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Research Article

QUALITY ASSESSMENT OF DRINKING WATER WITH REFERENCE TO HEAVY METALS IN MORENA CITY, MADHYA PRADESH, INDIA

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ABSTRACT

Heavy metals in drinking water cause a serious threat to human health. Urban population is exposed to heavy metals primarily through water consumption and some heavy metals can bio accumulates in the human body and may induce cancer and other risks. The general objective of the study is to analyze the heavy metals in drinking water. The results revealed that Pb, Fe, Zn, and Asare present in the drinking water of Morena and may cause health risks to the residents. According to the indices, the city drinking water quality is good in terms of heavy metals.Continuous monitoring of drinking water quality is essential in terms of heavy metals and toxic substances.

Keywords: *Heavy metals, Drinking Water, Health, Morena City*

1. INTRODUCTION

Pollution of drinking water by heavy metals is a subject of serious concern because of their assimilation in different tissues in the human body [1]. Besides, heavy metals, for example, cadmium can remove essential minerals, like vitamin C and E from their metabolically active site and can be harmful to the humans [2, 3]. As indicated by House croft and Sharpe [4], heavy metals, like Mn, Fe and Ni are required for the protein action in human body. The different elements connected with heavy metal contamination in drinking water are the different sources like filtering of the substantial metal from the pipeline and unhygienic drinking water supply [5-8].

The groundwater is vulnerable to substantial metal contamination because of regular event and anthropogenic exercises [9, 10]. Anthropogenic activities, like mining, modern and farming action, poor wastewater supervision and other sources add Pb, As, Zn and Fe to the drinking water [10, 8]. All things considered, heavy metals could drain out from the eroded pipeline system [6, 11]. Erosion of channels happens as they are not renewed for quite long period of time and setting that relies upon the pipe material and defensive covering of internal pipe, which normally degenerates after some time and gets interacted with the water [6]. The other factor is unhygienic practices at home, for example, despicable drinking water stockpiling compartment and unhygienic handlers [7].

Heavy metals are dangerous to people if the metals are uncovered or ingested in large amounts [12-15]. The diverse courses of introduction are ingestion, assimilation and inward breath pathways. Ingestion course is tortuous introduction by admission of sustenance and drinking water into the gastrointestinal tract [16, 17]. Ingestion and inhalation are different courses of direct contact of substantial metal through skin and the respiratory tract in which the airborne or vapor metal noticeable all around is breathed into the lung [16, 17]. Cornelis and Nordberg [17] expressed that entry of heavy metal through respiratory pathway is typically little contrasted with ingestion pathway.

Lead has been perceived as most dangerous the most lethal metals, principally in ionic state. Because of its extreme poisonous quality and incredible potential on the earth and life forms, lead (Pb) is viewed as one of the crucial risk to the human well-being. Lead poisoning (Plumbism) is a restorative condition caused by abnormal state of lead in the body [18]. The real source of lead release into the earth is modern exercises, for example, electroplating, battery, produce, metallurgy. The greater part of the world's lead formation (no less than 1.15 million metric tons) is utilized as a part of cars, particularly in auto battery. Lead is a conventional base metal which blends with changing measures of tin to control the tone of the pipe. The drinking of water debased with Pb by the general population of Morena can cause medical issues including hypertension, weakness, kidney harm, stomach torment, disarray, cerebral pain, crabbiness, memory and learning lacks and in serious cases seizures, extreme lethargies and demise [19].

Dissimilar to different metals lead does not normally exist in the human body, and hence there isn't a base lead level which is to be considered non-poisonous.

As indicated by the USEPA control, the adequate grouping of Pb(II) in drinking water is of 0.015 mg/L [20]. In this way, these days the ejection of lead particles from waste water is an issue of most extreme significance [21]. Traditional strategies that have been utilized to expel Pb(II) particles from different mechanical effluents by different analysts have been studied in great detail [22, 23]. Zinc is the 24th most bottomless component on the worlds outside layer. German Chemist Andreas Sigismund Marggraf is ordinarily given acknowledgment for finding unadulterated metallic Zinc in 1746. Zinc is considered as a basic follow component forever and goes about as a micronutrient, it is one of the parts of specific proteins inside the human body, however at lifted and additionally inadequate fixations Zinc might be hindering to human wellbeing [24, 25].

