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Microbiological Analysis of Drinking Water from Different Areas of Lahore

Imran Khan,[1] Saima Mohsin[2*]

[1]Pakistan standard and quality control authority, Karachi, Pakistan
[2]Dr. Panjwani Center for Molecular Medicine and Drug Research, University of Karachi, Pakistan

*Email: saimamohsin@hotmail.com

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Abstract: Access to safe drinking water and its regular monitoring is essential to ensure the health and safety of the public. This study aimed to analyze the microbiological quality of drinking water supplies (filtered and unfiltered) from various towns of Lahore, Pakistan. In total, 135 water samples, with and without filtration (n=90) and additional 45 bottled drinking water samples of different brands from the local market were collected from 9 towns of Lahore. To determine the microbiological quality, all samples were subjected to total plate count, total coliform, *E. coli*, *Streptococci* and *Salmonella* detection. According to the findings, the total plate count from various water supplies was significantly higher as compared to bottled drinking water samples. Drinking water from supplies with filtration and without filtration was found to be contaminated with total coliform (51%), *E. coli* (51%) and total coliform (84.5%), *E. coli* (84.5%), faecal *Streptococci* (15.5%), and *Salmonella* (11.1%) respectively. In total, 22 (49%) of the filtered and 7 (15.5%) of the unfiltered water samples were found to be microbiologically safe for drinking, whereas 41 (91.1%) bottled drinking water samples met the WHO criteria. To summarize, bottled drinking water is safer than both filtered and unfiltered drinking water. However, all bottled water should not be assumed to be safe for use. The microbial contamination in drinking water supplies, as well as bottled water samples, insinuates for strict monitoring of drinking water by regulatory authorities, and immediate action is required to avoid public health hazards.

Keywords: Drinking water, microbiological parameters, Lahore, *Salmonella,* faecal *Streptococci.*

Introduction

Water is vital for life and the major constituent of the human body. Safe drinking water must be available to all human beings in the world. According to the WHO, safe drinking water must not contain any negative health effects and be beneficial for human life. Due to the increasing rate of the global population, deforestation and land degradation ultimately exert a huge impact on the limited water resources and are expected to further decline by 2025 in two-third of countries (Kamble et al., 2020; Mohsin et al., 2013; World Health Organization, 2017). Only 20% of Pakistan's population has an access to safe drinking water while the rest of the public is using unsafe drinking water (Daud et al., 2017). The PCRWR in June 2007 issued its fifth technical report under the project National Water Quality Monitoring Programme (NWQL-2005-06). According to this study, a total of 357 water samples were collected and assessed from all over the country according to the WHO guidelines and Pakistan Standards Quality Control Authority standards (PSQCA). Sixteen locations of Punjab were targeted and the results showed that 50% of the water samples were not safe for drinking purpose due to bacterial contamination (Kahlown et al., 2005). It is also the main route of disease transmission is the drinking water contaminated with human or animal excreta. Moreover, poor personal hygiene is also a contributing factor, for instance, contamination of hands, foods, utensils, or clothing increase the likelihood of infection (Watto et al., 2021; WHO, 2017). However, several other reasons are also causing contamination in drinking water supplies, such as pesticides, dyeing, industrialization, use of heavy metals, chemicals, and nitrogen-based fertilizers (Mohammad et al., 1997; Tahir and Bhatti, 1994).

Water borne infections account for roughly 40% of all ailments in Pakistan, while water borne diseases account for 20–40% of hospitalizations (Ahmad et al., 2020). In both urban and rural parts of Pakistan, lack of potable water is a major concern (Deeba et al., 2019). The inappropriate distribution networks, increased industrialization, lack of chlorination, poor waste management infrastructure, and insufficient monitoring of the quality of water in treatment plants are the main reasons for contamination in drinking water resources (Daud et al., 2017). Several studies have been conducted in the same connection, in various locations of Pakistan (Ahmed et al., 2015; Ali et al., 2011; Baig et al., 2012; Farooq et al., 2008; Hashmi et al., 2011; Shahid et al., 2015). Present study was conducted to highlight the microbiological quality of drinking water in the city of Lahore. In addition, drinking water of public supplies with filtration and without filtration were also examined. It will help us to determine the effectiveness of public filtration plants of drinking water supplies installed in various areas of Lahore, Pakistan.

Materials and Methods

A total of 135 drinking water samples were analyzed

from various places of Lahore i.e. Gulberg town, Iqbal town, Samanabad town, Wagha town, Dathaganjbaksh town, shalimar town, Aziz Bhatti town, Nishther town, and Ravi town, in which public water supplies with filtration (n=45) and without filtration (n=45) were collected in sterilized disposable water bottles with 200-500 ml capacity. Each bottle was checked for any physical defects before sampling to prevent leakage (Total samples =90). An additional 45 water samples of different brands of sealed bottles from the local market were also collected to compare the quality. The samples were then transported in iceboxes within 2 h of sampling to the laboratory.

