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Chemical and heavy metal Profile of Coconut Palms Irrigated with lake water

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Abstract: Lakes in any urban region are ecological security zones and true indicators of sustainable urban development. Tanks and lakes are a very important aspect of water supply for drinking and irrigation. The world's fragile and dwindling fresh water resources and over-burdened sanitation systems, leading to environmental degradation is attributed to Rapid urbanization. In this study the differential accumulation of heavy metals (Fe, Zn, Cr, Cu, Pb, Ni, Cd) among coconut trees irrigated with three different lakes water (Bellandur lake, Madivala lake and Sankey tank) from Bangalore was investigated . The heavy metal concentration for the experimented lakes was of the order for :-
soil and water sample Bellandur lake (Cr > Cu> Ni> Pb> Cd> Fe) > Madivala Lake (Zn > Ni > Cr > Cd > Fe >Cu> Pb) >Sankey tank, (Zn > Cr > Ni > Cd > Cu>Fe > Pb).
Coconut water ; Bellandur lake (Fe > Ni > Cr > Cu > Pb > Zn> Cd)> Madivala Lake (Fe > Cr > Cu > Pb > Zn >Cd) > Sankey tank, (Fe > Cu > Pb > Zn > Ni).
Coconut leaf extract; Bellandur lake (Fe > Cr > Ni> Zn > Cu > Pb > Cd) > Madivala Lake (Fe > Cr > Zn > Cu > Pb > Cd > Ni) > Sankey tank, (Fe > Cu > Zn > Pb > Ni> Cd).
Coconut root extract ; Bellandur lake (Fe > Cr > Ni> Zn > Cu > Pb > Cd) > Madivala Lake (Fe > Cr > Zn > Cu > Pb > Cd > Ni) > Sankey tank, (Fe > Cu > Zn > Pb > Ni> Cd). The maximum accumulated concentration of metals such as iron , Chromium, nickel and copper in coconut root and leaf extract was 100,47.9, 30.8 and 24.5 mg/l; 122.6, 36.9,28.6 and 21.6 mg/l respectively. Coconut water contained 7.6 mg/l of iron, 4.5 mg/l of Zinc; 5.7 mg/l of chromium and 3.5 mg/l of cadmium. The trace metal concentration was maximum in all the tested samples of Bellandur Lake when compared to the other two lakes.
Key words: Coconut trees; Heavy metals ; Madivala lakes ; Bellandur Lake; Sankey Tank.

Introduction

"A Lake is the landscape's most beautiful and expressive feature. It is earth's eye: looking in to which the beholder measures the depth of his own nature. The fluviatile trees next to the shores are slender eyelashes which fringe it, and the wooded hills and cliffs are its over hanging brows" - Henry David Thoreau

The water bodies of the earth are being continuously polluted by a variety of sources. The pollution is occurring in all types of water bodies; both freshwater bodies like ponds, lakes and rivers as well as marine bodies like coastal and deep-water seas. Major causes of water pollution are deposition of acid, organic sewage, detergents, agricultural chemicals, industrial effluents, silt, oil and heat into the water bodies.

These urban water bodies have become dumping grounds for the untreated sewage and garbage of the city and this is due to lack of scientific management approaches by planners with comprehensive action plans. Stress to lakes arises from easily identifiable point sources such as municipal and industrial wastewater, and non-point sources such as urban and

agricultural run-off within a lake's watershed, and insidious long-range atmospheric transport of contaminants. Major categories of stress include excessive eutrophication from nutrient and organic matter loading, siltation from inadequate erosion control in agricultural, construction, logging and mining activities, introduction of exotic species; acidification from atmospheric sources and acid mine drainage; and contamination by toxic (or potentially toxic) metals such as mercury and organic compounds such as poly-chlorinated biphenyls (PCB's) and pesticides.[3,4]

Bellandur tank is situated in Bangalore with Surface Area 328.87 ha , at a Longitude 13°00´ north – 12° 50´ south and Latitude 77°35´ west – 77° 45´ east with Annual Rainfall in the catchment 859 mm. About 174.33 ha are full of slush and weeds. The total area irrigated by the tank water is approximately 10,271.15 ha

Madivala lake area is 114.3 hectare, shore line is 5.84 k.m., depth is 4.5m, breadth is 0.7km and length is 1.8 k.m. Karnataka State Forest Department carries out the routine maintenance of this lake. Children park and boating facility are available. Madiwala lake receives sewage and storm water from surroundings localities. Untreated sewerage flows in to the lake from Bommanahalli CMC area kodichikkanahally side.

