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Comparison of bioadsorptive properties of seaweed and tea waste

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ABSTRACT

Seaweeds are noteworthy sources of metal-sorbing biomass. Sorption techniques are widely used to remove heavy metal ions from large volume of aqueous solution. Seaweeds have suitable surface properties able to absorb different kinds of metallic and organic pollutants from effluents. Tea waste is capable of binding with appreciable amounts of heavy metals from aqueous solution. Impact of antimony (III) chloride toxicity at various concentrations such as 5mM, 10mM, 15mM, 20mM and 25mM (W/V) was analysed on growth and biochemical characteristics of *Pennisetum typhoides* (Burm F) Stap F & C. E. Hubb. Apart from morphometric characteristics, gradual decrease in pigment contents was also observed with increasing the concentration of antimony (III) chloride. When optimal concentration 15mM of antimony(III)chloride was treated with various concentrations such as 2gm, 4gm and 6gm of seaweed (*Padina commersonii*) and used tea waste and the filtrate was applied on *Pennisetum typhoides* (Burm.f.) Stapf & C. E. Hubb. The reduced growth and pigment characteristics due to metal toxicity were found improved considerably, but biosorbent dependent. From this study it was inferred that the biosorbents used have not only nullified the metal toxicity but also the rate of recovery is biosorbent dependent which means, *Padina commersonni* was more effective compare to tea waste.

KEY WORDS: Heavy metals, Padina, Biochemical, bioadsorbent.

1. INTRODUCTION

Heavy metals are dangerous because they tend to bio accumulate. Bioaccumulation means an increase in the concentration of a chemical in a biological system over time, compared to the chemical's concentration in the environment. Compounds accumulate in living things any time they are taken up and stored faster than they are broken down (metabolized) or excreted (Lenntech and Rotterdamseweg, 2011). Many of the products, which we have used contain heavy metals in them. Heavy metals are in the foods we eat, water we drink, and the air we breathe. We take in more than twenty heavy metals which are non-essential for our healthy functioning.

An adsorbent can be assumed as “low-cost” if it requires a little bit processing, is abundant in nature, or is a by-product or a waste from an industry. Natural material or certain waste from industrial or agricultural operation is one of the resources for low cost adsorbents. Generally, these materials are locally and easily available in large quantities. Therefore, they are inexpensive and have little economic value. (Mohana and Pittman, 2007). Seaweed is an abundant source adsorbent for metals. They have been found to be potential and suitable biosorbent because of their fast and easy growth as well as their wide availability. Some seaweeds such as brown algae have significant ion exchange properties associated with their polysaccharide content.

Algae possess the ability to take up toxic heavy metals from the environment; resulting in higher concentrations than those in the surrounding water (Megharaj, 2003; Priyadarshani, 2011). Microalgae, in particular, are known to exhibit a number of heavy metals uptake processes involving different metabolisms (Ajayan, 2011).

In recent years, tea factory waste (TFW) is also gaining ground due to its potential to overcome heavy metal pollution. Insoluble cell walls of tea leaves are largely made up of cellulose and hemicelluloses, lignin, condensed tannins and structural proteins. The responsible groups in lignin, tannin or other phenolic compounds are mainly carboxylate, aromatic carboxylate, phenolic hydroxyl and oxyl groups. Several authors have reported studies on various low cost adsorbents. Among these materials, agricultural by products and biomass showed very high adsorption capacities. However, the applicability of these materials has been found to be limited due to leaching of organic substances into the solution. To overcome such problems, chemical treatment on solid adsorbents has been used as a technique for improving physical and chemical properties of them and to increase their adsorption capacity.

In this study, the efficiency of seaweed and tea waste has been determined in the process of heavy metal removing from the environment. They were chosen based on their industrial applications and potential pollution impact on the environment.

