Assessment of potability of different water sources at Bhopal city

1 Jyoti Jotwani *, 2 Bharti Jain and 1 Suman Malik
1. Department of Chemistry, Sadhu Vaswani College, Bairagarh, Bhopal, M.P.
2. Department of Chemistry, Sarojini Naidu PG Girls College, Bhopal, M.P.
jotwani.jyoti@gmail.com
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ABSTRACT

Availability of safe and wholesome drinking water for all is one of the most significant challenges faced by the municipal authorities worldwide. Human settlements are urbanizing at a brisk pace and the availability of water for the masses bearing the desired water quality is becoming increasingly rare. The situation is more serious in developing nations where the population is very large and the water demand in the cities is always on a constant rise. India is a nation of vast resources and supports a huge population. The water supply in Indian cities has always been a problem with ever rising demands and shrinking availability. Due to the deficit in the water demand and supply, the quality of water being supplied is often neglected. Therefore, keeping a close vigil on the water quality of the water being supplied is essential to ascertain potability. Bhopal, the capital city of Madhya Pradesh depends on lentic water sources to cater its needs of potable water. Apart from the surface water sources a significant portion of the population also depends upon the groundwater for its potable water. The present paper deals with the assessment of water supply from different sources in Bhopal city.

1. Introduction

Bhopal, the capital city of Madhya Pradesh is a rapidly urbanizing city soon likely to gain the metropolitan status. The current population of the city is nearly 2 million which is on a steady rise due to improvement in the urban infrastructure, better livelihood opportunities and higher standard of living. The undulating terrain of the city is dotted with a large number of large numbers of lentic water bodies, which by and large supply the potable water to the city. According to the BMC’s calculations done in 2005-06, the city gets a supply of 266 million liter a day (MLD). The majority of Bhopal’s drinking water supply is met by two surface water sources: the Upper Lake and the Kolar reservoir. Besides, there are tubewells, handpumps and a few large diameter dugwells. Bhopal also has an unaccounted number of privately owned dugwells and borewells. Out of its total supply, the city gets about 135 MLD from Kolar, 99 MLD from the Upper Lake and 33 MLD from groundwater. Raw water from Kolar is pumped to a 154-MLD treatment plant by two long pipes, 36 km long. After treatment, the water is pumped to the service reservoirs. Thus, the piped water supply in the city covers about 67 % of the population; the rest have to depend on handpumps and private borewells. If we presume that of the total population in 2005, 100 people depended on each community tap and handpump in the city, about 35 % of Bhopal’s population could be said to be getting its daily supply from community taps and handpumps of this, 27 % might have community taps as their exclusive source. The supply of potable water to the entire city is a never ending battle as the population of the city is on a constant rise, but the resources bearing water quality of potable sources are fast shrinking. As a result the quality of the water being supplied is often neglected. The situation in Bhopal city is like many others on global
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1.1 billion people did not have access to an improved water supply in 2002, and 2.3 billion people suffered from diseases caused by contaminated water. Each year 1.8 million people die from diarrheal diseases, and 90% of these deaths are of children under five (WHO, 2004). Further there in no quality check on the groundwater quality as it is supplied and used without any treatment. This has resulted in health concerns of the residents of the Bhopal city, which has been the site of the worst environmental tragedy of the world. The present study has been designed to assess the potability of the water sources of the city of Bhopal. The objectives of the present study include:

1. To assess the water quality of treated water supplied from Upper Lake.
2. To assess the water quality of treated water supplied from Kolar Reservoir.
3. To assess the water quality of groundwater sources scattered all around the city.
4. To identify the sources of pollution/contamination of the water resources.
5. To suggest remedial measure for ensuring the potable water quality of the sources.

2. Materials and Methods

The present investigation is aimed at assessment of quality of water being used by the residents of the city of Bhopal for potable purposes. The sources of potable water in Bhopal include piped water supply from surface water sources and individual water sources i.e. groundwater. At the onset of the study a meticulous survey was carried out across the city to identify different zones of the city and to assess the water supply scenario therein. Sampling stations were then chosen so as to cover the maximum possible areas of the city. The criteria for choosing the sampling stations included:

1. Geographical location
2. Land use of the area
3. Demographics of the area
4. Groundwater status
5. Significance of area for the city.

Keeping the above points into consideration, following sampling stations were chosen for the study (Map- 1).

