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**ESTIMATION OF METALS IN GODAVARI RIVER WATER BY ICP-MS DURING
MAHA PUSKARAM IN EAST AND WEST GODAVARI DISTRICT, ANDHRA
PRADESH, INDIA**

T.Vijaya Prasadini*, N. Srinivasu

* Department of Rural Water Supply and Sanitation, West Godavari 534005
Andhra Pradesh, INDIA.

Division of Chemistry, Department of Sciences and Humanities, Vignan's Foundation for Science,
Technology and Research University (VFSTRU; Vignan University), Vadlamudi, Guntur 522 213
Andhra Pradesh, INDIA.

ABSTRACT

Water quality plays an important role in different house hold and industrial activities. The quality of water is an essential requirement to the human health and life. The present investigation samples were collected pilgrim river water ie. Day one to day twelve in the year of 2015 over 5 crores pilgrims have attended the pushkarams in Rajahmundry and Pattiseema east and west Godavari district in Andhra Pradesh. The collected samples were brought to the laboratory to determine ICP-MS. The present study includes the analysis of 14 metal concentrations like Beryllium (Be), Boron (B), Aluminium (Al), Antimony (Sb), Manganese (Mn), Molybdenum (Mo), Iron (Fe), Copper (Cu), Zinc (Zn), Indium (In), Tin (Sn), Barium (Ba), Thallium (Tl) and Silver (Ag) by using ICP-MS in the selected samples. The minimum and maximum concentration levels of these 14 metals are summarized and discussed in the results and discussion and the concentrations of these 14 metal levels in the study area were compared with drinking water quality standards given by the Indian Standards (IS : 10500).

KEYWORDS: Godavari River pilgrim water, Metals, Rajahmundry and Pattiseema east and west Godavari district, ICP-MS.

INTRODUCTION

River water is an important and major source of drinking water in both urban and rural areas in India. Determination of water quality is one of the most important aspects in groundwater studies. River water is highly valued because of certain properties not possessed by surface water [1-2]. People around the world have been using river water as a source of drinking water, and even today more than half the world's population depends on river water for survival. The value of river water lies not only in its widespread occurrence and availability, but also in its consistent good quality, which makes it an ideal source of drinking water. In recent times, increasing focus is being given to studies on river water contamination. Since river water is directly in contact with soil, rocks, and plants, industrial effluent the constituents of these sources might contaminate the river water [3-5]. River Water pollution is one of the major problems in worldwide. The ground water pollution is due to the mineralogical contamination, soil erosion, dumping of industrial and municipal waste into the corners of river and other industrial and domestic activities. A number of ions and elements are present in the river water in dissolved state. Depending on the geological conditions of the location the concentration levels of the ions and elements might be varied and which might be present for ppb levels to ppm levels. The chemical parameters of river water play a significant role in classifying and assessing water quality [6].

Pushkaram or Pushkaralu (in Telugu), Pushkara or Puskar is an Indian festival dedicated to worshipping of rivers. Pushkara or Pushkar is a Sanskrit word derived from the element of Push (Pushti) meaning nourishment and Kara means one who does it. Pushkara is the energy that nourishes. With reference to the sacred rivers, pushkara means the one who energize the rivers and provide spiritual purification. Pushkara also means Lotus, sanctified water, swan, Sword, Sky, Lake etc. Pushkaram is a festival of rivers that is applicable only to the 12 important rivers in India

which occurs once in 12 years for each river. The rivers Ganga, Narmada, Saraswathi, Yamuna, Godavari, Krishna, Kaveri, Tambrapani, Brahmaputhra, Tungabhadra, Indus, and Pranahita are the privileged rivers. The first 12 days period is called Aadhi pushkaram and the last 12 days period is called Anthya pushkaram. In the year 2003 over two crores pilgrims have attended the Pushkarams in Rajahmundry and Basara Gnana sarasawathi temple of located on the banks of river Godavari, in the year 2015 over 5 crores pilgrims have attended the pushkarams in Rajahmundry and Pattiseema east and west Godavari district in Andhra Pradesh.

The Pushkara festival (also known as Kumbh Mela) is celebrated for 12 days once in every 12 years and is one of the biggest festivals in the world. Rajahmundry and pattiseema in Andhra Pradesh has been a centre place for this festival from ages. The pushkarams that are going to be celebrated this year are called "Maha Pushkarams" which occurs once in every 144 years. This year Godavari has celebrated its "Maha Pushkaram" from July 14th to July 25th, 2015.