2. MATERIALS AND METHODS

The control and treated seedlings were grown in mixture of soil ie., red, black and sandy soil (1:1:1). The seedlings were treated with various concentration of antimony chloride such as (5mM, 10mM, 15mM, 20mM and 25mM). After 10 days of treatment, various growth and pigment characteristics were analysed. Another set of seedlings were applied with the filtrate of 15 mM antimony (III) chloride [The concentration at which toxicity was found to be optimum on LSD analysis (Zar, 1984)]. Obtained by mixing with 2gm/L, 4gm/L and 6gm/L of *Padina* and tea waste separately, kept in rotary shaker for 24 hours. The filtrate was applied for 10 days. After ten days the morphometric and pigment characters were analyzed. The same morphometric, pigment characteristics were analysed. Pigments such as chlorophyll by (Wellburn and Lichtenthalar, 1984) and anthocyanin used by (Swain and Hills, 1959).

3. RESULTS AND DISCUSSION

Table.1.Effect of various concentration of heavy metal on the morphometric characteristics of *Pennisetum typhoid's* (Burm. f.) Stapf & C. E. Hubb

Parameters	Control	5mM	10mM	15mM	20mM	25mM
Shoot length (cm)	24.7±0.004 (100)	22.9±0.067 (93)	17.1±0.003 (69)	14.2±0.034 (57)	13.1±0.005 (53)	12.7±0.087 (51)
Root length (cm)	12.3±0.054 (100)	10.1±0.073 (82)	9.4±0.007 (76)	6.3±0.98 (51)	6.2±0.007 (50)	5.8±0.005 (47)
Fresh weight (mg)	0.081±0.087 (100)	0.078±0.083 (96)	0.062±0.005 (77)	0.043±0.041 (53)	0.040±0.001 (49)	0.035±0.031 (43)
Dry weight (mg)	0.023±0.006 (100)	0.019±0.095 (83)	0.015±0.074 (65)	0.010±0.051 (43)	0.009±0.043 (39)	0.008±0.002 (35)
Leaf area (cm^2)	2.00±0.009 (100)	1.74±0.104 (87)	1.56±0.032 (78)	1.10±0.005 (55)	0.98±0.098 (49)	0.84±0.001 (42)

Values in parenthesis indicate percent activity; value represents mean of 10 samples with their standard error (±)

Table.2.Effect of various concentrations of heavy metal on biochemical characteristics of *Pennisetum typhoides* (Burm. f.) Stapf & C. E. Hubb

Parameters	Control	5mM	10mM	15mM	20mM	25mM
Chlorophyll *a* (mg/gLFW)	1.801±0.032 (100)	1.687±0.004 (94)	1.415±0.001 (79)	1.056±0.006 (59)	1.033±0.005 (57)	0.967±0.005 (54)
Chlorphyll *b* Carotenoids (mg/gLFW)	3.131±0.002 (100)	2.873±0.050 (92)	2.347±0.008 (75)	1.716±0.071 (55)	1.671±0.012 (53)	1.573±0.005 (50)
Total chlorophyll (mg/gLFW)	4.932±0.510 (100)	4.560±0.007 (92)	3.752±0.047 (76)	2.772±0.034 (56)	2.604±0.016 (53)	2.440±0.003 (49)
Carotenoids (mg/gLFW)	2.468±0.314 (100)	2.102±0.007 (85)	1.827±0.179 (74)	1.503±0.004 (61)	1.417±0.004 (57)	1.010±0.006 (41)
Anthocyanin (mg/gLFW)	1.004±0.345 (100)	1.056±0.114 (105)	1.312±0.001 (131)	1.406±0.098 (140)	1.534±0.045 (153)	1.732±0.031 (173)

Values in parenthesis indicate percent activity; value represents mean of 10 samples with their standard error (±)

Table.3. Effect of Heavy metal and *Padina commerssioni* on the Morphometric characteristics of *Pennisetum typhoides* (Burm. f.) Stapf & C. E. Hubb.