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Locality</th>
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<tbody>
<tr>
<td>1</td>
<td>One Tree Hills Bairagarh</td>
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<tr>
<td>2</td>
<td>Lalghati</td>
</tr>
<tr>
<td>3</td>
<td>Airport Road</td>
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<tr>
<td>4</td>
<td>New Market</td>
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<td>5</td>
<td>M.P. Nagar</td>
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<tr>
<td>6</td>
<td>Idgah Hills</td>
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<td>7</td>
<td>Koh-E-Fiza</td>
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<tr>
<td>8</td>
<td>Arera Colony</td>
</tr>
<tr>
<td>9</td>
<td>Nehru Nagar</td>
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<tr>
<td>10</td>
<td>Hoshangabad Road</td>
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<tr>
<td>6</td>
<td>Idgah Hills</td>
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<tr>
<td>7</td>
<td>Koh-E-Fiza</td>
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From each identified area one surface water supply sample and one groundwater sample were collected using standard sample collection techniques. The samples were then analyzed for the water quality indicating parameters. To take into account the seasonal variations in the water quality of the water sources and also to ensure the reproducibility of the results, samples were collected from the identified sampling stations in different seasons for a period of two years. Samples were collected in the summer, monsoon and winter seasons of two consecutive years for the present study. The results of the two yearlong studies were then compiled to assess the actual water quality of the potable water being supplied in the city.

3. Results and Discussion

Bhopal the capital city of Madhya Pradesh has always been known for its water resources, however the quality and quantity of the water resources of this city known for its water availability has been degrading with the rapid expansion and population explosion, much of which has taken place in past few decades. The present water sources of the city include surface water sources viz. the Upper Lake, Kolar reservoir and recently commissioned River Narmada water supply. The water from all the three sources is subjected to conventional treatment which involves removal of flocculation, physical filtration and disinfection, but during the present investigation, it was observed that the water reaching the consumers was not satisfying the required standards. One of the most significant threat that potable water faces is the presence of pathogens. During the present investigation coliform bacteria were found positive in few of the municipal water supply samples including S-4 (New market) and S-11(Vijay market, Barkheda) which recorded a maximum of 5 org/100 ml and 4 org/100 ml respectively (Figure 1). Lamka et al., (1980) have reported contamination of drinking water with coliform group of bacteria. They have also suggested that the number of contaminated samples increase substantially during the monsoon period. Similarly, Gogoi and Sharma (2013) reported high number of coliform bacteria in community pond water in Dibrugarh district of Assam. Consumption of such water may pose health threats. A closer look at the problem reveals that the pipelines in the city are broken at many places. At some places the pipeline seems to be broken due to wear and tear resulting from usage for a long time but at some places the breakage of the pipeline seems to be intentional. These points of breakages and leakage of the pipeline attract residents from the neighboring slums who fetch potable water from these leakages. Furthermore washing of clothes, washing of vehicles, dumping of solid waste etc. are observed commonly at these points. The open spaces near the leakage also have unhygienic condition with open defecation, cattle wallowing, disposal of solid waste etc. a common sight. All these factors contaminate the piped water supply resulting in pollution of drinking water. Thus, the study identifies a number of factors responsible for the pollution of municipal water supplies. Despite the untriring efforts to achieve the drinking water quality standards at after treatment, some consumers do not receive the water of desired quality as a result of these factors. The breakage of the pipeline...
not only contaminates water but also results in wastage of precious treated water. The water quality of the municipal water was found to be satisfactory at most of the instances, however on certain occasions, deteriorated water quality was observed in the municipal water supply as well.

Apart from the municipal water supplies, residents of Bhopal city also depend on the groundwater sources for potable water. The dependence on the groundwater sources is increasing with the rapid expansion in the city limits. As the laying of pipelines is not able to keep pace with the rate of urbanization, the new developing areas of the city depend by and large on the groundwater sources for potable water. Areas of Bhopal like Hoshangabad road, Kolar road, Raisen road, Airport road and many other colonies situated on the outer fringe of the city depend on groundwater. Groundwater is contained in the lower strata of ground and is therefore relatively away from direct human intervention. It is believed that pathogens also could not penetrate to the depths of the aquifer and therefore the groundwater is used for drinking purposes without any treatment. However, the results of present investigation reveal that the groundwater sources of Bhopal city are contaminated both chemically and biologically. High concentrations of calcium, magnesium and hardness were recorded in most of the sampling stations which included G-7, G-8, G-9, G-10, G-11 (Figure 2, 3 and 4). Calcium and magnesium are important parts of drinking water and are of both direct and indirect health significance. Calcium and magnesium concentrations in water have been linked to outcomes in heart diseases. There is epidemiological evidence to suggest a lower incidence of heart disease in communities with hard water (high calcium and magnesium content) (Maureen et al., 2012). Low magnesium status has been implicated in hypertension, coronary heart disease, type 2 diabetes mellitus and metabolic syndrome (WHO, 2011). Too high magnesium causes nausea, muscular weakness and paralysis in human body when it reaches a level of about 400 mg/l (Dorairaju et al., 2012). At high concentration, magnesium salts also have a laxative effect particularly when present as magnesium sulphate (Srivastava and Pandey, 2012). Jinwal et al., (2009), Ramkrishnan (2010) studied groundwater of Bhopal and found hardness in the range of 112-560 mg/l and 232-1990 mg/l. The concentrations of these parameters exceeded than the desirable limit as prescribed by the BIS at many instances. The prolonged consumption of such water can result in health implications. Water rich in calcium is known to cause joint pains, arteritis etc. and most of the groundwater samples studied in the present investigation recorded high concentrations of the parameter (IS 10500, 1995). Similarly, high concentrations of some heavy metals were also recorded in some of the groundwater samples.

