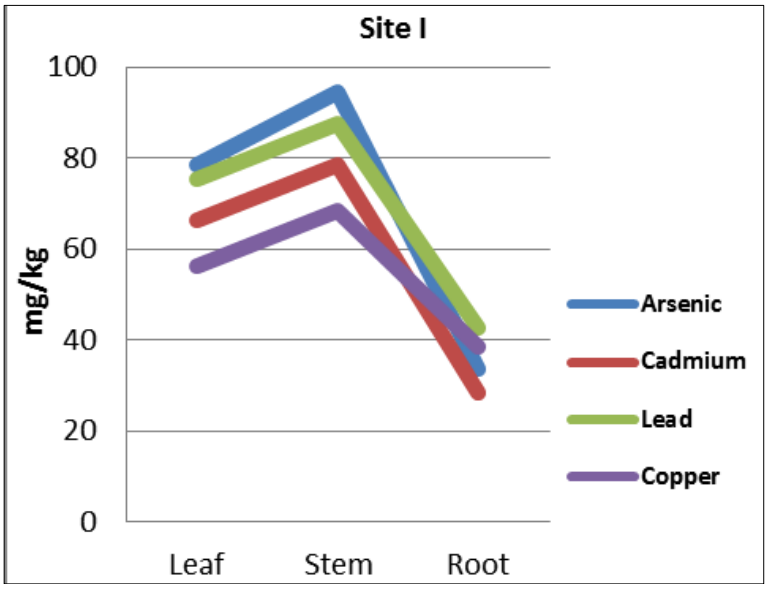
Analysis of plant samples

Samples of *Portulaca oleracea* collected from both, Site I as well as Site II, showed the presence of heavy metals in leaf, stem and root as well (Table II). Following points are clear from the observations and the result of the heavy metal analysis-

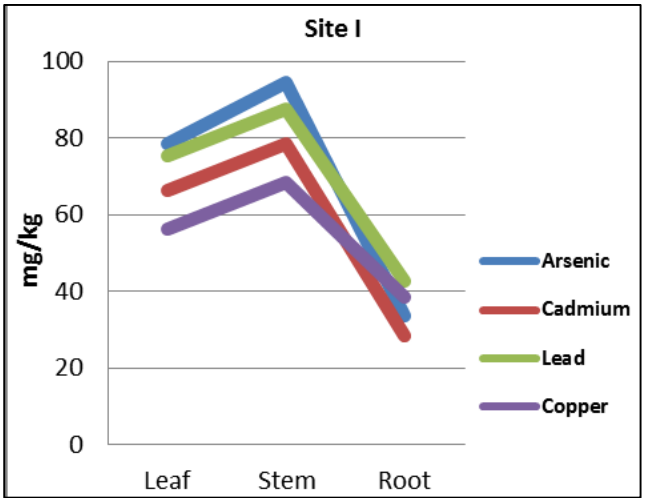
1. Presence of heavy metals is noticed in all underground as well as the aboveground parts of *Portulaca oleracea*.
2. Heavy metal content is relatively more in the plant samples that were collected from Site I than Site II.
3. *Portulaca oleracea* stem has tendency to accumulate more heavy metals as compared to other parts as it is indicated in Graph I and Graph II
4. Pattern of accumulation is in the range of stem > leaf > root, thereby showing that in root samples the accumulation of heavy metals is minimum, while in stem, the accumulation is maximum. Mobility of heavy metals from root to stem and leaves appear to be high.
5. Arsenic content was 94.5 mg/kg in stem, 78.3 in leaf and 33.7 mg/kg in root of the samples collected from Site I. Cadmium content was found to be 78.4 mg/kg in stem, 66.4 mg/kg in leaf, and 28.2 mg/kg in root. Lead content was found to be little higher than cadmium but less than arsenic. It was present in the range of 87.4mg/kg in stem, 75.2mg/kg in leaf, and 42.8 mg/kg in root. Copper content was found to be 68.3 mg/kg in stem followed by 56.3 mg/kg in leaf and 38.3 mg/kg in root samples of the plants collected from Site I.
6. In the samples collected from Site II, arsenic content was found to be 73.6 mg/kg in stem, 62.5 in leaf and 28.6 mg/kg in root samples of purselane. Cadmium was present in the range of 66.2 mg/kg in stem, 56.4 mg/kg in leaf, and 25.9 mg/kg in root. Lead content was found to be 71.1 mg/kg in stem, 56.8 mg/kg in leaf, and 26.2mg/kg in root. Copper concentration was recorded to be 55.4 mg/kg in stem, 49.4 mg/kg in leaf, and 18.8 mg/kg in root.