Parameters	Control	15mM	2%*padina*	4%*padina*	6%*padina*
Shoot length (cm)	24.7±0.004 (100)	14.2±0.034 (57)	16.4±0.004 (66)	17.5±0.004 (71)	19.8±0.001 (80)
Root length (cm)	12.3±0.087 (100)	6.3±0.98 (51)	7.6±0.008 (62)	8.2±0.009 (67)	8.9±0.003 (72)
Fresh weight (mg)	0.081±0.014 (100)	0.043±0.041 (53)	0.063±0.121 (78)	0.078±0.141 (96)	0.084±0.004 (104)
Dry weight (mg)	0.023±0.025 (100)	0.010±0.051 (43)	0.010±0.023 (63)	0.019±0.072 (83)	0.025±0.003 (109)
Leaf area (cm^2)	2.00±0.031 (100)	1.10±0.005 (55)	1.37±0.007 (69)	1.64±0.006 (82)	1.89±0.003 (95)

Values in parenthesis indicate percent activity; value represents mean of 10 samples with their standard error (±)

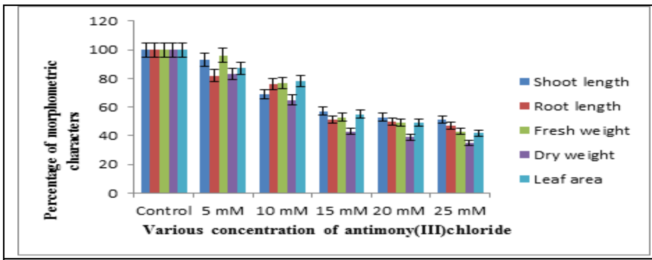

Figure.1.Effect of various concentrations of antimony (III) chloride on morphometric characteristics of *Pennisetum typhoides* (Burm.f.) Stapf & C.E. Hubb

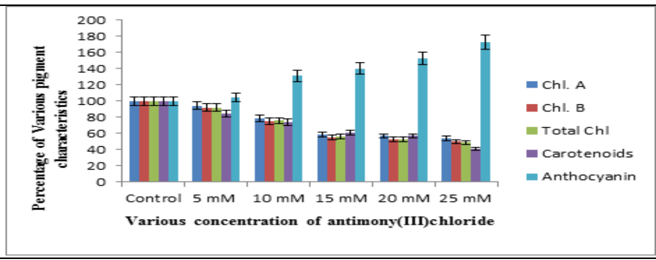

Figure.2.Effect of various concentrations of antimony (III) chloride on pigment characteristics of *Pennisetum typhoides* (Burm.f.)Stapf & C.E. Hubb

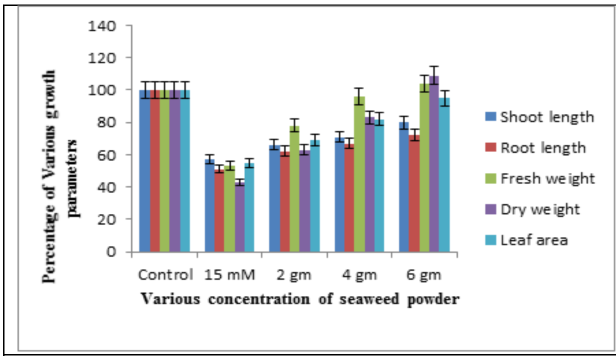

Figure.3. Effect of Heavy metal and *Padina commerssioni* on the Morphometric characteristics of *Pennisetum typhoid's* (Burm. f.) Stapf & C. E. Hubb

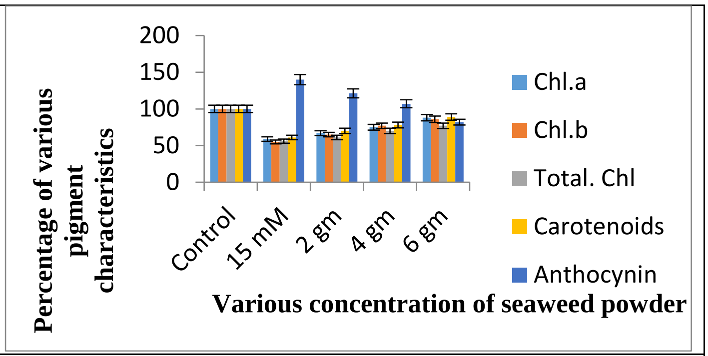

Figure.4. Effect of heavy metal and *Padina commersonii* on biochemical characteristics of *Pennisetum typhoides* (Burm. f.) Stapf & C. E. Hubb.

