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AVAILABILITY OF HEAVY METALS IN *AMARANTHUS SPINOSA* AND  
*AMARANTHUS SPECIOSA* DUE TO SABARMATI RIVER WATER  
POLLUTION

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[dr\\_anilkshrivastava@yahoo.co.in](mailto:dr_anilkshrivastava@yahoo.co.in)**ABSTARACT:**

Aquatic and semi-aquatic plants are suffered due to Sabarmati river water and sediments which passes through the Gandhinagar and Ahmedabad. Nabhoi village situated at Gandhinagar is less polluted locality while Vadaj situated at Ahmedabad is comparatively more polluted locality of the research study. Heavy metals like Fe, Zn, Cu, Mn etc. are available in water though which they enter in leaf and stem of *Amaranthus spinosa* and *Amaranthus speciosa*. Heavy metals were analysed through Atomic Absorption Spectrophotometer (AAS). *Amaranthus spinosa* leaves which was collected from less polluted locality has 12.1632 ppm Fe, 0.9912 ppm Zn, 0.2117 ppm Cu, 1.4109 ppm Mn, while collected from more polluted locality has 10.6236 ppm Fe, 0.9998 ppm Zn, 0.2449 ppm Cu, 2.0002 ppm Mn. *Amaranthus spinosa* stem which was collected from less polluted locality has 2.1132 ppm Fe, 0.3812 ppm Zn, 0.2112 ppm Cu, 1.9216 ppm Mn, while collected from more polluted locality has 3.4566 ppm Fe, 0.4613 ppm Zn, 0.2449 ppm Cu, 2.1003 ppm Mn. *Amaranthus speciosa* leaves which was collected from less polluted locality has 9.1262 ppm Fe, 0.9885 ppm Zn, 0.1764 ppm Cu, 1.4248 ppm Mn, while collected from more polluted locality has 5.3496 ppm Fe, 0.9925 ppm Zn, 0.2737 ppm Cu, 1.6259 ppm Mn. *Amaranthus speciosa* stem which was collected from less polluted locality has 1.9296 ppm Fe, 0.3799 ppm Zn, 0.2113 ppm Cu, 0.9213 ppm Mn, while collected from more polluted locality has 2.1619 ppm Fe, 0.4692 ppm Zn, 0.4225 ppm Cu, 0.9398 ppm Mn. *Amaranthus spinosa* is more sensitive, while *Amaranthus speciosa* is less sensitive towards pollution in terms of heavy metals depositions.

**KEY WORDS:** Heavy metals, *Amaranthus Spinosa*, *Amaranthus Speciosa*, Sabarmati River, Water Pollution.

**INTRODUCTION:**

Sabarmati river basin is situated in the mid-southern part of Rajasthan between the latitudes of 23°25' to 24°55' and longitudes of 73°00' to 73°48'. The total catchments area of the basin is 4164 km<sup>2</sup> according to the 1 : 250000 scale topographical maps published by the Survey of

India. River passes through Gandhinagar to Ahmedabad. The important soil types found in the basin are black, alluvial and sandy. An average annual surface water potential of 3.8 km<sup>3</sup> has been assessed and 1.9 km<sup>3</sup> is utilizable water in basin. Live storage capacity in the basin has increased significantly since independence. **Average irrigated area is 0.03 mega hactor, total mean annual surface water potential is 513 Mm<sup>3</sup> / year.** Safe drinking water is a basic survival need (USEPA, 1993). Pollution of river water is one of the critical problems of twenty first century. Main sources of river water contamination are sewage disposal and industrial waste disposal. The industrial waste disposal contains many toxic chemicals. Heavy metals like lead, copper, mercury etc. enter the water through many sources like industries, mines, vehicular exhaust etc. These metals reach to soil where crops and plants are grown. Animals feeding on these plants get infected immediately. These can damage any of the human organs like kidneys, heart, liver, etc., if consumed by human body. Children can become mentally retarded. Heavy metals are trace metals with a density at least five times that of water. They are stable elements that cannot be metabolized by the body and get passed up in the food chain to human beings called '*bioaccumulation*' (Harte *et al.*, 1993). Heavy metals are stable in the environment and cannot be degraded or destroyed. Therefore, they tend to build up in the atmosphere, soils, sediments and waters. Aquatic macrophytes are large, predominantly angiosperm plants inhabiting various sections of aquatic ecosystems and are of considerable importance from the productivity point of view in shallow water bodies or in the littoral zones of the deep water bodies.