Zinc is known as an inorganic contamination in the need poisons list [26] that appeared to bio accumulate through the natural process [27, 28]. Then again, Zinc is additionally a key component for people; free Zinc particles in agreement are exceptionally poisonous to plants, spineless creatures and even vertebrate fishes. Zinc particles can harm nature and kill a few life forms. Difficult to deal with entry of Zinc can support insufficiency in other dietary minerals. WHO prescribed the amount of Zinc in drinking water to be as 5.0 mg/L [29]. Zinc is toxic to human beings in both intense and never-ending structures [30]. Zinc inadequacy has various side effects in human and living things are the inability to eat, skin sore and sexual problems [31-34]. The drinking of water contaminated with Pb by the general population of Morena may cause drying up muscles, awkwardness of electrolytes, stomach, vertigo and disharmony [35]. Zn (II) accumulates in living beings causing illness and other poisonous impacts. Hence there is noteworthy enthusiasm with respect to zinc ejection from wastewater [36, 37]. Zinc is a crude material for consumption safe amalgams and metal for galvanization of steel and iron items. Zinc oxide is a white shade for elastic and paper. It is additionally used in paints, plastics, beautifying agents and pharmaceuticals [38, 39]

The drinking of water polluted with As cause incessant poisonous quality causes skin, lung, bladder, and kidney tumor and also pigmentation changes, skin thickening (hyperkeratosis) neurological disorders, solid shortcoming, loss of craving, and sickness (40-42). This contrasts from intense harm, which ordinarily causes spewing, esophageal and stomach pain, bleeding diarrhea. High concentration of arsenic in drinking water can cause stillbirths and unconstrained premature births [43, 44].

The normal requirement of iron is 200-250 mg/kg of body weight; however, the ingestion of dosages as low as 40 mg/kg of body weight can be tolerated (6). Examinations have identified hemorrhagic disintegration and wearing of regions of mucosa in the stomach with augmentation into the sub mucosa. Incessant iron over-burden comes about mainly from a hereditary issue (haemochromatosis) described by improved iron assimilation [10]. There are reports in which individuals have frequently taken iron supplements for long stretches with no pessimistic impacts [10], and an admission of 0.4– 1 mg/kg of body weight every day is probably not going to cause unfriendly impacts in healthy people (19).To the best of our knowledge no work has been done so far to analysed the effects and concentration of heavy metals in the water. Hence, the objective of the present study was to analysed the heavy metals like Pb, Zn, As and Pb in the drinking water of Morena. The conceivable pollution may have originated from point sources and non-point source in the area.

2. MATERIALS AND METHODS

Morena city is a located in Madhya Pradesh state of northern India and is considered as the administrative unit of Morena District. It has recently been governed by a municipal corporation. Morena city is located 26°.5 N latitude 78°.0 E longitude, 39 km away from the research center. It has an average elevation of 177 meters from MSL (580 feet) and as per reports of Census India, population of Morena in 2011 is 200,482; of which male and female are 108,390 and 92,092 respectively. The climate in the study area is termed as extreme, both in summer and winter. The summers are usually very hot and the winters very cold. The rainfall is however, restricted only to the monsoon months. The north westerns wind blows, predominantly, over the city of Morena.

The average temperature of the area during the winter is 22.90 ^{0}C and the average temperature during summer season remains 37.2^{0}C and the temperature in monsoon remain with the average of 35^{0}C and similarly the average rainfall throughout the year observed were 33mm.