The concentration of none of the heavy metals ever exceeded the desirable limit except Iron which exceeded the desirable limit at G-10 in April-10 (0.32 mg/l), Aug-10 (0.39 mg/l), April-11 (0.42 mg/l), Aug-11 (0.32 mg/l) and G-11 in April-10 (0.33 mg/l) and April-11 (0.34 mg/l). The shortage of iron causes a disease called “anemia” however prolonged consumption of drinking water with high concentration of iron may lead to liver diseases Mebrahtu and Zerabruk (2011). High level of iron may also results in nausea, vomiting, brain hemorrhage, anxiety, tension, cardiac arrest, metabolic disorder (Kaur and Mehra, 2012). With the use of groundwater on a rise, depletion in the groundwater table in the years to come is unavoidable. In such conditions when the availability of water will be less, the concentration of heavy metals is likely to increase due to concentration effect. Open sewage drains, open defecation on ground, disposal of solid waste etc. results in contamination of the surface runoff. This runoff when mixes into the groundwater contaminates it. Few samples of groundwater have been recorded positive for total as well as fecal coliform. Consumption of such water may result in immediate health implications. The present study to some extent

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breaks the myth that the groundwater is absolutely safe for drinking and could be used without treatment. Most of the parameters were recorded in higher range during the investigation suggest that proper treatment of groundwater is required before using it for drinking. Thus, it is evident from the study that the groundwater of the Bhopal city is contaminated due to many factors and it should not be used without proper treatment for drinking purposes.

5. Conclusion

The results of the present study reveal that the water quality at many places does not meet the required standards as per BIS requirements (IS 10050, 1995). The study identifies many factors for the degradation in the water quality of the water resources which include:

1. Breakage of pipelines at several places.
2. Washing of clothes near the pipelines/groundwater sources.
3. Washing of vehicles near broken pipeline/groundwater sources.
4. Open defecation near the pipelines/groundwater sources.
5. Cattle wallowing near pipelines/groundwater sources.
6. Disposal of solid waste near the pipeline/groundwater sources.
7. Flow of sewage in open drains.
8. Proximity of sewerage pipelines with drinking water pipeline/groundwater sources.
9. Leaching of inorganic minerals from soil/rocks.

5.1 Recommendations

The present study clearly indicates the health implications related to the potable water being used in the city of Bhopal. The city of Bhopal like most of the other larger cities in the country is facing the challenge of supplying safe and wholesome water to its residents. With the ever expanding city limits the challenge of water supply is increasing. However, some small measures can help in a long way to maintain safe and wholesome water supply to the residents of the city. Some of the recommendations for maintain safe water supply from surface as well as groundwater sources in Bhopal city are as follows:

1. Registration and regulated use of groundwater.
3. Maintenance of hygienic condition around groundwater sources.
4. Construction of cement platforms surrounding the groundwater abstraction sources.
5. Frequent chlorination of public groundwater sources.
6. Artificial recharge to augment the groundwater recharge.
7. Adoption of specific treatment process in case of absence of alternate.
8. Disinfection of groundwater Setup of decentralized treatment plants.
9. Laying of underground sewage system.
10. Scientific management and disposal of solid waste.
11. Avoid leakages in the pipelines of municipal water supply.
12. Regular public awareness campaigns to sensitize public.

Thus, a holistic approach of environmental management including all vital components like air, water and land shall go a long way in improving the overall health of environment in the city in general and potable water sources in particular.
6. References


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Figure 1: Sampling stations of the study area

Figure 1: Variations in Total Coliform
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Figure 2: Variation in calcium content

Figure 3: Variation in magnesium content

Figure 4: Variation in total hardness
Figure 5: Variation in Iron