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Research Article

Seasonal Variation of Water Quality Drawn Directly from the Lahore Aquifer

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Abstract: Water contaminated with pathogenic micro-organisms is a serious threat to human health, particularly in some developing countries. This study was designed to evaluate the quality of water used at the Shaukat Khanum Memorial Cancer Hospital in Lahore, Pakistan. Water samples collected from bore-holes sunk directly into the aquifer and at selected sites around the hospital were analysed for total viable count, coliforms, faecal coliforms and *Escherichia coli* using standard methods. Overall, the water quality was good but during the monsoon an increase in microbial contamination was observed. Although microbial contamination levels did increase the aquifer seemed to undergo natural restoration during the rest of the year.
Keywords: Drinking water, Water quality, Microbial contamination, Pakistan

INTRODUCTION

High quality, potable water is a fundamental requirement for human health and survival and increasing demands on water are creating many problems. A large portion of the population in developing countries suffer from health problems associated with either lack of drinking water or due to the presence of microbiological contamination in water[1]. The problem is further aggravated by a rapidly increasing population which results in poor water-quality management[2]. With a population of 130 million people, Pakistan is one of the largest nations to depend on a single river system. The water from the Indus River and its tributaries supplies most of the water needed for agriculture. As an added bonus, dams constructed on the main stem of the Indus River and its tributaries produce most of the electrical energy for Pakistan.

The Indus River originates in the Karakoram, Hindukush, and Himalayan regions along the north and northeastern borders of Pakistan. The river and its major tributaries descend south towards the Arabian Sea, discharging a combined annual average volume of 178 billion cubic metres into the Indus plains. The Indus system of rivers forms a link between two great natural reservoirs: the snow and glaciers in the mountains and the groundwater contained by the alluvium in the Indus Plains of the Punjab and Sindh Provinces[3].

The Indus River and its tributaries provide nearly 60% of the water utilized for irrigation. Most of the remainder is supplied by groundwater that is derived from basin streams. The Indus River is also the main source of domestic and industrial water at both the city and the village levels. Lahore, the second largest city in Pakistan, is located on the banks of the Ravi tributary and sits on top of an aquifer. The aquifer is composed of unconsolidated alluvial sediments, including sand, silt, and clay, and is recharged by winter rainfall[4]. Although the Ravi River (Figure 1) and canal run through most of the city and are used both by humans and animals for swimming, bathing, and washing, much of the city's drinking water is extracted from the aquifer. Recently, rapid growth in population, industrialisation, and urbanisation has increased demand and potentially increased contamination of the aquifer[5-11].

The ShaukatKhanum Memorial Cancer Hospital is located on the outskirts of Lahore and draws its water supply directly from the aquifer. The water is stored in a water tower (Figure 2), where it is chlorinated before distribution throughout the hospital and to onsite residences. Water from a number of boreholes that are sunk directly into the aquifer is used to water the hospital gardens.

METHODOLOGY

Each month, water samples were collected from the water tower, selected taps around the hospital, and from the boreholes in the aquifer. At each

collection, the taps were sterilized by a small spirit burner, which were then allowed to cool. A sterile specimen container was used to collect 150 mL of water. These were then assigned a specific code number and sent to the microbiology laboratory for processing. A total viable count (TVC) of microorganisms was carried out at both 30°C and 37°C. Rarely, the water sample had to be diluted to enable a count to be carried out. The TVC was reported as colony forming units (cfu)/mL. The test for coliforms was the standard MPN (most probable number) method where a series of fermentation tubes containing lauryl tryptose broth were inoculated with varying amounts of the water sample and incubated for 24 hours at 35°C. Each fermentation tube contained an inverted tube to trap gases produced by any coliform bacteria present in the sample. After 24 hours, the fermentation tubes were examined for gas production. If there was no gas production, the samples were incubated for another 24 hours and re-examined. Gas production after 48 hours was considered a positive result, indicating the presence of coliform bacteria. A confirmatory test for faecal coliform bacteria was then performed. For this confirmatory test, material from the fermentation tube was transferred with a sterile loop to a fresh fermentation tube and incubated in a water bath at 44.5°C for 24 hours. Gas production in the fermentation tube after 24 hours was considered a positive reaction, indicating the presence of faecal coliform bacteria.