Using stratified random sampling for heavy metal analysis, 10 sampling sites were selected, depicted as (S1) District hospital campus, (S2) Private bus stand, (S3) Railway station (High density area), (S4) Hanuman

Chauraha, (S5) Chambal colony, (S6) Morena gaon,(S7) Ambahporsa bus stand Badokhar, (S8) Lalor village, (S9) K. S. Mill Chauraha (Industrial site), (S10) Singalbasti. Water sampling was done regularly in first week of each month from November 2016 to April 2017 and samples were collected at thirty days interval. Bottles were properly labeled with sample number and well rinsed with the sample water to be collected. Hand pumps and tube wells were permitted to flow continuously for around 10 min before sample collection. The samples were taken to the laboratory and were analyzed using Atomic Absorption Spectrophotometer (Model No. Perkin ElemerAanalyst -700).

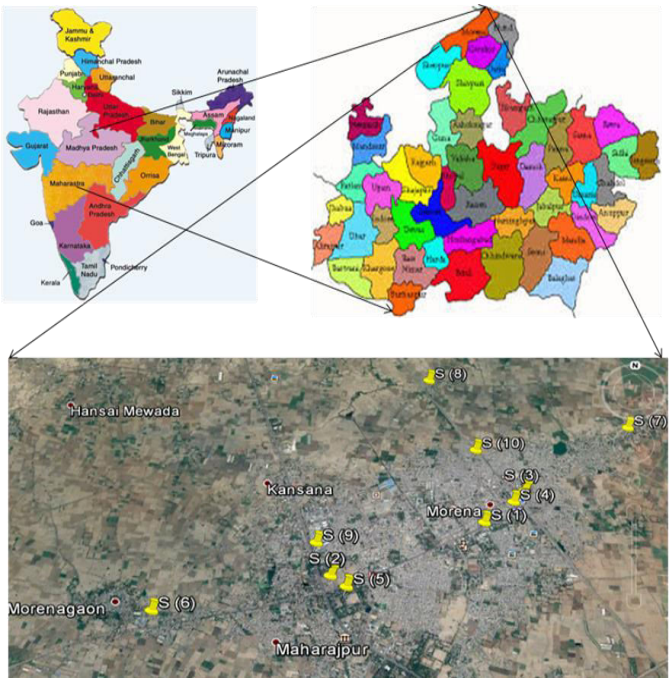

Fig 1: Map of Morena City sampling site Sample Collection

3. RESULTS AND DISCUSSION

Many land based, water based activities and over exploitation are causing contamination of aquifers leading to unsafe ground water [1]. In areas of high population density and intensive human use of the land, ground water becomes especially vulnerable. Many industrial activities where chemicals or wastes are released to the environment, either intentionally or accidentally, has the potential to pollute ground water [2]. When ground water gets polluted it becomes cause of water both disease and poses big challenge in cleaning process. WHO (World Health Organization) realized this problem earlier and started issuing standards for safe ground water from the year 1958.

The analysis of ground water for heavy metal was performed from Nov. 2016 to April 2017 at different selected sampling sites. The data obtained was interpreted and average value of heavy metals at different sampling sites was calculated which is mentioned in below table [3-6]. During the course of study, it was observed that heavy metals are present in the water. The concentration of metals in water at all sampling sites were recorded in range of 0.217-0.542 ppm) for Zn, 0.204-0.425 mg/L for Fe, 0.0001-0.016 mg/L for As and 0.0004-0.028 mg/L for Pb) [Table 2]. Among the analyzed metals the concentration of Fe was maximum but not more than permissible limit.