The 'Sankey Lake,' situated in the heart of Bangalore City (Lat.:13° 00'24" - 13° 00'41"N; Long.:77° 33'53" -77° 34'5"E; altitude: 921 m MSL, maximum water spread area 12 ha, maximum depth 23 ft, average depth 9 ft), is a 500 year old, perennial water body and supports a significant biotic community. Since a long time, drainage of industrial effluent and other domestic sewage into the lake has been stopped and the lake is expected to be free from noticeable pollution. As per the studies of hydrology and microbial ecology, Sankey tank has high potentiality for development of inland fisheries practices. There is a significance heterotrophic food chain in sustaining the higher trophic levels[1,2].

These lakes receives water mainly from rain, and fishery is undertaken by private agencies throughout the year. This has led to contamination of water, due to the addition of nutrients for fish. All agricultural fields nearby derive water from these lakes for irrigation. Some irrigation departments are using the water from this tank for coconut plantation. It is been often reported about the diseases of the coconut trees irrigated with these tanks contaminated water. The water and flesh from tender coconuts contains the full range of B vitamins, with the exception of B6 and B12. B vitamins are essential for providing us energy as they break down carbohydrates and proteins. They also support nervous system function and, interestingly, the muscle tone of the stomach. Tender coconut water is also high in minerals, particularly calcium (for bones), magnesium (for the heart) and potassium (for muscles).

An average tender coconut provides 3 grams of dietary fibre which helps proper digestion and elimination. Fresh coconut water is very high in electrolytes - much higher than most sports drinks. This makes it a great choice for athletes and children who exercise a lot and also, the water of tender coconuts is completely sterile and so close to the structure of human blood that it can be transfused directly.

Experimental

The coconut trees planted at a distance of about 0.3 km from the lake are irrigated with this water. Soil in this area is reddish brown and poor in organic matter. Water sample collection was made in the month of December 2009, along with soil and plant samples (viz., root leaves, and coconut water), from all the above mentioned lakes. Ten trees growing from nearby areas were considered.

Standard methods[2] were used during the collection, preservation and analysis of the samples. Soils samples were collected from a depth of 0-20 cm. Tender portion of root and leaf (from a tree of 3.5 years old) and nearly 3-5 months old tender coconut (from the 6-10 years old trees) were collected for analysis. Before analysis the plant samples were thoroughly washed with dilute acid to remove adsorbed metals. For estimating the heavy metal contents of the soil and plant samples, 5 g of material was oven dried (70°C) for 48 hr and fine powder was prepared . The samples were digested in for 4 hrs in a tri-acid mixture (HNO_3, H_2SO_4, $HClO_4$ in the ratio 10:1:4 v/v). For analysing heavy metal content of coconut water 100 ml of sample were taken and digested using hydrogen peroxide and nitric acid mixture. The chemical parameters analysed in the lake water were pH, electrical conductivity, dissolved oxygen, total alkalinity, nitrates, nitrites, total hardness, calcium, magnesium, chlorides, sulphates, phosphates, BOD, COD, sodium and potassium. The heavy metals analysed were Fe, Zn, Cr, Cu, Pb, Ni, and Cd. Electrical conductivity was measured using a conductivity meter, pH using a pH meter and temperature using a thermometer. D.O. was estimated using the Winkler's method. Total solids, total suspended solids, total dissolved solids, total hardness, alkalinity, chlorides, sulphates, nitrates, phosphates, B.O.D. and COD were determined according to APHA (1985) methods. Sodium and potassium were determined by flame-photometry, heavy metals using an Atomic absorption spectrophotometer[5-8].