Table.4. Effect of heavy metal and *Padina commersonii* on biochemical characteristics of *Pennisetum typhoides* (Burm. f.) Stapf & C. E. Hubb.

Parameters	Control	15mM	2%*padina*	4%*padina*	6%*padina*
Chlorophyll *a* (mg/gLFW)	1.801±0.032 (100)	1.056±0.006 (59)	1.207±0.003 (67)	1.356±0.004 (75)	1.583±0.005 (88)
Chlorophyll *b* (mg/gLFW)	3.131±0.002 (100)	1.716±0.071 (55)	2.034±0.007 (65)	2.411±0.001 (77)	2.678±0.007 (86)
Total chlorophyll (mg/gLFW)	4.932±0.510 (100)	2.772±0.034 (56)	2.987±0.067 (61)	3.467±0.003 (70)	3.821±0.045 (77)
Carotenoids (mg/gLFW)	2.468±0.314 (100)	1.503±0.004 (61)	1.734±0.033 (70)	1.920±0.001 (78)	2.205±0.011 (89)
Anthocyanin (mg/gLFW)	1.004±0.345 (100)	1.406±0.098 (140)	1.215±0.073 (121)	1.079±0.001 (107)	0.820±0.011 (82)

Values in parenthesis indicate percent activity; value represents mean of 10 samples with their standard error (±)

Table.5. Effect of Heavy metal and tea waste on the Morphometric characteristics of *Pennisetum typhoides* (Burm. f.) Stapf & C. E. Hubb.

Parameters	Control	15mM	2% TW	4% TW	6% TW
Shoot length (cm)	24.7±0.013 (100)	14.2±0.034 (57)	15.8±0.150 (64)	16.5±0.001 (67)	19.2±0.229 (78)
Root length (cm)	12.3±0.045 (100)	6.3±0.98 (51)	8.1±0.002 (66)	9.1±0.001 (74)	10.4±0.118 (85)
Fresh weight (mg)	0.081±0.006 (100)	0.043±0.041 (53)	0.062±0.004 (77)	0.076±0.007 (94)	0.079±0.140 (98)
Dry weight (mg)	0.023±0.034 (100)	0.010±0.051 (43)	0.014±0.002 (61)	0.017±0.532 (74)	0.022±0.044 (96)
Leaf area (cm^2)	2.00±0.001 (100)	1.10±0.005 (55)	1.34±0.003 (67)	1.67±0.0052 (84)	1.75±0.039 (88)

Values in parenthesis indicate percent activity; value represents mean of 10 samples with their standard error (±)

Table.6. Effect of heavy metal and tea waste on biochemical characteristics of *Pennisetum typhoides* (Burm. f.) Stapf & C. E. Hubb.

Parameters	**Control**	**15mM**	**2% TW**	**4% TW**	**6% TW**
Chlorophyll *a* (mg/gLFW)	1.801±0.032 (100)	1.056±0.006 (59)	1.254±0.114 (70)	1.462±0.003 (81)	1.497±0.004 (83)
Chlorophyll *b* (mg/gLFW)	3.131±0.002 (100)	1.716±0.071 (55)	1.845±0.0002 (59)	2.098±0.003 (67)	2.378±0.005 (76)
Total Chlorphyll (mg/gLFW)	4.932±0.510 (100)	2.772±0.034 (56)	3.215±0.008 (65)	3.575±0.004 (72)	3.689±0.045 (75)
Carotenoids (mg/gLFW)	2.468±0.314 (100)	1.503±0.004 (61)	1.693±0.082 (69)	1.879±0.007 (76)	2.117±0.031 (86)
Anthocyanin (mg/gLFW)	1.004±0.345 (100)	1.406±0.098 (140)	1.361±0.043 (135)	1.072±0.001 (106)	0.893±0.169 (89)

Values in parenthesis indicate percent activity; value represents mean of 10 samples with their standard error (±)