Table 2: Heavy metal accumulation in leaf, stem and root of *Portulaca oleracea* collected from Site I and Site II

Place	Arsenic (mg/kg)			Cadmium (mg/kg)			Lead (mg/kg)			Copper (mg/kg)		
	Leaf	Stem	Root	Leaf	Stem	Root	Leaf	Stem	Root	Leaf	Stem	Root
Site I	78.3	94.5	33.7	66.4	78.4	28.2	75.2	87.4	42.8	56.3	68.3	38.3
Site II	62.5	73.6	28.6	56.4	66.2	25.9	56.8	71.1	26.2	49.4	55.4	18.8



Graph I: Heavy metals in samples from Site I



Graph II: Heavy metals in samples from Site II

It was found that in leaf and stem, the accumulation of Arsenic was highest followed by Lead, Cadmium and Copper. This pattern was noticed both in the samples collected from Site I as well as Site II as indicated in Graph I and Graph II. However, in case of root, the accumulation of lead was highest in samples of Site I, followed by Copper, Arsenic and Cadmium. In the root samples of Site II, Arsenic accumulation was highest followed by Lead, Cadmium and Copper.

Biological Accumulation Coefficient (BAC), Biological Transfer Coefficient (BTC) and Bio-Concentation Factor (BCF)

BAC in the samples of *Portlaca oleracea* from both the sites was found to be in the range of 0.47 to 0.62. The values being less than one are under the safer side. BCF values are even lesser, i.e., in the range of 0.17 to 0.35. BTC, the transfer coefficient range is moderately high (table III). It therefore appears that *Portlaca oleracea* is a bioaccumulator of the said heavy metals. Its cultivation as a vegetable in unpolluted area and crop fields will make it a safe leafy crop for human consumption and medicinal uses.

Table 3: BAC, BCF and BTC factor for *Portlaca oleracea*

Sample collection	BAC (shoot/soil)				BCF (root/soil)				BTC (shoot/root)			
	As	Cd	Pb	Cu	As	Cd	Pb	Cu	As	Cd	Pb	Cu
Site I	0.48	0.54	0.48	0.62	0.17	0.19	0.23	0.35	2.80	2.78	2.04	1.78
Site II	0.47	0.48	0.49	0.58	0.18	0.18	0.18	0.19	2.57	2.55	2.71	2.95

Discussion

Soil moisture was recorded to be high in samples from Site II as compared to Site I. Reason for this might be the vicinity of Site II to residential area and the presence of domestic waste in the wasteland area. This also might account for higher organic matter in the Site II (16.8%) in relation to Site I (4.3%). Soil pH was found to be high, towards alkalinity, in both the sites. However their value was considerably high in soil samples from Site I, i.e., Mira Road area as this wasteland was located in vicinity of industrial area. Present findings revealed that the heavy metals, As, Cd, Pb, and Cu, were present in underground as well as the aboveground parts of *Portulaca oleracea* samples collected from wasteland area. Their content was relatively more in the plant samples that were collected from Site I than Site II. Studies also indicated that *Portulaca oleracea* stem has tendency to accumulate more heavy metals as compared to other parts. High concentrations of heavy metals in stem than those in roots, indicates their high mobility from roots to the stem.

Research conducted by other workers also indicated the fact that purslane growing in polluted area accumulates various heavy metals in vegetative parts [10, 11]. If it has to be used as a nutritious leafy vegetable crop for human consumption, or as a medicinal plant, it must be cultivated in unpolluted area and crop fields that will make it a safe leafy vegetable.

Cadmium, a non-essential element has a tendency to accumulate in the kidneys and liver [17]. The dietary limit for cadmium is 0.02 mg/100gm. Intake of cadmium and its accumulation may lead to serious ailments such as kidney damage, cancer, diarrhea and incurable vomiting. In the present study it was found to be present in the range of 25.9 to 78.4mg/kg in different parts of the *Portulaca oleracea*.