Result and discussion

Maximum values of BOD and COD may be attributed to the heavy input of variety of nutrients such as sulphates and phosphorous to the tank, creating a favourable environment for microbial activity. The normal pH range for irrigation water is from 6.5 to 8.4; pH values of all samples were within this range. Total salt concentration of the total dissolved solids is one of the most important agricultural water quality parameters. This is because the salinity of the soil water is related to, and often determined by, the salinity of the irrigation water. Accordingly, plant growth, crop yield and quality of produce are affected by the total dissolved salts in the irrigation water. Equally, the rate of accumulation of salts in the soil, or soil salinization, is also directly affected by the salinity of the irrigation water. Total dissolved solds ranged from 300-340 (mg/l). Irrigation water that contains certain ions at concentrations above threshold values can cause plant toxicity problems. Sodium (79-80 mg/l) is most common phytotoxic ions present in municipal sewage and treated effluents. The mean values of 24 observations on total trace metal content in water and soil samples, analysed in the month of Dec 2009 are given in the table -1. All the heavy metals analysed (Fe, Zn, Cr, Cu, Pb, Ni, Cd) were found in significant amounts in the all the samples of the lakes. The concentrations of these metals particularly Cr, Cu, Ni and Zn were high in soil samples collected from the Bellandur lake (table-1).

Comparative accumulation of trace metals in different parts of coconut trees growing near the lakes are given in table-2. Highest concentration of heavy metals analysed from coconut water from Bellandur lake is Co, 0.01; Cr,0.15 Cu, 4.00 Pb, 0.015 ;Zn, 16.0 and Ni, 1.0 mg/l as against Co, 2.09; Cr,15.45 Cu, 10.13 Pb, 6.14 ;Zn, 6.66 and Ni, 12.61 and Cd, 3.79 mg/l observed. The heavy metals for the other two lake (Madivala and Sankey tank) plants were considerably less. The roots contained high concentration of Cu, Ni and Cr than leaves .From table-2, Zn and Co contents of roots and leaf are not statically significant, whereas Pb content of leaves is higher than that of roots[9]. The pH values ranged from slightly acidic to slightly alkaline condition. Besides the physical-chemistry of metals, interactions with other metals and the factors influencing the physiology of organisms determine the level of heavy metals uptake. Organic matter has been considered as the other factor. However the heavy metal concentration in coconut water was under permissible limit of drinking water and we know , coconut plants have the ability to control the presence of certain inorganic elements in its water, whatever be the amount of those elements present in irrigation water[10,11].

The heavy metal concentration for the experimented lakes was of the order for :-

Soil and Water sample Bellandur lake (Cr > Cu> Ni> Pb> Cd> Fe) > Madivala Lake (Zn > Ni > Cr > Cd > Fe >Cu> Pb) >Sankey tank, (Zn > Cr > Ni > Cd > Cu>Fe > Pb).

Coconut water ; Bellandur lake (Fe > Ni > Cr > Cu > Pb > Zn > Cd) > Madivala Lake (Fe > Cr > Cu > Pb > Zn >Cd) > Sankey tank, (Fe > Cu > Pb > Zn > Ni).

Coconut leaf extract; Bellandur lake (Fe > Cr > Ni> Zn > Cu > Pb > Cd) > Madivala Lake (Fe > Cr > Zn > Cu > Pb > Cd > Ni) > Sankey tank, (Fe > Cu > Zn > Pb > Ni> Cd).

Coconut root extract ; Bellandur lake (Fe > Cr > Ni> Zn > Cu > Pb > Cd) > Madivala Lake (Fe > Cr > Zn > Cu > Pb > Cd > Ni) > Sankey tank, (Fe > Cu > Zn > Pb > Ni> Cd). Therefore the pollution level is considerably highest in Bellandur Lake when compared to the other two lakes.

Conclusion

The coconut plant has the ability to control the presence of certain inorganic elements in its water, whatever is the amount of those elements present in irrigation water. The trace metal concentration in coconut water in the present study is much under the permissible limit of drinking water.