A number of sophisticated instruments (like ICP-MS, ICP-OES, AAS, UV-VIS spectrometer, Cyclic Voltammetry, etc.) are used for the determination of metals in water. Inductively Coupled Plasma – Mass Spectrometer (ICP-MS) is one of the most widely and universally used techniques for the determination of metals contaminants in water up to parts per billion (ppb) levels. By using ICP-MS, we can determine up to 0.1 µg/L of metal concentration in pilgrim water. The 14 metals are determined by using ICP-MS technique and the observed metal levels in the study area were compared with drinking water quality standards given by the Indian Standards (IS : 10500) and World Health Organization (WHO), 4th edition in 2011.

SAMPLE COLLECTION

The pilgrim water samples are collected by following of standard sample collection protocol and guidelines given in Indian Standards methods IS: 3025 part-1 and American Public Health Association (APHA) 22nd edition. Special precautions were taken during the sampling of metals. Before collecting the samples, the sample containers are soaked overnight in 2% nitric acid and washed with double distilled water and dried in clean metal free area. At each sampling location, water samples were collected in two pre-cleaned containers for duplicate measurement. The bottles were rinsed three times with the ground water sample of the particular location and collected the final sample to avoid the contamination and 0.5 ml of Supra pure grade nitric acid is added to acidify the samples and also to prevent the loss of metals. All the collected pilgrim water samples are preserved at 4°C by using thermo-cool box with ice packs. The details of sampling locations have been summarized in **Table -1**.

DETAILS OF SAMPLING LOCATIONS:

Table -1

LOCATION CODE	LOCATION NAME	LOCATION CODE	LOCATION NAME
Day- 1	Rajahmundry	Day- 1	Pattiseema
Day- 2	-	Day -2	-
Day- 3	-	Day -3	-
Day- 4	-	Day- 4	-
Day- 5	-	Day- 5	-
Day- 6	-	Day- 6	-
Day- 7	-	Day- 7	-
Day- 8	-	Day- 8	-
Day- 9	-	Day- 9	-
Day-10	-	Day- 10	-
Day-11	-	Day-11	-
Day-12	-	Day- 12	-

ANALYTICAL METHODOLOGY:

Trace metals are analyzed using ICP-MS (Agilent 7500) Standard reference material of 1000mg/L (Multi elements-Merck) is used for analysis of trace elements. Seven different linear concentration standards are prepared ranging from 0.001 mg/L to 0.5 mg/L. Before doing sample analysis different concentrations of standards were analyzed and prepared linear curve. All the metals having good linear graph with correlation coefficient of > 0.999 is observed in standard curves preparation.

RESULTS AND DISCUSSION

ICP-MS is the most widely using technique for the determination of trace metals up to parts per billion levels. ICP-MS is very useful technique to determine trace levels of multi -elements in single aspiration.

The quantity of 14 metals (Beryllium, Boron, Aluminium, Antimony, Tin, Manganese, Molybdenum, Iron, Copper, Zinc, Indium, Barium, Thallium and Silver) observed in the 24 pilgrim samples in Gdavari puskaram at Rajahmundry and Pattiseema east and west Godavari district has been summarized in **Table -2 to 5** and the results are discussed below.

Table -2

S.NO	PILGRIM WATER	NAME OF LOCATION	B	Al	Mn	Fe	Cu	Zn	Ag
	UNIT	Rajahmundry	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	Day-1	-	0.184	0.008	0.011	0.019	0.007	0.141	0.001
2	Day-2	-	0.187	0.031	0.006	0.005	0.011	0.042	<0.001
3	Day-3	-	0.175	0.008	0.002	0.008	0.001	0.017	<0.001
4	Day-4	-	0.140	0.013	0.007	0.013	0.008	0.023	<0.001
5	Day-5	-	0.225	0.008	0.011	0.014	0.006	0.007	<0.001
6	Day-6	-	0.232	0.022	0.005	0.033	0.007	0.034	0.003
7	Day-7	-	0.264	0.030	0.014	0.053	0.002	0.009	<0.001
8	Day-8	-	0.123	0.066	0.848	0.265	0.022	0.024	<0.001
9	Day-9	-	0.369	0.099	0.987	0.282	0.031	0.737	<0.001
10	Day-10	-	0.113	0.006	0.008	0.005	0.003	0.032	<0.001
11	Day-11	-	0.150	0.005	0.221	0.022	0.005	0.126	<0.001
12	Day-12	-	0.381	0.007	0.555	0.035	0.006	0.362	<0.001