Microbiological Analysis of Water

Water samples were analyzed in the laboratory under standard conditions to detect the microbial load by using different methods: Total plate count (TPC), total coliform count, and detection of specific bacteria; such as *Escherichia coli*, faecal *Streptococci*, and *Salmonella* species. The total plate count and faecal coliform count test were performed by Most Probable Number (MPN) technique since this test is used to estimate the viable bacterial count in a water sample (Bartram and Balance, 1996; APHA, 2017). The presence of *Salmonella* was detected by the standard protocol described by McLandsborough (2005). For confirming the growth of faecal *Streptococci*, sub-culture on bile aesculin azide agar. The Petri plates were incubated at 37º C for 24-48 hours and the presence of typical black color colonies confirm the presence of faecal *Streptococci*. The identification of bacterial species was performed by colony morphology, Gram's staining and biochemical reactions. Biochemical tests used were catalase, coagulase, sulfide indole motility test, IMVIC tests (Indole, Methyl red, Voges Proskauer test, citrate medium, and triple sugar iron agar) (TSI) (Senior, 1996).

Results and Discussion

Public Supply Water

TPC, coliform count, *E. coli*, *Salmonella* and faecal *Streptococci* analysis were performed in filtered public supply water samples. In total, 45 filtered water samples were collected, 5 from each town. It wwas found TPC of all samples less than 500 CFU/ml. Growth of *E. coli* and coliform were detected in 23 samples with no growth of *Salmonella* and faecal *Streptococci* according to WHO criteria. The Iqbal and Gulberg town had the highest proportion of water samples that were confirmed to be safe to drink (80%), followed by Dathaganjbaksh and Shalimar town (60%), then by Aziz Bhatti town, Samanabad town, and Wagha town (40%). Nishther and Ravi had the worst fitness condition among all towns, with a fitness level of one water sample (20%) (Fig. 1). Overall, 22 (49%) of the samples were suitable for consumption while 23 (51%) samples were not fit for drinking.

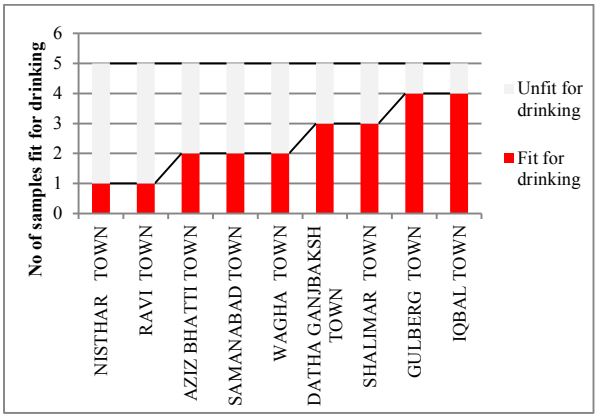

Fig. 1 Townwise comparison of filtered public supplies water.

Public Supply Water Without Filtration

A total of 45 water samples (unfiltered) were obtained, with 5 samples collected from each town of Lahore city. In 3 samples from Aziz colony Ravi town, Kotlakhpth Gulberg town, and Chah Miran Shalimar town, we found a TPC range greater than 500 CFU/ml. *E. coli* and coliform were found in 38 samples (84.5%). *Salmonella* and faecal *Streptococci* was found in 4 Aziz colony Ravi town, Kotlakhpth Gulberg town, Chah Miran Shalimar town, and Shahdra town Ravi town, and 7 samples respectively Aziz colony Ravi town, Kotlakhpth Gulberg town, Chah Miran Shalimar town, Shahdra town Ravi town, Jia Musa Ravi town, Shahdra station Ravi town, and Qilagujarsingh Dathaganjbaksh town.