Table-1: Chemical parameters of water in three Lakes of Bengaluru

Sl No.	Parameters	Characteristics of water samples used for coconut irrigation (15th to 20th December 2009)		
		Bellandur Lake	**Madivala Lake**	**Sankey tank**
1	Temperature	28° C	29° C	28° C
2	Colour	Light brown	Turbid	Turbid
3	Odour	Odourless	Odourless	Odourless
4	pH	6.6	8.2	7.9
5	Alkalinity (mg/L)	220.00	200.00	199.00
6	Total Dissolved Solids (mg/L)	340.00	300.00	300.00
7	Total Phosphorous phosphates (mg/L)	0.8	0.6	0.6
8	COD (mg/L)	103.00	99.00	87.00
9	BOD (mg/L)	84.00	79.00	72.00
10	Nitrates (mg/L)	0.15	0.11	0.09
11	Sulphates (mg/L)	76.00	52.00	48.00
12	Na	83	80	79
13	K	79	76	70

Table-2 Trace metal of the soil samples (mg/kg) and water (mg/l) in three lakes of Bengaluru during 15th to 20th December 2009

Factors	**Bellandur Lake**	**Madivala Lake**	**Sankey tank**	**Bellandur Lake**	**Madivala Lake**	**Sankey tank**
	Soil Samples (mg/kg)			**Water Samples (mg/l)**		
pH	7.8	6.9	6.5	6.6	8.2	7.9
Fe	10.34	5.9	5.6	12.5	7.8	6.7
Zn	32.5	24.6	20.2	35.6	18.7	15.7
Cr	200.5	15.4	12.5	140.0	12.3	10.8
Cu	99.6	2.4	7.6	47.5	4.5	7.2
Pb	31.0	0.99	1.0	22.3	1.5	1.7
Ni	42.5	21.16	11.0	46.5	18.5	9.4
Cd	25.8	14.5	10.2	26.5	10.6	6.8

Table-3 Trace metal concentration in coconut plants; a comparative account in (mg/l)

Sl. No.	Sample Discription		Fe	Zn	Cr	Cu	Pb	Ni	Cd
1	Coconut water	Bellandur Lake	6.7	4.5	5.7	2.7	7.6	0.5	3.5
		Madivala Lake	2.5	0.8	1.2	0.8	2.7	ND	1.5
		Sankey tank	3.3	0.5	ND	ND	0.5	ND	ND
2	Coconut leaf extract	Bellandur Lake	122.6	21.6	36.9	18.9	18.4	28.6	5.5
		Madivala Lake	92.5	17.8	32.5	15.6	8.8	1.2	3.6
		Sankey tank	94.3	10.5	ND	9.4	4.6	1.6	1.4
3	Coconut root extract	Bellandur Lake	100.0	25.4	47.9	24.5	19.4	30.8	7.8
		Madivala Lake	125.6	19.7	35.7	17.6	10.5	4.5	4.3
		Sankey tank	125.0	12.5	2.8	10.5	5.8	2.2	2.5