Table -3

S.NO	PILGRIM WATER	NAME OF LOCATION	In	Ba	Tl	Be	Mo	Sn	Sb
	UNIT	Rajahmundry	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	Day-1	-	<0.001	0.342	<0.001	<0.001	0.007	<0.001	<0.001
2	Day-2	-	<0.001	0.336	<0.001	<0.001	0.005	<0.001	<0.001
3	Day-3	-	<0.001	0.413	<0.001	<0.001	0.005	<0.001	<0.001
4	Day-4	-	<0.001	0.413	<0.001	<0.001	0.005	<0.001	<0.001
5	Day-5	-	<0.001	0.433	<0.001	<0.001	0.003	<0.001	<0.001
6	Day-6	-	<0.001	0.455	<0.001	<0.001	0.004	<0.001	<0.001
7	Day-7	-	<0.001	0.455	<0.001	<0.001	0.005	<0.001	<0.001
8	Day-8	-	<0.001	0.235	<0.001	<0.001	0.005	<0.001	<0.001
9	Day-9	-	<0.001	0.235	<0.001	<0.001	0.006	<0.001	<0.001
10	Day-10	-	<0.001	0.287	<0.001	<0.001	0.006	<0.001	<0.001
11	Day-11	-	<0.001	0.401	<0.001	<0.001	0.006	<0.001	<0.001
12	Day-12	-	<0.001	0.401	<0.001	<0.001	0.008	<0.001	<0.001

Table -4

S.NO	PILGRIM WATER	NAME OF LOCATION	B	Al	Mn	Fe	Cu	Zn	Ag
	UNIT	Pattiseema	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	Day-1	-	0.038	0.005	0.011	0.021	0.005	0.686	<0.001
2	Day-2	-	0.022	0.008	0.009	0.005	0.003	0.083	0.002
3	Day-3	-	0.014	0.013	0.011	0.016	0.012	0.045	0.004
4	Day-4	-	0.011	0.015	0.011	0.044	0.023	0.036	0.005
5	Day-5	-	0.007	0.006	0.014	0.016	0.001	0.022	0.002
6	Day-6	-	0.020	0.013	0.023	0.031	0.013	0.045	0.003
7	Day-7	-	0.031	0.004	0.034	0.013	0.007	0.010	0.003
8	Day-8	-	0.059	0.009	0.073	0.017	0.001	0.014	0.001

9	Day-9	-	0.063	0.017	0.013	0.020	0.013	0.013	0.005
10	Day-10	-	0.022	0.010	0.016	0.075	0.011	0.018	0.001
11	Day-11	-	0.145	0.020	0.008	0.002	0.007	0.014	0.003
12	Day-12	-	0.062	0.013	0.009	0.004	0.008	0.011	<0.001

Table -5

S.NO	PILGRIM WATER UNIT	NAME OF LOCATION	In mg/L	Ba mg/L	Tl mg/L	Be mg/L	Mo mg/L	Sn mg/L	Sb mg/L
1	Day-1	Pattiseema	<0.001	0.228	<0.001	<0.001	0.005	<0.001	<0.001
2	Day-2	-	<0.001	0.031	<0.001	<0.001	0.008	<0.001	<0.001
3	Day-3	-	<0.001	0.014	<0.001	<0.001	0.005	<0.001	<0.001
4	Day-4	-	<0.001	0.028	<0.001	<0.001	0.004	<0.001	<0.001
5	Day-5	-	<0.001	0.034	<0.001	<0.001	0.005	<0.001	<0.001
6	Day-6	-	<0.001	0.025	<0.001	<0.001	0.004	<0.001	<0.001
7	Day-7	-	<0.001	0.282	<0.001	<0.001	0.007	<0.001	<0.001
8	Day-8	-	<0.001	0.806	<0.001	<0.001	0.005	<0.001	<0.001
9	Day-9	-	<0.001	0.308	<0.001	<0.001	0.006	<0.001	<0.001
10	Day-10	-	<0.001	0.044	<0.001	<0.001	0.003	<0.001	<0.001
11	Day-11	-	<0.001	0.187	<0.001	<0.001	0.003	<0.001	<0.001
12	Day-12	-	<0.001	0.149	<0.001	<0.001	0.003	<0.001	<0.001

Boron concentrations vary from 0.007 mg/L to 0.381 mg/L in the overall study areas. The maximum concentration of boron has been observed at day-12 at Rajahmundry pilgrim water sample. The maximum acceptable limit for boron as per IS: 10500 is 0.5 mg/L and maximum acceptable limit as per World Health Organization is 2.4 mg/L. However the observed concentration levels of boron in the study area is observed within the acceptable limits given by the IS: 10500 and WHO guidelines.

