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Qualitative Analysis of Drinking Water for Pathogenic Bacteria of District Swabi, Pakistan

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Research Article

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Abstract

This research work presents a study on drinking water quality in District Swabi, Khyber Pakhtunkhwa Pakistan, which involved bacteriological analysis of drinking water for the presence of some pathogenic bacteria from different drinking water sources. Total 103 water samples were analyzed in which 95 (92.23%) samples were contaminated with pathogenic bacteria. The contamination was highest for *Staphylococcus aureus* (88.34%), followed by *Salmonella sp.* (68.9%) and least contamination was recorded for *Pseudomonas aeruginosa* (24.27%). Out of 99 bore water samples, over all contamination was 91.9% and 100% for well water. It is concluded that the drinking water of Swabi is contaminated with these pathogenic bacteria and is not safe for drinking purposes. Based on the results it is suggested that authorities should show responsiveness to supply safe water and suitable sanitary facilities to avoid epidemics of infectious diseases in future.

Keywords: Drinking Water; Quality Analysis; *Pseudomonas; Salmonella*

Introduction

Water is an important element of life. Without it, life would not have existed on earth. Drinking water from different reservoirs should be free from contamination with waterborne pathogens including bacteria, fungi, viruses and parasites. These pathogenic microbes can exist in surface and ground water sources and can cause serious illnesses, in humans if not treated properly. Water quality is important for the health, social and economic welfare of humans [1,2].

Contaminated water is a worldwide public health danger that places people at risk of diarrheal and other disease as well as chemical intoxication [3]. In term of human health the most dangerous water pollutants are pathogenic microorganism [4]. According to the WHO, the death from water related illnesses surpasses 5 million people per year. Out of these, more than 50% are microbial intestinal infections [5].

At present, the threat of water borne illnesses and epidemics still rumbles great on the skylines of developing countries. Contaminated water is the perpetrator in such cases [6]. Half of the people of developing world are victim of water associated illnesses throughout the year and 3.4 million individuals pass away each year as a result of intake of fecally polluted water, among these the majority is of infants and children [7]. An estimated 5 million children in the developing countries die due to poor water quality [8]. The fast increase in population has further intensified the problem which results in poor water-quality management [9]. Inadequate water supply and sanitation is responsible for infections

or diseases for nearly half of all people in developing countries [10]. The developed countries have adopted strategies of checking the quality of drinking water owing to its significance but in developing countries numerous outbreaks of water borne illnesses still occur around the year [11,12].

Pakistan, being a developing country, is also going through the problem of drinking water contamination and safe water is available only to 40-60% of its whole inhabitants [13]. About 30% of the patients approaching to hospitals and 40% of all the mortalities taking place in Pakistan have contaminated drinking water as their cause.

Drinking water quality checking and monitoring programs in the country are lacking. Also, the public awareness of the issue of water quality is miserably low [14]. Drinking water treatment is hardly done before consumption in Pakistan and no such international standards are used for drinking water. There is no proper water supply system to 70% population of Pakistan living in rural areas. Bacterial contamination of drinking water is one of the gravest problems all over the country [15]. The borehole water pollution occurs through a lot of domestic sewage and animal manure particularly if there is a hole in a layer of soil. The wastes and sewage when dumped near the boreholes may move with rain water and seep right into the boreholes or may be transported along the well-wall [16,17].

There is no study conducted in district Swabi to determine the level of pathogenic bacterial contamination of drinking water sources. Therefore, this study is designed to determine the level of contamination of different drinking water sources in District Swabi.

Materials and Methods

Sample Collection

A total of 103 water samples were collected from different areas of district Swabi including Adina, Asmaila, Kalo Khan, Yar Hussain, Thulanday, Dhobian, Shawe adda, Main bazar, Dhandoqa and Jaganath randomly between March 2015 to September 2015 in sterilized bottles.

Detection of Pathogenic Bacteria

Samples were inoculated on selective media for pathogenic bacteria including *Pseudomonas* cetrimide agar (Oxoid) for *Pseudomonas aeruginosa*, Baird parker agar (Rapid labs, UK) for *Staphylococcus aureus* and Salmonella /Shigella agar (Oxoid) for *Salmonella sp*. 100µl of each sample was inoculated on solid media and spread with the help of sterilized glass spreader. The plates were incubated at 37°C for 24-48 hours in an inverted position.

Analysis of Media for Pathogens

After 24-48 hours of incubation, the petri dishes were observed for bacteriological enumeration. *Salmonella sp.* was visible as clear, colorless and transparent colonies on *Salmonella sp.* agar [18,19]. *S. aureus* was visible as grey colonies. Colonies was presumptively identified as of *P. aeruginosa* when it exhibits a blue-green to green pigment or it may be non-pigmented [20].

