Original Article

Bacteriological Analysis of Drinking Water from Different Regions of Karachi from February 2016 to August 2016

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Abstract

There is the various disease which is caused by contaminated water. Unfortunately, only 40-60% Pakistani population has access to safe water. This raises a serious issue to perform bacteriological analysis of drinking water. Although such analysis was carried on by some laboratories but the method or techniques adopted were very old and also there is no database to evaluate the actual figure. The study was cross-sectional. In the present study, the bacteriological quality of the drinking water supply was analyzed. Different districts of Karachi were selected for the study. The quality of drinking water in both rural and urban areas is not properly accomplished resulting in a higher occurrence rate of water-borne diseases. Pathogenic organisms cause water-borne diseases. Water samples from four different districts were collected. A total of 115 water samples were assessed for bacteriological contamination. The result showed that 55 out of 115 (47.8%) did not comply with the World Health Organization(WHO) standard guidelines for drinking water. Escherichia coli was identified among 23 out of 55 samples (41.8%) and overall coliform organisms were grown from 63.3%. It is a matter of great concern that 47.8% of samples were sub-standard and unsatisfactory to be consumed by humans. It requires serious strategies to cope up with the issue.

Keywords: Contamination, Pathogenic, Escherichia coli, Drinking water, Karachi

Introduction

Water is an essential element for the survival of human beings [1, 2]. Safe and pure water is the most essential element for life but unfortunately, the limited number of people in developing countries have access to clean water leading to the occurrence of waterborne diseases like diarrhea, typhoid, and cholera [3]. Globally, basic sanitation is not accessible to2.-4 billion people, which leads to serious water and sanitation-related diseases [4]. In developing countries like Pakistan majority of all illnesses are caused by contaminated water with diarrhea being the leading cause of childhood deaths [5]. A USAID (United States Agency for International Development) report states that 2 million children under age five die of diarrhea-related diseases every year and an estimated 250,000 child deaths occur each year because of water-borne diseases. Water-borne diseases are widespread in the country imposing significant economic losses [6]. The present study focused on an objective to evaluate the drinking water quality from different regions of Karachi and to emphasize the preventive measures and the necessary steps to be taken at the grass-root level to avoid these issues.

According to a study by UNICEF (United Nations International Children's Emergency Fund), patients suffering from water-borne diseases occupy20-40% of hospital beds in Pakistan, which contribute to other illnesses. Safe water alone can reduce diarrhea and other related diseases up to 50%. It is a real fact that unluckily poor attention has been given to water quality and the country also lacks well-equipped labs and surveillance programs. Lack of public awareness about the quality of water further aggravates the situation [7]. World Health Organization recommends that drinking water should be free from coliform bacteria, fecal coliform, enterococci, *E-coli (Escherichia coli*), and *Pseudomonas aeruginosa* and must have <20 Colony-forming unit/ml(CFU/ml) heterotrophic bacterial count. The coliform bacteria presence may not necessarily indicate fecal contamination but it may have the potential for the presence of pathogenic enteric microorganisms. *Pseudomonas aeruginosa* may cause respiratory tract infections and urinary tract infections in

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immunocompromised patients as illustrated [8].

Kosek M in 2003 studied that the elementary source of providing water is groundwater supply in the majority of the cities of Pakistan [9]. It contains various pathogens which include many protozoan agents, bacterial, and viral, which causes 2.5 million deaths from the endemic diarrheal disease each year. The most popular method for disinfecting drinking water in the sanitation system and at the treatment plant is Chlorination [10].

Water supply in Pakistan is managed through either piped networks or hand pumps. According to Global Water Partnership, Draft South Asia - Water Vision 2025, Country Report – Pakistan 2000 an estimated30% of all diseases and 40% of all deaths are because of poor water quality in Pakistan. The Draft South Asia–water vision 2025, Country Report, Pakistan [11] published in 2000 showed that among Children and infants diarrhea, a waterborne disease considered as the main cause of death, on the other hand, every fifth citizen become the victim of disease and illness, which are caused by the polluted water [6]. One of the reasons for this scenario as illustrated by Aziz J.A. 2002 that toxic chemicals discharged from industries and urban communities without any treatment into water bodies depreciate the quality of water and develop adverse effects on human beings [12]. Unfortunately, not a lot of attention was paid to issues of drinking-water quality and the priority focuses on the agencies for water supply become quantity rather than quality. Very little importance is being given to monitoring drinking-water quality and surveillance in the country. The other contributing factors that further aggravate the scenario are fragile institutional arrangements, being short of well-equipped laboratories, and the lack of a legal framework for the issues of drinking-water quality. Despite these, warily there is a lack of public awareness regarding the issue of water quality [13]. As a result, cities that were majorly affected by outbreaks of waterborne epidemics in 2006 were Karachi, Lahore, Faisalabad, and Peshawar and the provision of sanitation rises from 38% to 54% between 1990-2002 [14].