**Keeping in view the aforesaid facts, an extensive study was taken up with the following broad objectives:**

1. To decide the level of water pollution at different localities of Sabarmati river due to heavy metals
2. To decide the level of soil-sediment pollution at different localities of Sabarmati river due to heavy metals
3. To analyse the accumulation of heavy metals in different parts of semi-aquatic / terrestrial plants

**Samples Collection Points:** Water, Sediment and Plants were collected from the following localities of Sabarmati River;

Less polluted Locality : Nabhoi Village

More polluted Locality : Vadaj

**METHOD OF ATOMIC ABSORPTION SPECTROPHOTOMETER (AAS) FOR THE ANALYSIS OF HEAVY METALS:** The following heavy metals were studied on AAS

standard method (Standard Methods (3110), 1998 and Standard Methods (3111), 1998) given by APHA, 1998;

(1) Iron, (2) Zinc, (3) Copper, (4) Manganese

**Step 1: Sample preservation:** Sample preparation was depended on the metal being measured.

**(a) Collection and Preservation of Water Samples:** Water samples were collected in three seasons i.e. monsoon, summer and winter from the aforesaid localities of Sabarmati river and mean of it was presented as a results. Water samples were collected and preserved for Heavy metals analysis with the following methods; 500 ml of water samples were collected, preserved (IS: 2296, (1982)) and immediately acidified with 2 ml Nitric acid ( $\text{HNO}_3$ ) (1:1 or 50 ml conc.  $\text{HNO}_3$  + 50 ml DW). Preserved water samples were analysed with AAS in standard methods given by APHA, 1998.

**(b) Collection and Preservation of Sediments Samples:** Sediments samples were collected and preserved with the following methods; 500 g of oven dried sediment samples were collected in clean and white clothed bag. 10 g of dry sample was dissolved in 100 ml of DW and made a soil solution from it. Further, it was acidified with the same process of water samples and used for the heavy metals analysis.

**(c) Collection and Preservation for various parts of semi-aquatic / terrestrial plant samples:** 1 g oven dried plant sample was digested using diacid mixture and made up to 100 ml using DW. Heavy metals from plant samples (Kushizaki, 1968) were studied on AAS in standard method given by APHA, 1998.

**Step 2: AAS Instrument operation:** A hollow cathode lamp was installed for the desired metal in the instrument and wavelength dial was also adjusted. Slit width was adjusted according to manufacturer's suggested setting for the element being measured. Instrument was turned on and the current was applied to the hollow cathode lamp suggested by the manufacturer and instrument was warmed up until energy source stabilized generally about 10 to 20 minutes. Current was readjusted as necessary after warm up. Wavelength was optimized by adjusting wavelength dial until optimum energy gain was obtained. Lamp was aligned in accordance with manufacturer's instructions. Suitable burner head was adjusted in position. Air connection was turned on and flow rate was adjusted which was specified by manufacturer to give maximum sensitivity for the metal being measured. Acetylene was turned on, flow rate was adjusted and flame was ignited. Flame should be stabilized for a few minutes. Blank which was deionised water contained the same concentration of acid in standard and sample was aspirated. Instrument was adjusted at zero. Standard solution was

aspirated so that the rate of nebulizer could obtain maximum sensitivity. Burner was adjusted both vertically and horizontally to obtain maximum response. Blank was aspirated again and the instrument was adjusted at zero. Standard was aspirated near the middle of linear range. Absorbance of standard was recorded through a hollow cathode lamp. Flame was extinguished by turned off the acetylene and then air after the completion of analysis.