Table 1: Acceptable and permissible limits for drinking water as per BIS 10500:2012

Heavy metals	BIS Standard	
	Acceptable limit (mg/L)	Permissible limit (mg/L)
Iron	0.3	No relaxation
Zinc	5.0	15.0
Arsenic	0.01	0.05
Lead	0.01	No relaxation

Iron is the most commonly available metal on planet earth. Iron is a secondary priority chemical contaminant (United Nations International Children's Emergency Fund UNICEF 2008). During the analysis of water it was observed that Iron content of the water sample is also within the permissible limit at some sites and exceeds at few sites above the permissible limit. The maximum value of iron content was observed at site S1 with the average value of 0.552 mg/L and the minimum iron content was observed at site S2 with the average value of 0.221 mg/L. The high concentration of iron is a matter of concern as large amount of ground water is abstracted by drilling waterwheels both in rural and urban areas for drinking and irrigation purposes. The level of iron could be the result of clay deposits in the area. Also the presence of iron is responsible for the brownish-red colour of the water when allowed to stay for some minutes [9]. Excess of iron will also influence the presence of bacteria (iron-reducing) in ground water [10]. Other sources of iron in drinking water are iron pipes, and cookware. It affects target organs which are the liver, cardiovascular system and kidneys.

Table 2: Concentration of heavy Metals in drinking water at different sampling sites

Sampling sites	November	December	January	February	March	April	Mean ± Std. Error
Iron (Fe)							
S1	2.18	0.222	0.212	0.228	0.232	0.235	0.552±0.326
S2	0.204	0.21	0.215	0.225	0.228	0.245	0.221±0.00602
S3	0.278	0.282	0.285	0.275	0.28	0.286	0.281±0.00171
S4	0.292	0.298	0.295	0.285	0.29	0.298	0.293±0.00207
S5	0.318	0.312	0.315	0.31	0.298	0.31	0.311±0.0028
S6	0.348	0.352	0.36	0.356	0.365	0.367	0.358±0.00302
S7	0.417	0.398	0.422	0.412	0.415	0.425	0.415±0.00388
S8	0.341	0.35	0.35	0.35	0.354	0.365	0.352±0.00319
S9	0.342	0.335	0.34	0.354	0.364	0.37	0.351±0.00576
S10	0.358	0.365	0.352	0.362	0.367	0.37	0.362±0.00267
Zinc (Zn)							
S1	0.298	0.312	0.288	0.293	0.29	0.288	0.295±0.00376
S2	0.321	0.328	0.325	0.335	0.312	0.32	0.324±0.00319
S3	0.435	0.398	0.44	0.42	0.41	0.42	0.42±0.00634
S4	0.478	0.452	0.46	0.445	0.425	0.432	0.449±0.00786
S5	0.304	0.298	0.31	0.325	0.314	0.332	0.314±0.00522
S6	0.217	0.225	0.225	0.228	0.222	0.234	0.225±0.00233
S7	0.232	0.24	0.235	0.242	0.245	0.255	0.241±0.00331
S8	0.501	0.489	0.515	0.498	0.488	0.494	0.498±0.00406
S9	0.518	0.527	0.522	0.532	0.512	0.542	0.526±0.00435
S10	0.304	0.31	0.306	0.332	0.339	0.344	0.323±0.00729
Arsenic (As)							
S1	0	0	0	0.002	0	0	0.000333±0.000333
S2	0	0	0	0.004	0	0.0001	0.000683±0.000664
S3	0	0	0	0	0	0	0±0
S4	0	0	0.0013	0.006	0	0.0008	0.00135±0.000956
S5	0	0	0.0003	0.001	0	0	0.000217±0.000164
S6	0	0	0.001	0	0	0	0.000167±0.000167
S7	0	0	0.002	0	0	0	0.000333±0.000333
S8	0	0	0.0012	0.003	0	0.0005	0.000783±0.000483
S9	0	0	0.0016	0	0	0	0.000267±0.000267
S10	0	0	0.0009	0.001	0	0.0002	0.00035±0.000193
Lead (Pb)							
S1	0	0.004	0.006	0.008	0.005	0.004	0.0045±0.00109
S2	0.0011	0.0015	0.009	0.004	0.007	0.009	0.00527±0.00146
S3	0.001	0.006	0.003	0.005	0.002	0.001	0.003±0.000856
S4	0.0014	0.0018	0.02	0.025	0.019	0.023	0.015±0.00434
S5	0.001	0.005	0.007	0.009	0.011	0.013	0.00767±0.00176
S6	0.0018	0.0022	0.0018	0.022	0.026	0.023	0.0128±0.00489
S7	0.0015	0.0017	0.0022	0.028	0.022	0.018	0.0122±0.00484
S8	0.008	0.0012	0.0017	0.021	0.027	0.022	0.0135±0.00459
S9	0.0014	0.0019	0.0021	0.024	0.028	0.024	0.0136±0.0053
S10	0	0.0013	0.0004	0.0006	0	0	0.000383±0.00021