Aim of the Study

The current study was done intending to assess the quality of drinking water from different regions of Karachi for bacterial contamination from February 2016 to August 2016 and to emphasize the preventive measures and the necessary steps to be taken at the grass-root level.

Materials and Methods

Collection of Samples

115 water samples were collected from different districts of Karachi. The main source of water suppliers is the Hub water supply system of KWSB (Karachi water and sewerage board). From February to August 2016 samples were collected randomly and immediately transported to the laboratory and processed within two hours.

Processing of Sample

According to WHO (World Health Organization) and Pakistan Standard procedure, the collected samples of water were analyzed for the following parameters [15]:

Physical appearance: Physical Appearance of all water samples were analyzed either clear or being contaminated.

Determination of pH and Turbidity: Both these parameters are tested to check the quality of disinfection in the water sample. According to WHO guidelines the pH must be less than 8.5 and turbidity must be less than 0.5 NTU [16] (Nephelometric Turbidity Units).

Determination of Hardness and Total Dissolved Solids (TDS, Total dissolved salt): As it is necessary to balance the hardness and TDS as too much hardness result in high consumption of soap in household chores while high TDS has an impact on the taste of water. Therefore, we check these chemical parameters [16].

Bacteriological Analysis

1. Total Viable Count: A sample of 10 µl water spread on MacConkey agar medium(Sigma) with sterile spreader and incubated at 37ºC and 22ºC for 24 hours and colonies were counted after completion of the incubation period.
2. Identification of Coliform Bacteria: The membrane filtration technique was used to isolate coliform bacteria. Samples of drinking water were filtered through a 0.45 µm pore size Millipore membrane filter which is then placed on CHROM agar surface and incubated at 37ºC for 18 to 24 hours (Thermofisher™). Then diagnostic tests like TSI (Triple sugar Iron), Citrate test were performed to get the differential results for the presence of coliform bacteria by the formation of acid or gas.
3. Identification of ***Escherichia coli (E-coli)***: The purple-colored colonies of *E.Coli* were sub-cultured on MacConkey agar medium and identified based on Gram staining and biochemical profile. They were found oxidase negative, indole positive and beta-glucuronidase, and lactose fermenting.

Results and Discussion

Karachi is considered a highly populated and urbanized city of Pakistan where water is supplied through primarily groundwater supply which makes it essential to analyze the quality of drinking water. In the present study, we take samples of drinking water from different localities of Karachi as mentioned in **Table 1** to check their compliance with the standard guidelines **(Table 2)**.

Table 1. Districts of Karachi and areas of sampling.

Districts	Location	No. of Samples
Central	Nazimabad	32

East	Gulshan-e- Iqbal,Ferozabad	27
West	Orangi Town	13
South	Garden	12
Malir	Bin Qasim	15
Korangi	Landhi	16

Table 2. Standards for Quality Drinking Water in Pakistan concerning WHO guidelines, 2004.

Properties /Parameters	Who Guidelines
Bacterial:	
All water intended for drinking (e.Coli or Thermotolerant Coliform bacteria)	Must not be detectable in any 100 ml sample
Treated water entering the distribution system (E.Coli or thermotolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml sample
Treated water in the distribution system (E.coli or thermotolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml sample In case of large supplies, where sufficient samples are examined, must not be present in 95% of the samples taken throughout any 12 months.
Physical & Chemical:	
Colour	≤15 TCU
Taste	Non-objectionable/Accept able
Odour	Non-objectionable/Accept able
Turbidity	‹ 0.5 NTU
Total hardness as CaCO3	---
pH	6.5 – 8.5

We collected 115 samples and alarmingly 55 out of 115 (47.8%) did not comply with the WHO standard guidelines for drinking water and this aspect could not be ignored. At 37ºC TVPC (Total viable plate count) is higher than the normal recommended range i.e.<20 CFU/ml. One set is incubated at 22ºC for 24 hours and another set is incubated at 37ºC for 24 hours. The presence of heterogenic bacteria indicated the pollution of water. Polluted water is responsible for various water-borne diseases in the country. Actual data of these diseases could not quantify due to a lack of regular record maintenance both at the local and national levels. According to Draft South Asia–water vision 2025, Country Report, of Pakistan 2002 most prevalent water-borne diseases in Pakistan include cholera, typhoid, hepatitis, and dysentery with rare cases of methemoglobinaemia, dental fluorosis, and skin problems [17].