Aluminium concentrations vary from 0.004 mg/L to 0.099 mg/L in the overall study areas. The maximum concentration of Aluminium has been observed at Day-9 at Rajahmundry pilgrim sample water. The permissible limit for aluminium as per IS: 10500 is 0.2 mg/L and maximum guideline value as per World Health Organization is 0.9 mg/L. However the observed concentration levels of aluminium in study area is observed excess of acceptable limits given by the IS: 10500, but within the permissible limit of IS: 10500 and WHO guidelines.

Manganese concentrations vary from 0.002 mg/L to 0.987 mg/L in the overall study areas. The maximum concentration of manganese has been observed at Day-9 at Rajahmundry pilgrim sample water. The maximum acceptable limit for manganese as per IS: 10500 is 0.1 mg/L and permissible value 0.3 mg/L and provisional guideline value as per World Health Organization is 0.4 mg/L. The observed manganese values are within the permissible limits given by IS: 10500 and WHO guidelines except three samples at day-8, day-9 day-12 sample waters.

Iron concentrations vary from 0.002 mg/L to 0.282 mg/L in the overall study areas. The maximum concentration of iron has been observed at Day-9 at Rajahmundry pilgrim sample water. The maximum acceptable limit for iron as per IS: 10500 is 0.3 mg/L and no guideline value is given by World Health Organization for Iron content. However the observed concentration levels of Iron found within the permissible given by the IS: 10500.

Copper concentrations vary from 0.001 mg/L to 0.031 mg/L in the overall study areas. The maximum concentration of copper has been observed at Day-9 at Rajahmundry pilgrim sample water. The maximum acceptable limit for copper as per IS: 10500 is 0.05 mg/L and permissible value is 1.5 mg/L and WHO guidelines are 2.0 mg/L. However the observed concentration levels of copper is within the acceptable and permissible limits given by the IS: 10500 and guideline value given by the WHO.

Zinc concentrations vary from 0.005 mg/L to 0.737 mg/L in the overall study areas. The maximum concentration of zinc has been observed at Day-9 at Rajahmundry pilgrim sample water. The maximum acceptable limit for zinc as per IS: 10500 is 5.0 mg/L and permissible limit is 15 mg/L and no guideline value given by the World Health Organization. However the observed values are within the permissible and acceptable limit specified in IS: 10500.

Silver concentrations vary from <0.001 mg/L to 0.005 mg/L in the overall study areas. The maximum concentration of silver has been observed at day-9 at pattiseema pilgrim sample water. The maximum acceptable limit for silver as per IS: 10500 is 0.1 mg/L and there is no guideline value given by World Health Organization. However the observed concentration level of silver is observed within the permissible limits of IS: 10500.

Barium concentrations vary from 0.014 mg/L to 0.806 mg/L in the overall study areas. The maximum concentration of barium has been observed at day-8 pilgrim sample water. The maximum acceptable limit for barium as per IS: 10500 and WHO guidelines are 0.7 mg/L. However the observed concentration levels of Barium observed within the acceptable limit suggested by IS: 10500 and WHO guidelines expect day-8 pilgrim sample water.

Molybdenum concentrations vary from 0.001 mg/L to 0.008 mg/L in the overall study areas. The maximum concentration of molybdenum has been observed at day-2 pattiseema pilgrim sample water. The maximum acceptable limit for molybdenum as per IS: 10500 is 0.07 mg/L and no guideline value has established by the World Health Organization. However the observed concentration levels of Molybdenum are observed within the acceptable limits suggested in IS: 10500.

Indium, Thallium, beryllium, Tin, Antimony concentration levels has been observed <0.001 mg/L. in overall collected pilgrim water samples.

CONCLUSION

River water is one of the major important drinking water sources in throughout the world. Especially in most of the village areas the public are using river water for drinking purpose. Metals are most considerable contaminants in river water. Excess levels of metals might be cause several short term and long term health effects to the human beings. Determination of these metals with high accuracy and precision at trace levels is one of the major challenges in analytical chemistry. ICP-MS is one of the most widely and universally using technique for determination of metals upto trace levels. The present study is focused on determination of 14 metals like Beryllium (Be), Boron (B), Aluminium (Al), Antimony (Sb), Tin (Sn), Manganese (Mn), Molybdenum (Mo), Iron (Fe), Copper (Cu), Zinc (Zn), Indium (In), Barium (Ba), Thallium (Tl), and Silver (Ag) in pushkarams in Rajahmundry and Pattiseema east and west Godavari distict in Andhra Pradesh.

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