**Step 3: Standardization for water samples, sediment and plant samples:** At least three concentrations of each standard metal solution were selected for the preparation of standard curve;

(1) Standard Iron solution: 1 g iron metal was dissolved in 20 ml 5 N HCl + 5 ml 6 N HNO<sub>3</sub> and final volume was made up to 1000 ml with DW. A series of standards (1 ppm, 2 ppm and 5 ppm) were prepared from the stock and a standard graph was made.

(2) Standard Zinc solution: 1 g Zn metal was dissolved in 40 ml 5 N HCl and final volume was made up to 1000 ml with DW. A series of standards (2 ppm, 4 ppm and 6 ppm) were prepared from the stock and a standard graph was made.

(3) Standard Copper solution: 1 g Cu metal was dissolved in 50 ml 6 N HNO<sub>3</sub> and final volume was made up to 1000 ml with DW. A series of standards (1 ppm, 2 ppm and 5 ppm) were prepared from the stock and a standard graph was made.

(4) Standard Manganese solution: 1 g Mn metal was dissolved in 50 ml 6 N HNO<sub>3</sub> and final volume was made up to 1000 ml with DW. A series of standards (1 ppm, 2 ppm and 3 ppm) were prepared from the stock and a standard graph was made.

### RESULTS AND DISCUSSION:

Following were the results of plant samples which were available on river bank and heavy metals get accumulated in various organs due to river water and sediment pollution (**Table 1, Table 2, Table 3 and Table 4**) ;

1. *Amaranthus spinosa* leaves which was collected from less polluted locality has 12.1632 ppm Fe, 0.9912 ppm Zn, 0.2117 ppm Cu, 1.4109 ppm Mn, while collected from more polluted locality has 10.6236 ppm Fe, 0.9998 ppm Zn, 0.2449 ppm Cu, 2.0002 ppm Mn.
2. *Amaranthus spinosa* stem which was collected from less polluted locality has 2.1132 ppm Fe, 0.3812 ppm Zn, 0.2112 ppm Cu, 1.9216 ppm Mn, while collected from more polluted locality has 3.4566 ppm Fe, 0.4613 ppm Zn, 0.2449 ppm Cu, 2.1003 ppm Mn.
3. *Amaranthus speciosa* leaves which was collected from less polluted locality has 9.1262 ppm Fe, 0.9885 ppm Zn, 0.1764 ppm Cu, 1.4248 ppm Mn, while collected from more polluted locality has 5.3496 ppm Fe, 0.9925 ppm Zn, 0.2737 ppm Cu, 1.6259 ppm Mn.

4. *Amaranthus speciosa* stem which was collected from less polluted locality has 1.9296 ppm Fe, 0.3799 ppm Zn, 0.2113 ppm Cu, 0.9213 ppm Mn, while collected from more polluted locality has 2.1619 ppm Fe, 0.4692 ppm Zn, 0.4225 ppm Cu, 0.9398 ppm Mn.