Statistical Analysis

Results were presented in percentages and analyzed statistically by Chi- square test ($\chi 2$).

Results

This study has revealed that drinking water can get contaminated with pathogenic bacteria which in human cause infections.

Overall Prevalence of Some Pathogenic Bacteria

A total of 103 water samples were taken from various areas of district Swabi. The frequency of bacterial contamination in drinking water samples is shown in Table1. Out of 103 water samples 95 (92.23%) were contaminated with pathogenic bacteria. The highest number of positive samples were contaminated with *S. aureus* with an overall prevalence of 88.34% (91), followed by *Salmonella sp.* 68.9% (71). The lowest prevalence rate was that of *P. aeruginosa* i.e., 24.27% (25). Statistical analysis revealed significant difference between the prevalence of all the three pathogens (P<0.001) as shown in Table 1.

Types of bacteria	No. of Positive Samples (N=103)	Prevalence (%)	Chi- Square Test (χ^2)
Salmonella sp.	71	68.9	*P<0.001
Staphylococcus aureus	91	88.34	
Pseudomonas aeruginosa	25	24.27	

*P<0.001=highly significant.

Table 1: Overall prevalence of *Salmonella/Shigella*, *S. aureus* and *P. aeruginosa* in different water sources of district Swabi.

Prevalence of Pathogenic Bacteria in Different Water Sources

Out of 103 water samples 99 were of bore water and 4 samples were of well water. The overall contamination in bore water was 91.9% (91) and well water 100% (4) (Table 2). There was no significant difference in overall contamination of different water sources of (P>0.05= non-significant).

Water Sources	No. of Samples	No. of Positive Samples	Prevalence (%)	Chi- Square Test (χ^2)
Bore water	99	91	91.90%	*P>0.05
Well water	4	4	100%	
Total	103	95	92.23%	

*P>0.05= non-significant.
Table 2: Overall contamination of different water sources.

The positive samples of *Salmonella sp.* in bore water were 67.67% (67). The entire 4 well water samples 100% were contaminated with *Salmonella sp.* showing overall 68.9% (71) contamination (Table 3). There was no significant difference in contamination from all the three sources of drinking water (P>0.05= non-significant).

Water Sources	No. of Samples	*Salmonella sp.*	*S. aureus*	*P. aeruginosa*	Chi- Square Test (χ^2)
Bore water	99	67.67	87.87	23.23	*P>0.05
Well water	4	100	100	50	
Total	**103**	**68.90%**	**88.34**	**24.27**	

*P>0.05= non-significant.
Table 3: Prevalence (%) of Pathogenic bacteria in two water sources.

Presence of *S. aureus* in bore water was 87.87% (87), while all 4 well water samples 100% were also contaminated with this bacteria (Table 4). Overall prevalence of *S. aureus* contamination was 88.34%. There was no significant difference in contamination from all the three sources of drinking water (P>0.05= non-significant).

Areas (N)[a]	*S. aureus*	*P. aeruginosa*	*Salmonella sp.*	Chi- square test (χ^2)
Asmila (19)	89.47	31.5	89.47	*P>0.05
Adeena (17)	100	11.7	58.8	
Yar Hussain (10)	100	10	70	
Dhobian (10)	90	20	80	
Tulanday (11)	81.8	36.36	63.6	
Kalo Khan (14)	78.57	42.8	64.28	
Jaganath (100	90	30	80	
Shawe adda (2)	50	0	0	
Dhandoka (5)	60	0	20	
Main bazar (5)	100	20	80	
Total (103)	**88.34**	**24.27**	**68.9**	

*P>0.05= non-significant; Na= No. of samples collected from each area.
Table 4: Prevalence (%) of pathogenic bacteria at different areas of district Swabi.

Overall contamination with *P. aeruginosa* was 24.27%. Out of 4 well water samples 2 (50%) were contaminated with *P. aeruginosa*. There was no significant difference in contamination from the sources of drinking water (P>0.05= non-significant), (Table 3).

Area Wise Prevalence of Pathogenic Bacteria

Bacterial contamination was variable in different areas (Table 4). The highest prevalence of *Salmonella sp*. was found in Asmaila i.e 89.47% followed by Dhobian, Jaganath and Swabi main bazar where the contamination

was 80%, Kalo Khan, Tulanday and Adeena the contamination was 64.28%, 63.6% and 58.8%, respectively. The lowest contamination was detected in Dhandoka i.e., 20%. No *Salmonella* were found in Shawe adda. No significant difference was observed in contamination of drinking water from all areas (P>0.05).

Area Wise Prevalence of *S. aureus*

The highest percentage of *S. aureus* was recorded in Adeena, Yar Hussain and Swabi main bazar where the percentage of contamination was 100%. In Jaganath and Dobyan the contamination was 90% followed by Asmaila, Toolandai, Kalu Khan and Dandoqa where the contamination was 89.47%, 81.8%, 78.57% and 60%, respectively. In Shawa adda the contamination was 50% (Table 4).