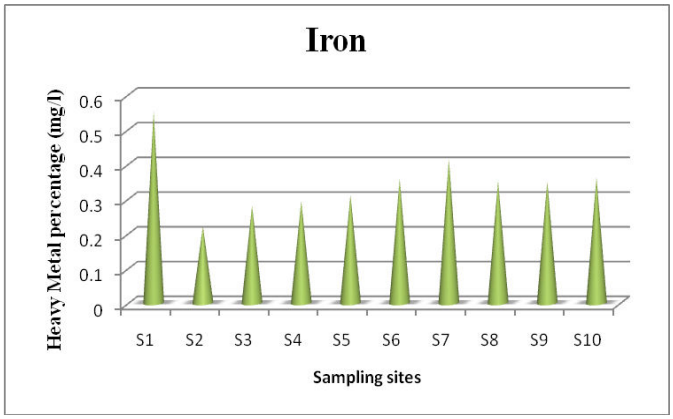

Fig. 2: Graphical representation of Iron at different sampling sites.

Zinc can be introduced in water naturally by erosion of minerals from rocks and soil; however since zinc ores are only slightly soluble in water. Zinc can enter the environment from several sources including mine drainage, industrial and municipal wastes, urban runoff and mainly from the erosion of soil particle containing zinc [45, 46].

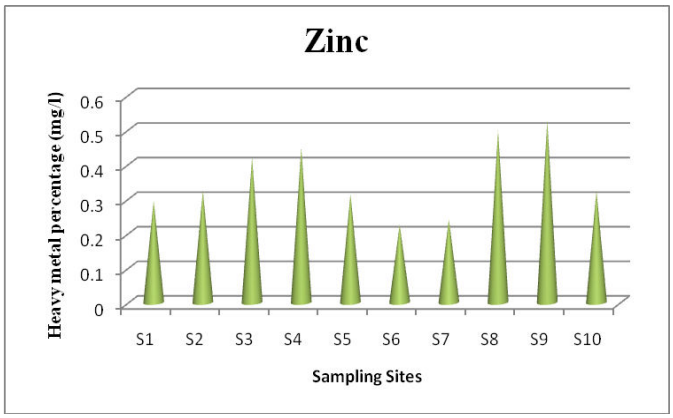

Fig 3: Graphical representation of Zinc at different sampling sites.

The average value of zinc at all sampling sites was calculated as show in table-4 and was found within the acceptable limit. The maximum value of zinc was observed at sample site 9 with the average of 0.525mg/L and minimum value was observed at sampling site S6 with average of 0.225mg/L as shown in fig. 3. Zinc is one of the most ubiquitous and mobile of the heavy metals and is transported in natural waters in both dissolved forms and associated with suspended particles.

During the study the concentration of arsenic found within the maximum concentration of arsenic was observed at site 4 with average value of 0.00135 mg/L (fig. 4) was observed at site 10 with average value of 0.00065mg/L.Arsenic contamination of ground water in different parts of world is an outcome of nature and/or anthropogenic sources, leading to adverse effects on human health & ecosystem. (2)As is major constituents of more than 200 minerals and the desorption and dissolution of naturally occurring arsenic bearing minerals and alluvial results in high concentration in ground water.