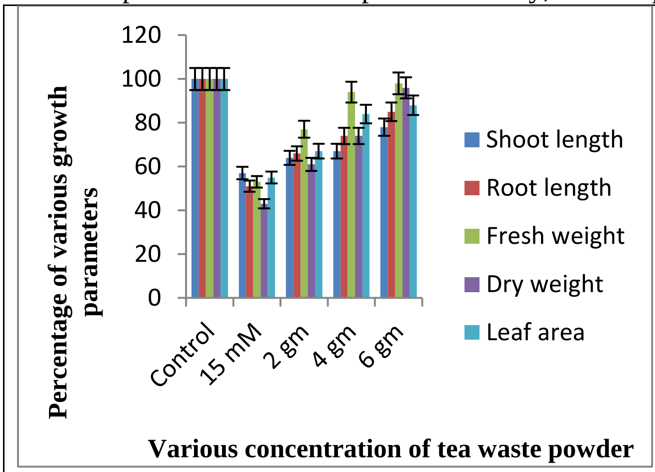

Figure.5. Effect of Heavy metal and tea waste on the Morphometric characteristics of *Pennisetum typhoides* (Burm. f.) Stapf & C. E. Hubb.

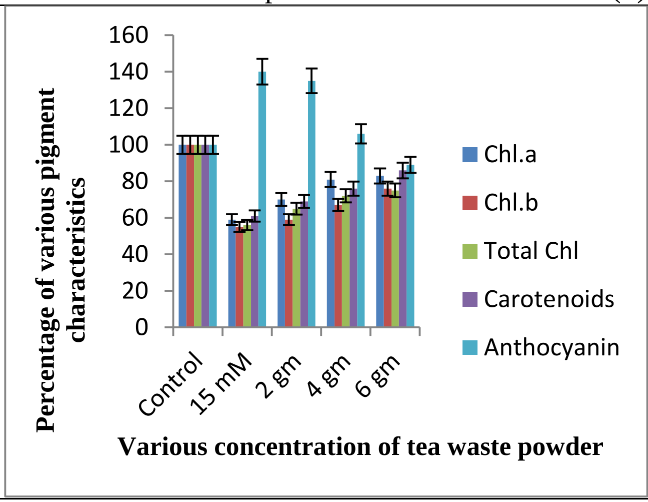

Figure.6. Effect of heavy metal and tea waste on biochemical characteristics of *Pennisetum typhoides* (Burm. f.) Stapf & C. E. Hubb.

In the present analysis growth characteristics such as shoot length, root length fresh weight, dry weight are found to be decreased in plants treated with untreated antimony (III) chloride applied (Table.1 & Figure.1). Pan (2010) showed that plant growth and biomass were reduced due to Sb pollution. He and Yang (1999) found that different forms of antimony had different effects in rice during the period of germination and growth. The decline in shoot and root length is the main cause of the reduction in fresh and dry weight of seedlings as a result of uptake of heavy metals through the root (Arduini,1996). The decrease in biomass accumulation is directly related to the photosynthetic process (Sevugaperumal, 2012). Photosynthetic pigment decreased when an increase in the concentration of antimony (III) chloride (Table.2 & Figure.2). Chlorophyll content in the shoot decreased considerably as soil Sb concentration increased from 50 to 1,000 mg/kg soil, indicating that chlorophyll synthesis was inhibited by Pan (2010).

Biosorption has brought about increase in the suppressed morphometric characteristics after the application of dried powder of *Padina commersonii*. The morphometric characteristics such as shoot length increased to about 21%, root length was 34%, fresh weight 45%, dry weight 53% (Table.3 & Figure.3) the same phenomenon was treated true for pigmental characteristics. Thus the present study coincides with the observation of Sekar (1995) and Jeyakumar and Ramasubramanian (2009).

Tea waste has a good adsorptive property, to remove the metal ion by depressing its bioavailability in soils (Ibrahim and Perveen, 2012). The morphmetric characters such as shoot length, root length, fresh weight, dry weight and leaf area were increased in plants applied with tea waste at 6gm/L concentration treated metal solutions. The pigment content like chlorophyll *a*, *b*, total chlorophyll and carotenoids baring anthocyanin increased while the concentration of anthocyanin was in negative.