Area Wise Prevalence of *P. aeruginosa*

The highest percentage of contaminated samples with *P. aeruginosa* was recorded in Kalu khan where the percentage of contamination was 42.8%. In Toolanday the contamination was 36.36% followed by Asmaila, Jaganath, Dobyan, Swabi main bazar, Adeena, Yar Hussain where the contamination was 31.5%, 30%, 20%, 20%,11.7% and 10% respectively. No samples were contaminated in Shawe adda and Dandoqa. In shawe adda and Dandoqa the contamination was 0% (Table 4).

Discussion

Consuming clean and hygienic water is one of the basic requirements of a society [21]. Pakistan has water supplies adequate only to achieve the drinking requirements of 79% of its total inhabitants and a chief portion of that water supply is from ground i.e. boring water which they use for drinking [22].

In the present study drinking water samples were analyzed for bacterial contamination from areas of district Swabi, Khyber Pakhtunkhawa Province, Pakistan. The results revealed the total number of positive samples of *Salmonella spp.* were 68.9%, *S. aureus* 88.34% and *P. aeruginosa* were found in 24.27%. This indicating very high contamination of drinking water of swabi and high risk for the diseases caused by these bacteria. Although mostly studies are conducted on presence or absence of coliforms, presence of these pathogens in drinking water was reported from other areas of Pakistan. Ahmad, et al. [23] worked on drinking water quality of District Peshawar (Khyber Pakhtunkhwa Province), Pakistan and reported lesser prevalence of these pathogens. According to him 16.67% samples were contaminated with *Salmonella typhi*, 26.67% samples with *Pseudomonas* and 26.67% samples with *Shigella spp*. This difference may be due to better sanitary conditions in Peshawer and people are much aware of importance of personal hygiene as compared to Swabi, which is less developed.

Some studies were conducted in Karachi (Sindh Province) which also indicated positive samples of drinking water for *P. aeruginosa*, *S. aureus* and *Salmonella* [23-26]. Another study from Sindh was conducted in Sukkur and reported the prevalence of *P. aeruginosa* in 78% drinking water samples [27].

Many studies have been conducted in various parts of the world for the bacteriological analysis of drinking water for the presence of pathogenic bacteria. From Iran *P. aeruginosa* separated from the drinking water samples was 2% [21]. *P. aeruginosa* was also detected in 6 (11.4%) of the hospital water systems in Tehran, Iran. Masoumi, et al. [28] reported contamination with *P. aeruginosa* as 3.70% in chlorinated tap water and 20.37 % in water filter system from Shiraz, Iran, respectively.

In Nigeria the contamination of *Salmonella typhi*, *Shigella sonnei* and Staphylococci was reported 3.1%, 5.6% and 10.8% respectively in drinking water [29]. *Salmonella spp*., (44.8 %) and *Staphylococcus spp*. (37.9 %) were more prevailing in the samples of packaged drinking water sold in Nigeria [30] while from Ahiazu Mbaise, Eastern Nigeria *Salmonella spp.* and *Shigella spp*. were 100% in drinking water sources [31]. *Salmonella enterica* was also found in 3.3% of the drinking water resources from Gidan Kwano, Minna, Niger state, Nigeria [32].

From Uttarakhand region of India, *S. aureus* found dominating species comprising of 68.75% of the total Staphylococci, while from Andhra Pradesh, India also *Salmonella typhi*, *S. aureus* and *Shigella dysenteriae* were reported [33,34].

In the present study the percentage pathogens were high in well water as compared to contamination in bore water. From Andhra Pradesh, India the percentage of *Salmonella typhi*, *S. aureus* and *Shigella dysenteriae* was 10.6%, 19.9% and 8.2%, respectively, in bore water used for drinking and in well water was 12.40%, 19.57% and 10.65% respectively [34]. *P. aeruginosa* was also found in different drinking water resources of Makkah city, Saudi Arabia. Eleven drinkable wells water samples (91.7%) and all non-drinkable wells water samples (100%) were contaminated with *P. aeruginosa* [35]. *S. aureus* also reported from highly developed country of USA. Over 6% of 320 drinking water samples from Oregon, United States

were contaminated with this pathogen [36]. The most common source examined was that of well water.

The differences in results of all studies discussed above, may be due to several reasons including geographical differences, scio-economic conditions, types of sample collection method, number of microorganisms which were isolated and type of water samples.

The results of this study exposed that the bacteriological quality of given sources was not satisfactory. The water sources were contaminated with *Salmonella sp*., *P. aeruginosa*, *S. aureus*. It is a serious threat to the people of the area if proper measurements are not taken by the concerned authorities.

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