Gulberg town and Iqbal town showed the good quality of water with 3 samples and 2 samples respectively. Wagha town and Samanabad town with 1 sample of water was found to be fit for drinking. In contrast, highly contaminated drinking water we found in Dathaganjbaksh town, Shalimar town, Aziz Bhatti town, Nishther town, and Ravi town. The fitness status of the drinking water was evaluated concerning WHO criteria. In total, 7 of the unfiltered water samples were found to be safe for drinking while 38 of the samples were unsafe which is a comparatively high and alarming situation (Fig. 2). A similar study conducted in the district of Punjab, Vehari, reported the presence of *E. coli* and coliforms in drinking water where the area's water quality was also not in compliance with WHO guidelines (Khalid et al., 2018). The previous studies indicated a high bacterial count in drinking water, particularly at Punjab University, where a count of 1066/0.5 ml of drinking water was found (Zameer et al., 2015). Furthermore, 71% of the water supply schemes were found to be contaminated with fecal coliform bacteria, accounting for 30 percent of bacteriological contamination in drinking water samples of Mianwali, Punjab (Akhtar et al., 2019). As far as our study is concerned, 84.5% of samples were

contaminated with *E. coli* and coliform, indicating that drinking water supplies for the public are not satisfactory and the quality is deteriorating over time. According to these findings, drinking water samples from various locations of Punjab were found to be unfit for human consumption and these results are in concordance with prior reports in the province, Punjab (Shahid et al., 2015). It is suggested that regular monitoring of water samples should be done to determine the bacterial load and the control of water-borne diseases. The current findings demonstrate that the drinking water distribution infrastructure is gradually deteriorating in Lahore.

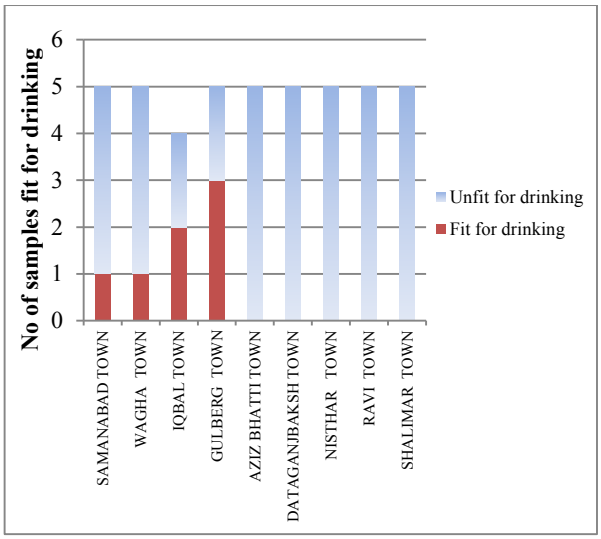

Fig. 2 Townwise Comparison of Public supply water (without filtration).

Out of 90 water samples (filtered and unfiltered), 29 samples were found to be fit for drinking, with 22 being filtered and 7 being non-filtered water. In terms of unfit water, we found 61 samples of which 23 samples were with filtration and 38 samples were without filtration. The overall performance of filtration plants was found to be less than 50% in controlling the microbial load in drinking water. According to previous studies, only 1 out of the 14 water-filtration plants was functioning properly and meeting the national standards (Ahmed et al., 2020). In this study, 40% (unfiltered water) and 80% (filtered water) in Gulberg town were found to be safe to consume. Similar results were found in Iqbal town, indicating that the filtration plant improves the microbiological quality of water by 50% but does not provide 100% protection, and this can be misleading.

Bottled Drinking Water Samples

Total coliform and E. coli were detected in unfit water samples (8.8%) but the percentage of contamination was less than water samples of public supplies. TPC was less than 100 CFU /ml in all samples, indicating that TPC levels can be decreased to a significant level if water is adequately filtered and treated. No growth of *Salmonella* and faecal *Streptococci* was found in any bottled drinking water. Overall, 41 samples were microbiologically fit for human consumption, and 4 samples were unfit in terms of WHO criteria. However, there is a huge difference in the water quality as bottled water was processed with filtration and disinfectants and there are no such treatment steps for public water supplies. The bacterial count can be controlled, if the drinking water is properly filtered and treated like bottled water. It is common to observe water coolers in public places whether commercial or domestic, without sufficient maintenance and filter change, which is one of the leading causes of waterborne diseases. It is suggested to evaluate the microbiological quality of drinking water at regular intervals and consideration should be given to its maintenance following installation. Drinking water samples were found to be contaminated with indicator organisms in counts exceeding the WHO criteria. Bacterial contamination of drinking water supplies is mostly caused by a faulty water supply system and cross-contamination of water distribution pipelines with sewage supplies. However, microbiological contamination varies in different places of the country, mainly due to maintenance levels of the water distribution systems. The effectiveness of the disinfection process, prolong use of filters, breakages and leaks in the supply system and different reservoirs of water.

Conclusion

Microbiological studies revealed that 51%, 85%, and 8% water samples taken from filtered, unfiltered, and bottled water supplies respectively were found unfit for drinking purpose. Steps should taken to maintain the water distribution system and ensure the chlorination of drinking water as per national/international standards. Proper attention should also be given to check cross-contamination of sewerage supplies with drinking water sources.

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