RESULTS

A table of most probable numbers was used to estimate the coliform content of the sample, based on the dilutions that were positive for coliform and/or faecal coliform bacteria. The results were reported as the total viable count (TVC) and the most probable number (MPN) of coliform bacteria per 100 mL (American Public Health Association, 1998) (Figure 3). Both the TVC and the number of coliform bacteria varied seasonally, peaking in August and September, which corresponds to the monsoon season in Pakistan.

DISCUSSION

Water-related diseases continue to be a major global health problem, thus the provision of clean water is important[12]. This is especially true at the SKMCH as many of the patients are immune-compromised and vulnerable to infection[13-16]. The quality of groundwater is a function of natural processes as well as anthropogenic activities such as soil fertility remediation, septic tank use, and indiscriminate refuse and waste disposal[17-19]. As the population of Lahore continues to increase, so will the issues of water-quality management related to a number of socio-economic and environmental factors, leading to the possible contamination of the aquifer that serves as the main water source. Certainly, problems of water pollution and ecosystem deterioration have led to severe stress on the human society and economic development. Monitoring of water quality is therefore an important means of identifying contamination, allowing water treatment and prevention of waterborne disease. After introduction of regular water monitoring by the SKMCH Microbiology Laboratory, it was noticed that, although the water quality from the aquifer was generally of high quality, contamination increased at certain times of the year. This seasonal increase in contamination was thought to be caused by a seasonal pool situated just outside the hospital walls (Figure 4), but the limited resources of the laboratory made that difficult to prove. This pool tended to appear after the first monsoon and stay for about 1 month before drying up again and was used by wandering herdsmen to water their animals. However, during the heavy rains, a lot of surface water was present that took time to soak into the ground, presumably leaching away contaminants from refuse and waste disposal, soak-away pits, and pit-latrines. Although microbial contamination levels did increase during the monsoon period, the aquifer seemed to undergo natural restoration during the rest of the year, with contamination levels dropping to more acceptable levels.

Fig-1: Ravi River in Lahore

Fig-2: Water Tower at the SKMCH during the monsoon

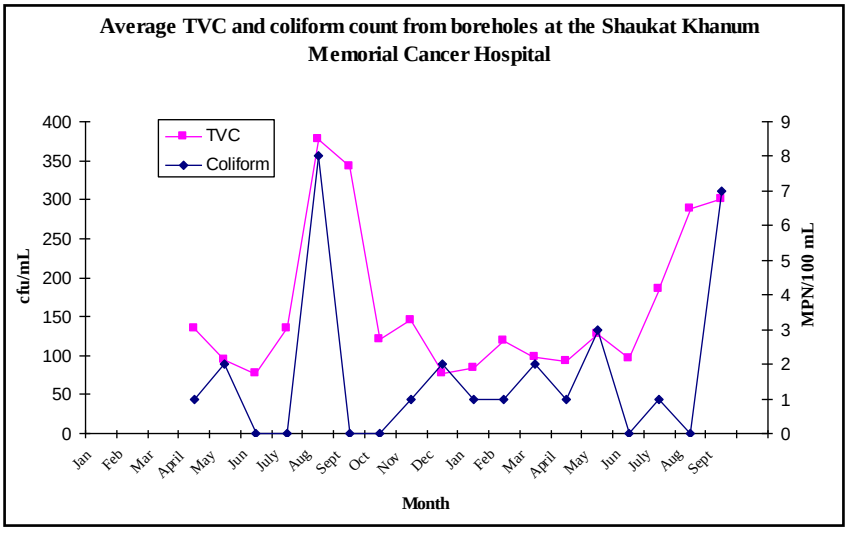

Fig-3: TVC and Coliform counts

Fig-4: Buffalo swimming in seasonal pool outside the SKMCH

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