Figure-1 Physicochemical parametes of three lakes of Bengaluru

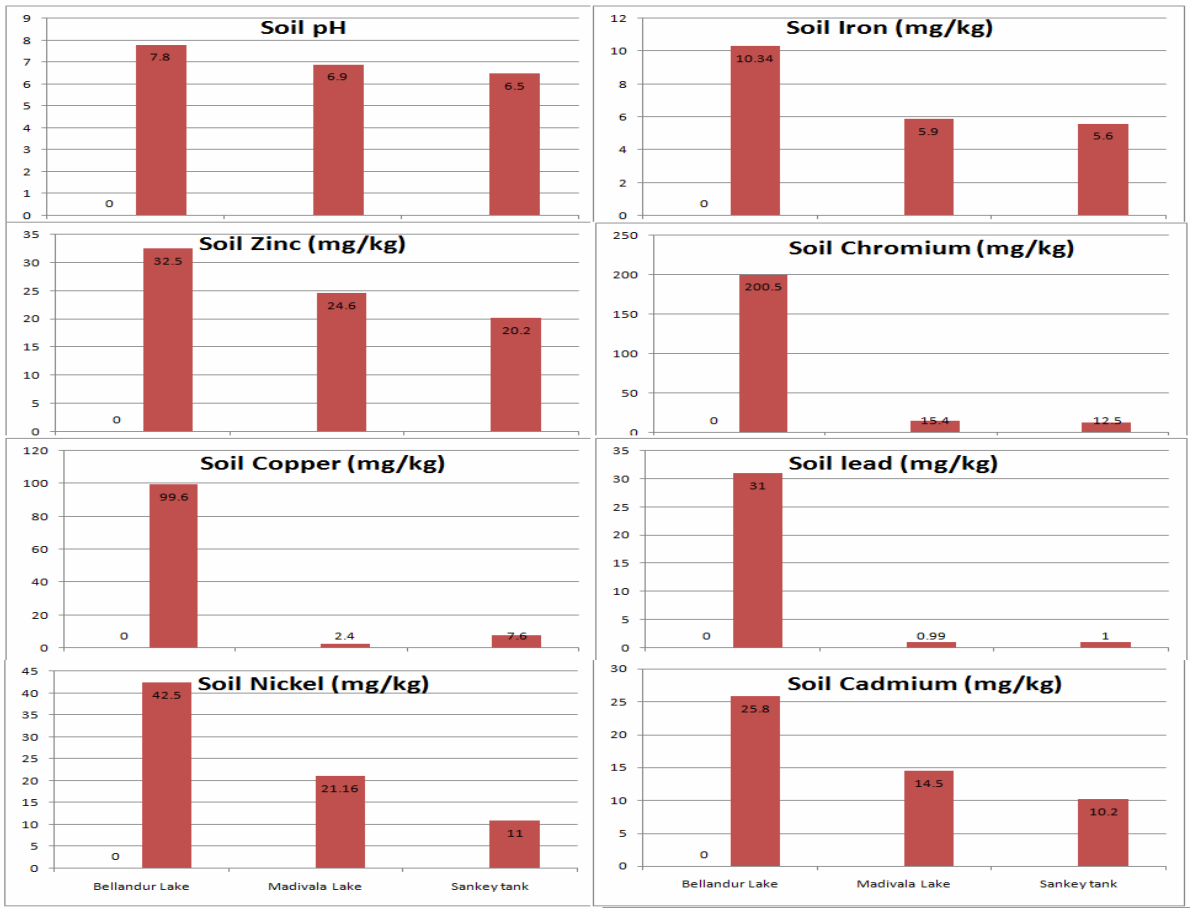


Figure -2 heavy metal level in leaf extract of coconut trees irrigated with lake water