4. CONCLUSION

The present study inferred that the dry powder of *Padina commersonii* and tea waste powder can effectively remove and nullifying the toxicity of heavy metal. Hence, we strongly suggest that these bioadsorbents could well be used to boost the yield of crops commonly cultivated in much metal contaminated areas.

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REFERENCES

Ajayan KV, Selvaraju M and Thirugnanamoorthy K, Growth and heavy metals accumulation potential of microalgae grown in sewage wastewater and petrochemical effluents, Pak.J.Biol.Sci., 14(16), 2011, 805–811.

Arduini I, Godbold DL and Onnis A, Influence of copper on root growth and morphology of *Pinus pinea* L. and *Pinus pinaster Ait*. Seedlings, Tree physiology, 15, 1996, 411 – 415.

He MC and Yang JR, Effects of different forms of antimony on rice during the period of germination and growth and antimony concentration in rice tissues, Science of total Environment, 243-244, 1999, 149-155.

Ibrahim S and Perveen R, Adsorbent potential of tea waste to control cadmium toxicity on plant: with respect to the seedling growth of wheat (*Triticum aestivum* L.) and Methi (*Trigonella foenum-graecum* L.), Lab Lambert Academic publishing, 2012, 136.

Kousha M, Daneshvar E, Sohrabi MS, Koutahzadeh N and Khataee R, Optimization of C.I. Acid Black 1 Biosorption by *Cystoseira indica* and *Gracilaria persica* Biomasses from Aqueous Solutions, International Bio-deterioration & Biodegradation, 67, 2012 56- 63.

Lenntech B.V and Rotterdamseweg, The Netherlands, Sources of Heavy Metals, 1998-2011.

Megharaj M, Ragusa SR and Naidu R, Metal algae interactions: implications of bioavailability. In**:** Naidu R. Gupta, VVSR Rogers, S Kookana RS, Bolan NS, Adriano DC, (Eds.), Bioavailability, Toxicity and Risk Relationship in Ecosystems, Science Publishers, Enfield, USA, 2003, 109 -144.

Mohana D and Pittman JR CU, Arsenic Removal from Water/wastewater using Adsorbents- A Critical Review, 2007, 105-111.

Pengthamkeerati P, Satapanajaru T and Singchan O, Sorption of Reactive Dye from Aqueous Solution on Biomass Fly Ash, Journal of Hazardous Materials, 153, 2008, 1149-1156.

Priyadarshani I, Sahu D and Rath B, Microalgal bioremediation: Current practices and perspectives, J.Biochem.Technol., 3(3), 2011, 299–304.

Sekar R, Thangaraju N and Rengasamy R, Effect of seaweed fertilizer from *Ulva lactuca* on *Vigna unguiculata* (L) Walp, Phykos, 34, 1995, 49-53.

Sevugaperumal R, Selvaraj K and Ramasubramanian V, Removal of aluminium by *Padina* as bioadsorbent, International Journal of Biological & Pharmaceutical Research, 3(4), 2012, 610 – 615.

Swain T and Hills WE, The phenolic constituents of *Prunus domestice* L., the quantitative analysis of phenolic constitution, J.Sci.Food Agric., 10, 1959, 63 – 68.

Volesky B, Biosorption of Heavy Metals, CRC Press, Boca Raton, 1990.

Vymazal J, Algae and Element Cycling in Wetlands, Lewis Press, Boca Raton, 1995.

Wase J and Foster C, Biosorbents for Metal Ions, Tay- lor & Francis, 1996.

Wellburn A.R and Lichtenthaler H, In: Advances in photosynthesis Research (ed.Sybesma) Martinus Nijhoff Co., The Hague, 2, 1984, 9 – 12.

X Pan D, Zhang X, Chen A, Bao and Li.L, Antimony accumulation, growth performance, antioxidant defense system and photosynthesis of *Zea mays* in response to pollution in soil, Water Air Soil Pollut., 215, 2010, 517 – 523.

Zar JK, Biostatistical analysis, Prentice – Hill international. INC, Engle Wood Cliffs, New Jersey, 1984.