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Rising Arsenic Level in Drinking Water: A Study of Schools and Local Areas of Multan, Pakistan

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ABSTRACT

Water is the basic need for the survival of all living organisms; however, its contamination has caused disastrous effects on human health. Almost 80% of the total population in Pakistan is forced to use unsafe drinking water due to the scarcity of clean water sources. To assess, the risk involved and to monitor the amount of Arsenic and bacterial growth in drinking water, water samples were collected from different government schools and underdeveloped areas of Multan, Pakistan. Moreover, water samples were collected by randomly visiting areas and were sent for laboratory analysis to determine and detect the arsenic amount along with other parameters including aesthetic, physical, chemical, and bacteriological growth. The results indicated that all the data collected from Govt. schools and developed locality were having a large amount of arsenic in drinking water. A huge amount of Coliform growth was found in the Peer colony water, which indicated a highly unhealthy intensity of pollutant water for the population residing in this area. Therefore, urgent and regular monitoring of drinking water in Multan was required to prevent such contamination.

Keywords: arsenic, coliform, health risk, water pollution, water scarcity

1. INTRODUCTION

Water holds the second most significant position after oxygen, which is essentially important for human survival. Therefore, water is an essential component of life not only for human beings but for all living organisms. In some living organisms, approximately 90% of the body weight consists of water. The majority of the world's population is suffering from water

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scarcity, due to unsafe and unsuitable water consumption, which has been regarded as a fundamental right for nations. As indicated in a study, the heart and brain mainly comprise almost 73% of water, whereas 83% of water is found in the lungs. Water plays a vital role in our body by maintaining the body temperature, functions as a shock absorber for sensitive parts of the body like the brain and spinal cord, which aids in the growth of body cells, forms saliva that helps in digestion, and maintains the moisture in the mucosal membrane. Various human activities have caused impurity and toxicity in water, which has resulted in water contamination, which is a leading health problem nowadays. Harmful metals, such as arsenic, iron, and cobalt are easily and excessively found in water. These metals have affected different organs of the body, such as kidney dysfunction, cancer, nervous system disorder, skin lesions, and immune and gastrointestinal disorders. According to a case study, almost five million children have lost their life because they were subjected to bad water consumption and toxic water intake [1].

In many areas, fecal matter is mixed with water due to poor sanitation systems and leakage of pipes in poorly developed areas. This contamination may worsen health problems, which may lead to serious health problems [2]. Different pathogenic bacteria are found in drinking water such as *Shigella sonnei*, *Salmonella enterica*, and other bacteria. These bacteria were chiefly disseminated by fecal excretion [3]. Coliform bacterium was found in the feces of warm-blooded animals, which cause severe disease when exposed to water [4].

However, Pakistan has faced water toxicity issues due to its poor sanitation systems. In some areas, these detrimental chemicals and pathogens have caused major health problems by putting massive people's life at stake. According to WHO and UNICEF, approximately 1.1 billion people worldwide are suffering due to the nonexistence of pure drinking water [5]. Many other water-borne diseases like hepatitis, diarrhea, and cryptosporidium are increasing rapidly due to the flawed sanitary system. As per Child Rights International Network, nearly 250,000 children have faced a high death rate, due to the high impurity and toxicity of drinking water [6]. In industrial areas of Pakistan, water gets contaminated when exposed to injurious chemicals. Furthermore, it was also identified that in underdeveloped areas of Pakistan, when drinking water is mixed with sewage water it caused many health issues even leading to death [7]. The

quantity of arsenic found in drinking water was quite high in secondary schools of Vehari (mostly ranging between 12.9µg/L-19.5µg/L), which predominantly affected the health of students [8]. Highly populated cities like Karachi, Lahore, Rawalpindi, and others face severe drinking water pollution due to human activities, rendering it unsuitable for consumption [9].

Many developing countries like Pakistan are facing the common issue of water scarcity. Pakistan has ranked as the 7th country, which faces water pollution and water scarcity problem. Exterior as well as interior water is contaminated with arsenic. Arsenic is a carcinogen that causes cancer [10]. Chlorination is an effective method to extract toxic chemicals and microbes from the water, making it suitable for drinking [11].

2. MATERIALS AND METHODS

The current study was conducted in different government schools and some local underdeveloped areas of Multan like Mumtazabad, Peer Colony, Chungi no. 8, Northern Bypass, and Ghanta Ghar Multan, to find out the amount of arsenic in the drinking water. The Environmental Protection Agency (EPA) has set the standard for arsenic in drinking water to be 10 micrograms per liter. This study considered all the physical, bacteriological, synthetic, and aesthetic analysis reports issued by the water quality laboratory in Multan to conduct further analysis.