Shrivastava and Pandit, 2004 had worked on Sabarmati river basin, (Gandhinagar to Ahmedabad), Gujarat and analysed the heavy metals parameters from different six localities. Boron, molybdenum, fluorine, manganese and iron were higher than the desirable limit but within the permissible limits of BIS. Katnoria and Nagpal, 2004 had studied the soils from different fields of Amritsir and showed the presence of heavy metals like Cr, Co, Cu, Mn, Hg, Ni and Zn. Plant growth (e.g. *Allium cepa*) was suffered in the field and showed the low mitotic index because of these heavy metals. Bansal, 2005 had collected the soil from Aligarh, Uttar Pradesh. They showed the presence of pesticides ranged from 0.015 – 0.05 ppm and heavy metal in the soil. Because of the soil pollution, the plants had also accumulated heavy metals in different organs. Ambrose et al., 1994 had worked on the effect of tannery effluent on *Hydrilla* and *Ceratophyllum*. They concluded that the gross primary productivity and net primary productivity were decreased in both plant grown in pond water and Cooum river, Madras. Barman and Lal, 1994 had worked on the effect of heavy metals on vegetables and weed grown near industrially polluted field of Lucknow, Uttar Pradesh. They had worked on *Solanum tuberosum*, *Allium sativum*, *Brassica oleracea botrytis*, *Brassica oleracea capitata*, *Coriandrum sativum*, *Spinacea oleracea*, *Clerodendron viscosum*, *Chenopodium ambrozoides*, *Chenopodium album*, *Cyperus rotundus*, *Eupatorium odoratum*, *Cynadon dactylon*, *Croton bonplandianum*, *Polygonum hydropiper*. They concluded that the accumulation of heavy metals in leaf and fruits of said plants. Nivethitha et al., 2002 had worked on the accumulation of heavy metal in plants and soil contamination through heavy metals. They concluded that *Prosopis julifera* could be effectively used to decontaminate heavy metal polluted soil. Kumar et al., 2007a had showed the effects of environmental pollution on plants like damage in leaf, decreased growth which was collected from Agra, Uttar Pradesh. Kumar et al., 2007b had showed the effects of heavy metals in solid waste pollution on medicinal plants like *Azadirachta indica*, *Argemone maxicana*, *Lantana indica* and *Pongamia pinnata*.

The Sabarmati River Front Development Corporation has won the Prime Minister's award for the year 1998-1999 for excellence in urban planning and designing for cleaning up the river and getting water to the nearly dry river in Ahmedabad and for innovative ideas, concepts and plans where the projects are still in the pipeline. The Sabarmati River Front Development Project was originally conceived in the early 1960s by Bernard Cohen, the French architect.

But, the project failed to take off as it involved the rehabilitation of slum-dwellers. The project was also opposed by some NGOs. The project was revived in 1990. Ahmedabad Municipal Corporation (AMC) established the Sabarmati River Front Development Corporation Limited (SRFDCL) under section 149 (3) of the companies Act 1956 in May 1997. The SRFDCL was formed to design, plan, strategies, finance and executes the project. Sabarmati river was included in the National River Conservation Plan (NRCP) in 1992 (SRFDCL, 1998).

**CONCLUSIONS:**

Following are the outputs from the aforesaid minor part of research work;

1. Fe, Zn, Cu and Mn are higher in Sabarmati river water as compare to the permissible limits of WHO, BIS and ICMR.
2. Fe, Zn, Cu and Mn are higher in Sabarmati river water as compare to the permissible limits of BIS and IARI.
3. Nabhoi village is less polluted site and Vadaj is more polluted site.
4. *Amaranthus spinosa* is more sensitive while, *Amaranthus speciosa* is less sensitive towards pollution in terms of heavy metals depositions.

**OBSERVATION:**

**TABLE 1: Comparative data of ‘Fe’ in Water and Sediment samples with Standards And Accumulation of that Heavy metal into various parts of plants which were available at different localities**

Samples	Standards	Standard Limits	Standard Value	
Water	WHO, 1982	Desirable limit	100 ppb	
		Permissible limit	1000 ppb	
	BIS, 1991	Desirable limit	300 ppb	
		Permissible limit	1000 ppb	
	ICMR, 1975	Desirable limit	100 ppb	
		Permissible limit	1000 ppb	
Sediment	BIS, 1991	Low	0-5 ppm	
		Medium	5.01-10 ppm	
		High	>10.1 ppm	
	IARI, 1981	Low	0 ppm	
		Medium	-	
		High	2 ppm	
Samples		Locality / Plant parts	Less Polluted site	More Polluted site
Water		Locality	193.2800 ppb	958.6200 ppb
Sediment		Locality	19.3140 ppm	23.8605 ppm
<i>Amaranthus spinosa</i>		Leaf	12.1632 ppm	10.6236 ppm
		Stem	2.1132 ppm	3.4566 ppm