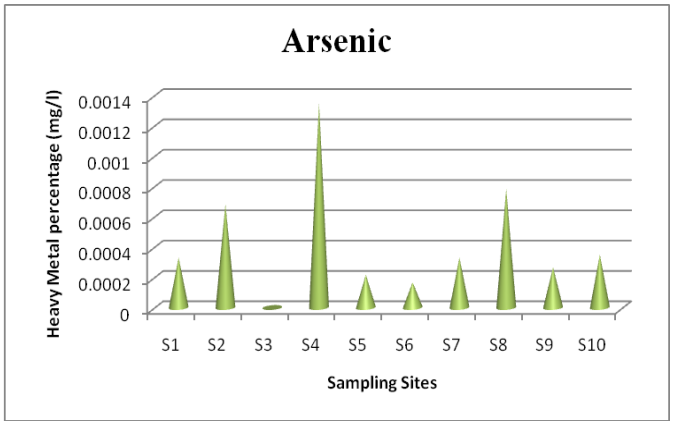

Fig 4: Graphical representation of Arsenic at different sampling sites

The maximum concentration of arsenic was observed at site 4 and the minimum value was observed at site S10. . Arsenic is a widely distributed metalloid, occurring in rock, soil, water and air. Inorganic arsenic is present in ground water used for drinking in several countries all over the world (e.g. Bangladesh, Chile and chain) where as organic arsenic compounds (such as arsenobetabaine) are primarily found in fish, which may pavers to human exposure. In organic arsenic is acutely toxic and intake of large quantities leads to gastrointestinal symptoms, severed disturbances of the cardiovascular and central nervous systems, and eventually delta [47].

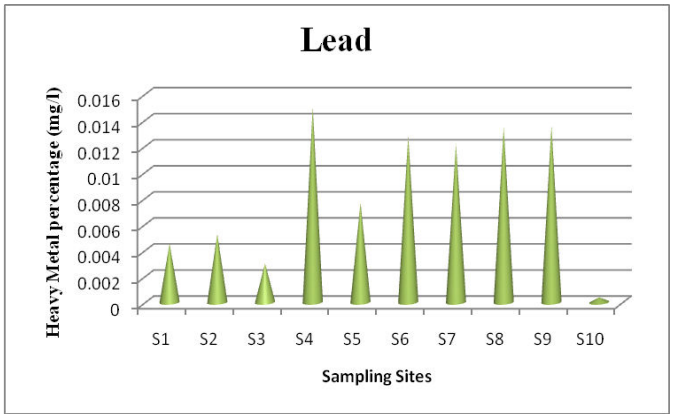

Fig 5: Graphical representation of Lead at different sampling sites.

Lead can enter drinking water when service pipes that contain lead corrode, especially where the water has high acidity or low mineral content that corrodes pipes and fixtures. The most common problem is with brass or chrome-plated brass faucets and fixtures with lead solder, from which significant amounts of lead can enter into the water, especially hot water.the amount of lead at all the sampling sites were observed with permissible limit. The maximum concentration of Pb mg/L was observed at site S4, with average value of 0.015mg/L while lowest concentration of lead was noticed at site S10 0.0048with average value of 0.000383g/L (Table 2). Lead is unlikely to be present in source water unless a specific source of contamination exists. However, lead has long been used in the plumbing materials and solder that are in contact with drinking water as it is transported from its source into homes. Lead leaches into tap water through the corrosion of plumbing materials that contain lead US Environmental Protection Agency, 2012). The greater the concentration of lead in drinking water and the greater amount of lead-contaminated drinking water consumed, the greater the exposure to lead (fig. 5).

4. CONCLUSION

The paper highlighted heavy metal contamination in drinking water from Morena. The study concluded that heavy metal in Morena drinking water is still under permissible limits. But in future the concentration may go up and will cause all the negative impacts on the residents if measures are not taken to control the dispersion of heavy metals into the ground water. The risk assessment studies are very limited for cities like Morena; heavy metal ingestion study in Morena is still limited. Risk assessment is important to be included in drinking water studies because it can be used to estimate the potential of adverse health effects in humans.

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