2.1. Sample Collection

For this purpose, the researcher randomly visited government schools and collected water samples from the cooler, electric cooler, drinking water bottles, water fountains, and taps. Sterile 250mL plastic bottles were used for the sampling purpose. During collection of samples gloves were used by the collector. The bottles were filled up to 240mL leaving the headspace of the bottle, capped the bottles immediately, and delivered to the lab on the same day of their collection.

2.2. Bacterial Detection

For the detection of total coliform, fecal coliform, and E. coli petri, petrifilm calculation plates were used. Place Petrifilm EL plate on a leveled surface and lift the top to place 1ml of sample onto the center of the bottom film. Now release the top film and allow it to drop. Place the spreader on top of the film and gently apply pressure to distribute it evenly. Lift the

spreader and wait for one minute for the gel to solidify. Now incubate the petri film count plates on the clear side up at a temperature of 30°C for almost 48 hours. In, the end the bacterial colonies growing on petrifilm were identified with a magnifier.

2.3. Arsenic Test

Arsenic was analyzed in the drinking water samples by using a hydride generation atomic absorption spectrometer (HG-AAS). All samples were tested thrice for better results.

3. RESULTS AND DISCUSSION

Drinking water samples from different schools identified a high level of arsenic (15µg/l-75µg/l). None of the selected schools' arsenic level in drinking water was normal. The graph given below presented a level of arsenic in school water available for school children.

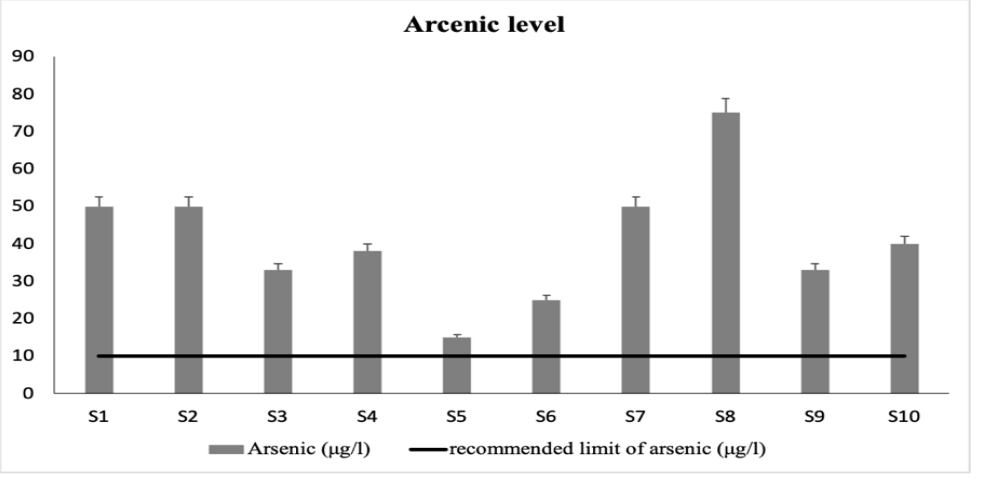

Figure 1. Arsenic Level in Drinking Water of Different Schools

The first step was to collect samples from different schools located in different areas of Multan. The above graph presents the level of arsenic in different schools. The schools are presented with symbols and numbers from S1-S10. According to the results sample collected from S5 indicated arsenic 15µg/l, which is the lowest value as compared to other samples collected, however, they were still unsafe to drink. The highest value of arsenic was evaluated in S8 School with 70µg/l. These values of arsenic

were also informed in schools and later schools set up filter water for children.

A direct link between drinking water and health was noticed in the samples. The consumption of arsenic in drinking water can lead to various problems like skin diseases, stomach diseases, and cancers. Also, in order to check the concentration of arsenic in water, its distribution was also analyzed across different locations in Multan City.