<i>Amaranthus speciosa</i>	Leaf	9.1262 ppm	5.3496 ppm
	Stem	1.9296 ppm	2.1619 ppm

**TABLE 2: Comparative data of ‘Zn’ in Water and Sediment samples with Standards And Accumulation of that Heavy metal into various parts of plants which were available at different localities**

Samples	Standards	Standard Limits	Standard Value	
Water	WHO, 1982	Desirable limit	5000 ppb	
		Permissible limit	15000 ppb	
	BIS, 1991	Desirable limit	5000 ppb	
		Permissible limit	15000 ppb	
	ICMR, 1975	Desirable limit	5000 ppb	
		Permissible limit	15000 ppb	
Sediment	BIS, 1991	Low	0-0.5 ppm	
		Medium	0.51-1 ppm	
		High	>1.01 ppm	
	IARI, 1981	Low	0.5-1 ppm	
		Medium	-	
		High	1-5 ppm	
Samples		Locality / Plant parts	Less Polluted site	More Polluted site
Water		Locality	447.8100 ppb	548.4450 ppb
Sediment		Locality	0.7855 ppm	5.3465 ppm
<i>Amaranthus spinosa</i>		Leaf	0.9912 ppm	0.9998 ppm
		Stem	0.3812 ppm	0.4613 ppm
<i>Amaranthus speciosa</i>		Leaf	0.9885 ppm	0.9925 ppm
		Stem	0.3799 ppm	0.4692 ppm

**TABLE 3: Comparative data of ‘Cu’ in Water and Sediment samples with Standards And Accumulation of that Heavy metal into various parts of plants which were available at different localities**

Samples	Standards	Standard Limits	Standard Value	
Water	WHO, 1982	Desirable limit	50 ppb	
		Permissible limit	1000 ppb	
	BIS, 1991	Desirable limit	50 ppb	
		Permissible limit	300 ppb	
	ICMR, 1975	Desirable limit	50 ppb	
		Permissible limit	1500 ppb	
Sediment	BIS, 1991	Low	0-0.20 ppm	
		Medium	0.21-0.40 ppm	
		High	>0.41 ppm	
	IARI, 1981	Low	0.2-0.5 ppm	
		Medium	-	
		High	1-3 ppm	
Samples		Locality / Plant parts	Less Polluted site	More Polluted site
Water		Locality	27.6250 ppb	82.7100 ppb
Sediment		Locality	1.9130 ppm	8.4625 ppm
<i>Amaranthus spinosa</i>		Leaf	0.2117 ppm	0.2449 ppm

	Stem	0.2112 ppm	0.2454 ppm
<i>Amaranthus speciosa</i>	Leaf	0.1764 ppm	0.2737 ppm
	Stem	0.2113 ppm	0.4225 ppm

**TABLE 4: Comparative data of ‘Mn’ in Water and Sediment samples with Standards And Accumulation of that Heavy metal into various parts of plants which were available at different localities**

Samples	Standards	Standard Limits	Standard Value
Water	WHO, 1982	Desirable limit	50 ppb
		Permissible limit	500 ppb
	BIS, 1991	Desirable limit	100 ppb
		Permissible limit	200 ppb
	ICMR, 1975	Desirable limit	100 ppb
		Permissible limit	300 ppb
Sediment	BIS, 1991	Low	0-0.15 ppm
		Medium	0.16-0.20 ppm
		High	>0.21 ppm
	IARI, 1981	Low	2 ppm
		Medium	3-4 ppm
		High	5-20 ppm
Samples	Locality / Plant parts	Less Polluted site	More Polluted site
Water	Locality	8.9350 ppb	132.845 ppb
Sediment	Locality	0.6305 ppm	4.4440 ppm
<i>Amaranthus spinosa</i>	Leaf	1.4109 ppm	2.0002 ppm
	Stem	1.9216 ppm	2.1003 ppm
<i>Amaranthus speciosa</i>	Leaf	1.4248 ppm	0.6259 ppm
	Stem	0.9213 ppm	0.9398 ppm

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