Heavy metals are the non-essential compounds and are harmful if consumed with food. Cadmium has a tendency to accumulate in the kidneys and liver [17]. The dietary limit for cadmium is 0.02 mg/100gm. Intake of cadmium and its accumulation may lead to serious ailments such askidney damage, cancer, diarrhea and incurable vomiting, In the present study it was found to be present in the range of 25.9 to 78.4mg/kg in different parts of the *Portulaca oleracea*. According to WHO the maximum permissible limits of lead for human consumption is 0.03 mg/100 gm [18]. Higher concentration has negative effect on nervous system, bones, liver, pancreases, teeth and gums. Results of the present study showed that *Portulaca oleracea* has the tendency to accumulate lead and it was found to be in the range of 26.2 to 87.4 mg/kg in different parts of the plant samples collected from two sites.

Arsenic is another serious contaminant highly toxic to man and other living organisms [18]. It was found to be present in relatively high range of 28.6 to 94.5 mg/kg in different parts of purselane growing in polluted wasteland of Site I and Site II. Copper content though minimum among other heavy metals, it was present in the range of 18.8 to 68.3 mg/kg in vegetative parts. It is therefore further emphasized that if *Portulaca oleracea* has to be consumed for its nutritious values, it needs to be cultivated as a crop in unpolluted crop fields.

References

1. Chibuike GU, Obiora SC. Heavy Metal Polluted Soils: Effect on Plants and Bioremediation Methods. Applied and Environmental Soil Science. 2014; 752708:1-12.
2. Assche F, Clijsters H. Effects of metals on enzyme activity in plants. Plant, Cell and Environment.1990; 24:1-15.
3. Popova E. Accumulation of heavy metals in the soil-plant system. AIP Conference Proceedings. 2016, 1772. doi: 10.1063/1.4964576.
4. Sharma A, Katnoria JK, Nagpal AK. Heavy metals in vegetables: screening health risks involved in cultivation along wastewater drain and irrigating with wastewater. Springerplus. 2016; 5:488. doi: 10.1186/s40064-016-2129-1

5. Sharma RK, Agrawal M, Marshall F. Heavy metal contamination of soil and vegetables in suburban areas of Varanasi, India. Ecotoxicology and Environmental Safety. 2005; 66:258-66.
6. Ramteke S, Sahu BL, Dahariya NS, Patel KS, Blazhev B, Matini L. Heavy Metal Contamination of Leafy Vegetables. Journal of Environmental Protection. 2016; 7:996-1004.
7. Ezekwe MO, Omara AT, Membrahtu T. Nutrition characterization of Purslane accessions as influenced by planting data. Plant Foods in Human Nutrition (Dordrendit), 1999; 54:183-191.
8. Lim YY, Quah EPL. Antioxidant properties of different cultivars of PO. Food Chemistry. 2007; 103:734-774.
9. Simopoulos AP. Omega-3 fatty acids and antioxidants in edible wild plants. Biological Research.2004; 37:263-277.
10. Begum HA, Hamayun M, Zaman K, Shinwari ZK, Hussain A. Heavy metal analysis in frequently consumable medicinal Plants of khyber paktunkhwa, Pakistan. Pakistan Journal of Botany. 2017; 49:1155-1160.
11. Nazir A, Malik RN, Ajaib M, Khan N. Siddiqui MF. Hyperaccumulators of Heavy Metals of Industrial Areas of Islamabad and Rawalpindi. Pakistan Journal of Botany. 2011; 43(4):1925-1933.
12. Wang X, QX Zhou. Distribution forms of cadmium, lead, copper and zinc in soil and its influences by modifier. Journal of Agro-Environment Science. 2003; 22:541-545.
13. Price WJ. Spectrochemical Analysis by Atomic Absorption. Heydon and Sons Ltd. London. 1979, 254-255.
14. Brady NC. The Nature and Properties of the Soil. MacMillan Publishing Company, New York. 1990, 621.
15. Zu YQ Y, Li JJ Chen, HY Chen, L Qin, C Schvartz. Hyperaccumulation of Pb, Zn and Cd in herbaceous grown on lead-zinc mining area in Yunnan, China. Environment. Int. 2005; 31:755-762.
16. Yoon J, X Cao, Q Zhou, QL Ma. Accumulation of Pb, Cu and Zn in native plants growing on a contaminated Florida site. Science of the Total Environment. 2006; 368:456-464.
17. Divrikli U, Saracoglu S, Soylak M, Elci L. Determination of trace heavy metal contents of green vegetables samples from Kayseri- Turkey by flame atomic absorption spectrometry. Fresenius Environ. Bull. 2003; 12:1123-1125.
18. WHO. Trace Elements in Human Nutrition and Health. World Health Organization, Geneva, 1996.