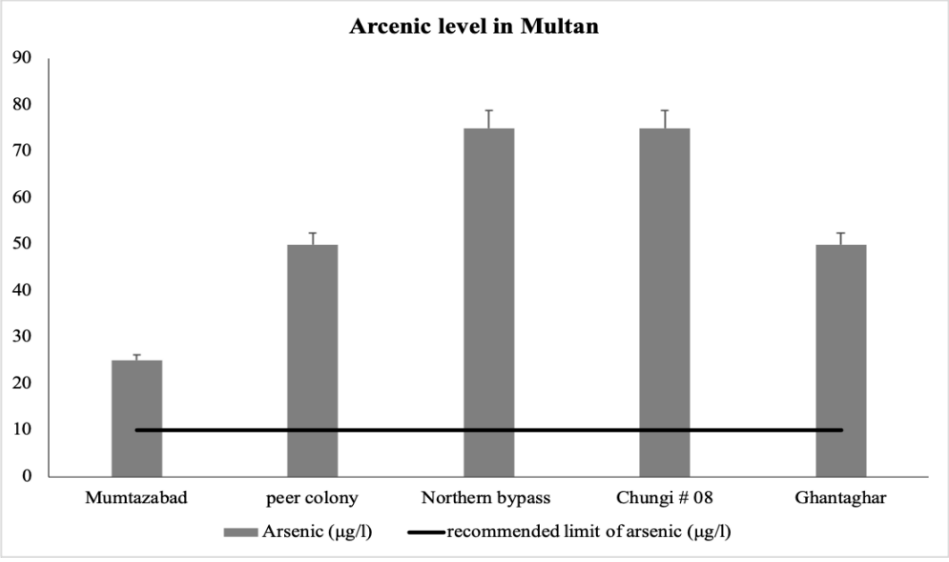

Figure 2. Arsenic Data in Drinking Water of Different Locations in Multan

The above graph presents arsenic values tested from the water samples collected from different areas of the Multan, Pakistan. These areas were selected randomly. The lowest level of arsenic found in selected areas was Mumtazabad with 25µg/l and highest value in areas Northern Bypass and Chungi no.8 with 75µg/l. However, even the lowest value found in Mumtazabad water was still high to consume. The other two areas Ghanta Ghar and Peer colony both were found with 50µg/l arsenic in drinking water. The presence of arsenic in these areas can be due to high amount present in the ground water plus the rusting of pipes and the contamination of water due to high industrialization in these areas. A small survey was also conducted related to different skin, eyes, kidney, stomach, and other diseases in order to recognize conditions of people using this water. This

area according to our small survey indicated people with skin, stomach diseases, and eyes issues each house. Although detail planning and data collection is required to find the complete detail of types of skin, stomach, and eyes diseases related to arsenic in water. All the data collected was depicted in the graphs to determine the purity of water. In drinking water supplies, arsenic is a significant problem because of its toxicity. In this research, the aesthetic, physical, chemical, and bacteriological analysis reports were incorporated, which were issued by the water laboratory, Multan, Pakistan.

According to previous research, arsenic was calculated (0->50µg/l) in 2005 Multan City, while [12] the updated data of 2022 presented the maximum value calculated of arsenic in the Multan, which is 75µg/l. There are limitations applied here but still it gave us an idea about the increase of arsenic level in the city water from 2005-2022, which is an alarming situation.

There is another issue of bacterial colonies in the drinking water. Various samples from different areas of Multan for *E. coli* and Coliform bacterial colonies were tested. None of the water was found with disease causing bacteria except Peer colony water. The petri film was observed very carefully and was found with colonies of total coliform. Five colonies were found countable, while others were not in range of counting due to the presence on gridline and out of the circle. The coliform bacteria present in the water sample of Peer colony was further evaluated for the presence of fecal coliform. Peer colony was found with 2 colonies of fecal coliform. These results were evaluated thrice and calculated as per ml of sample and the presented colony numbers are the mean of all results. The results presented in Table 1 indicates absence of *E. coli* and presence of coliform bacteria with specifically indication of some colonies of fecal coliform bacteria. Such type of bacteria was hazardous for human health. This presence opens a new research study to be setup in Peer colony. The presence of total coliform and fecal coliform bacteria in water indicated risk of contracting a water borne illness increase in this area. There are other publications which have presented a high percentage of arsenic in Multan but no specific areas were mentioned that can be compared with future studies [13]. In parallel, another ongoing study sheds light on arsenic levels, underscoring groundwater contamination and echoing our findings of elevated concentrations. Together, these revelations emphasize an

immediate call for proactive mitigation strategies to address arsenic contamination in Sindh's water sources. Elevated levels, influenced by natural processes and human activities, exceed WHO limits, necessitating urgent action to mitigate health risks and ensure the safety of the water supply [14, 15].

Table 1. Identification of Bacterial Colonies in the Water of Peer Colony Houses (Per Sample)

Sr No.	Water Quality Parameters	Heights Desirable Level	Result
1	Total Coliform	0/100 ml (PSQCA)	5
2	Fecal Coliform	0/100 ml (PSQCA)	2
3	E. coli	Negative	Negative

A prior study conducted on the localized areas of Multan presented no signs of coliform bacteria, however, this study found the presence of total coliform and fecal coliform in Multan city from every one out of five areas of the collected samples. This difference can be due to the area selection or it can be due to clean water present in 2005. After the positive result of peer colony bacterial contamination, there should be a selection of many more areas to confirm other species and chemicals present in the water.

3.1. Conclusion

The current study identified that in many cases, groundwater was found to be polluted with high amounts of arsenic, which has caused major health issues, especially in young children and adults. Notably, if groundwater is recharged directly from the land surface, which has a historical association with industrial usage or the disposal waste, there exists a significant risk of high arsenic concentrations in the groundwater. For this purpose, new technologies for purification should be developed to achieve high quality drinking water to avoid any future health disasters and exposure due to the toxic elements present in the drinking water. Hence, it was identified that Multan water still requires an extensive study with large study samples to cover major external and internal factors in order to find specific areas where arsenic level is high, which should be considered serious for health issues.

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