Among 55 non-complied samples, 10 samples showed higher TVPC only, 20 samples showed TVPC related to *Pseudomonas aeruginosa* and the remaining 15 showed TVPC associated coliform, *E-coli*, and *Pseudomonas aeruginosa* **(Figure 1)**.

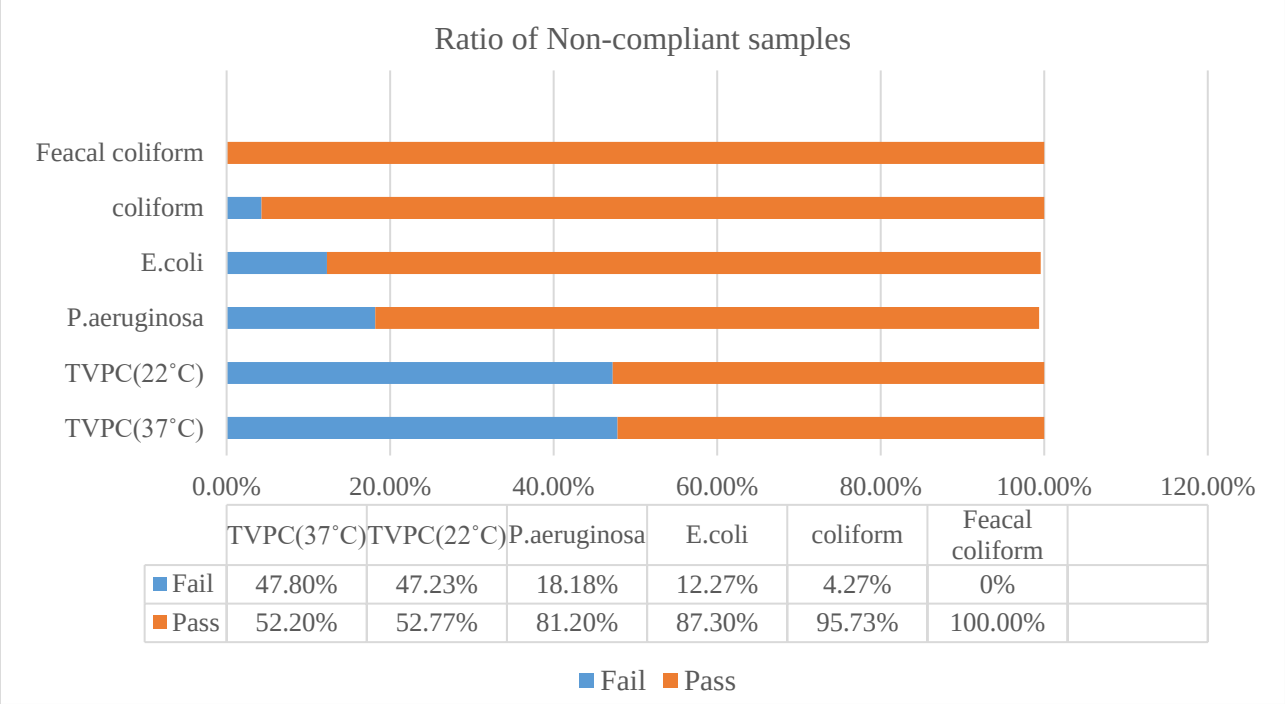

Figure 1. Pass and Fail ratio on the basis of TVPC.

It is a matter of great concern that E-coli was found in almost 13%of the sample with 5% of coliform bacteria that is an indication of fecal contamination. This not only indicates the presence of pathogenic enteric micro-organisms but also raises queries about channels of transportation and required management strategy along with various barriers of protection from supply point to the area of use to prevent public health problems.

The presence of *Pseudomonas aeruginosa* (18.18%) in 20 samples is also alarming. The TVPC for *Pseudomonas aeruginosa* is also higher that could be due to its resistance against various disinfectants and due to the long survival rate in a low nutrient environment [18].

The results also focus on the requirement of proper legislation to establish and implement standard guidelines not only for developing sources of drinking water but also for safe water supply distribution. There is a lack of surveillance teams or agencies at the governmental level that should monitor the quality of drinking water on a need basis according to WHO guidelines [13].

Major and mutual interventions are required at the district and tehsil level to maintain the quality of drinking water up to standard. This could involve technical assistance plus a highly equipped lab and special water treatment facilities along with the qualified staff.

It is evident from the present study that drinking water quality in Karachi is not according to WHO standard and found to be unsatisfactory to be consumed by humans. This could pose a serious health risk for the general public.

Conclusion

There is a strong need for management strategy along with the development of a proper database to establish drinking water quality standards. It required the contribution of all stakeholders and raising public awareness at all levels regarding issues of the quality of drinking water.

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