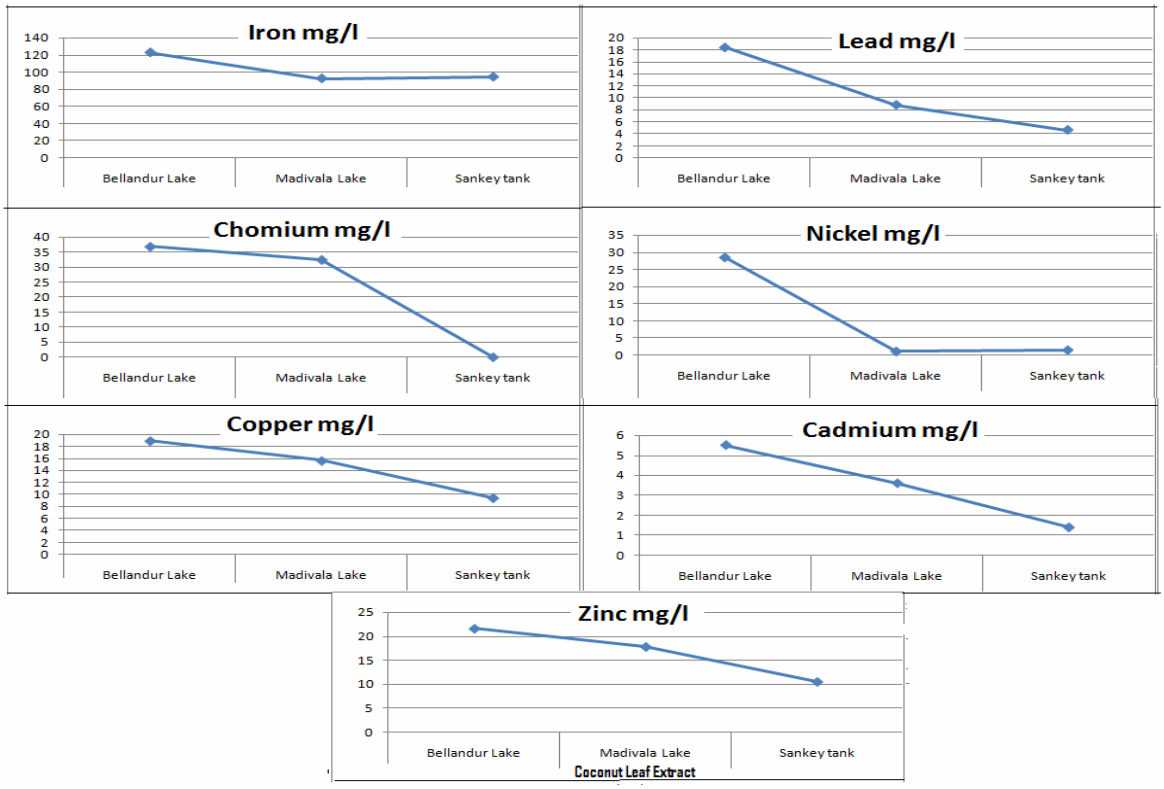
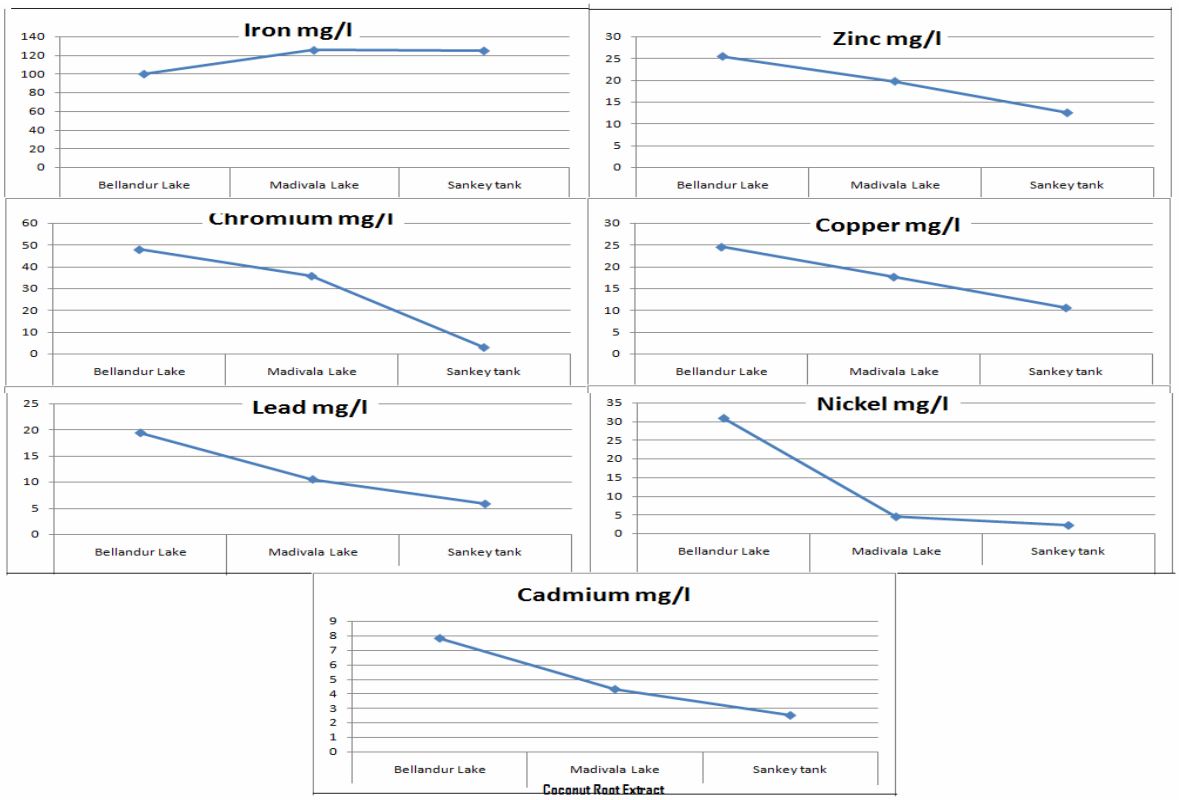


Figure -3 heavy metal level in root extract of coconut trees irrigated with lake water



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