Bacteriological Quality Evaluation of Drinking Water of District Swat Khyber PAkhtunkhwa-Pakistan

[*1]Farhat Ali Khan, [2]Javid Ali, [1]Naseem Ullah, [3]Said Hassan, [4]Sudhair Abbas, [2]Zia-ur- Rahman

[1]Sarhad University of Science and Information Technology Peshawar, KPK-Pakistan
[2]PCSIR Laboratories Complex, Jamrud Road Peshawar, KPK-Pakistan
[3]Department of Agricultural Chemistry, University of Agriculture, Peshawar 25130, KPK- Pakistan
[4]Department of Pharmacy, Abasyn University, KPK- Pakistan

Abstract: The quality of drinking water especially bacteriological point of view is very important for human being. In the current study twenty four (24) samples of drinking water collected from different hand pumps, direct water supply and open well of Swat district were evaluated for bacteriological quality parameters such as Total Plate Count (TPC), Coliform bacteria, fecal coliform bacteria and *E. coli*. Fifteen samples were higher TPC vales as compared with World Health Organization (WHO) drinking water standards. Similarly 66.66% samples were contaminated with coliform bacteria and 58.33% samples were contaminated with fecal coliform bacteria according to WHO drinking water standards. *E. coli* were present in twelve samples.
[Farhat Ali Khan, Javid Ali, Naseem Ullah, Said Hassan, Sudhair Abbas, Zia-ur- Rahman. **Bacteriological Quality Evaluation of Drinking Water of District Swat Khyber PAkhtunkhwa-Pakistan.** *Life Sci J* 2014;11(2s):1-5]. (ISSN:1097-8135). http://www.lifesciencesite.com. 1

Keywords: Bacteria, Diseases, Health Risk, Drinking water, WHO Standards.

Introduction

Right to use safe drinking water is the fundamental human right of all inhabitants and ensuring provision of safe drinking water is of supreme significance to defend health of the communities, though entrance to this essential need is a huge confront for Pakistan in the current century (Aziz et al., 2013). It is well recognized that a great number of contagious diseases are transmitted principally during water supplies polluted with animal and human excreta mainly faeces. Outbreaks of water borne diseases carry on to happen during the world but particularly severe in budding countries. The human germs that present severe hazard of disease when present in drinking water include Campylobacter, Shigella, Salmonella, Yersinia enterocolitica, diverse viruses such as Hepatitis E Virus, Rota Virus, Hepatitis A Virus and parasites like Giardia lamblia, Entamaeba histolytica and so on (Muhammad *et al*., 2010). The greater part of the populations in budding countries are not sufficiently supplied with drinkable water and are therefore bound to use water from sources like boreholes and shallow wells that make the water dangerous for drinking and domestic purposes due to elevated potential of pollution (WHO 2006, 2011).

Pathogens are a severe worry for managers of water resources, because extreme amounts of faecal microbes in manure and urban run-off have been known to point out danger of pathogen-induced illnesses in humans (Fleisher *et al*., 1998). Numerous species of gram-negative bacteria occur in public wastewater are pathogenic. This pathogenisty is typically linked with certain ingredients of the cell walls, in mainly the lipopolysaccharide. Therefore, recognition of these disease causing agents in water resources is helpful for prevention and controlling planning of the communicable diseases (Shawky and Saleh 2007). Microbiological pollution has been measured main drinking water issue in Pakistan (Aziz et al., 2013).

District Swat is located in the North-West of Pakistan is a beautiful and fertile area. It is situated in latitude 34.09 °N through 35.56 °N and longitude 72.07 °N-E through 73.00 °E. The district is bordered by Chitral and Gilgit District in the north, Buneer at south, Shangla at east and Dir and Malakand agency at the West. Their inhabitant is about 1.249 million. Of which about 14% is living in cities while remaining are living in villages. The total numbers of villages are 1246 with 145038 farm families (Sultan et al., 2008).

The principal objectives of the present study are to analyze the bacteriological quality and bacterial contamination of drinking water of district Swat with different water sources and its contributes towards the environmental pollution.

Material and Methods

Sample Collection

The study was carried out in the Food Microbiology Laboratory of Pakistan Council of Scientific and Industrial Research Laboratories Complex Peshawar, Khyber Pakhtunkhwa- Pakistan during the period of March 2013 to August 2013. A total 24 water samples were randomly collected from the entire region of the District Swat. Water sources were divided into three basic types: Hand ump water,

direct water supply and well water. About 500 ml of water were aseptically collected by presterilized screw capped bottle and transported to the laboratory as early as possible using ice pack insulated box.

Total Viable Count

Total Viable Count was determined by pour plate method as described [10]. Take 1 ml of the sample from the three dilutions (10^{-1}, 10^{-2} and 10^{-3}) and added to each duplicate Petri dish. Plate Count Agar ((PCA) was added to each Petri dish and incubated at 35 °C for 48 hours ±2, after incubation colonies were counted by Colony Counter and result was expressed as CFU/ml.

Total Coliform Bacteria/fecal Coliform Bacteria

The MPN of total coliforms bacteria were determined by multiple tube fermentation technique [10]. Prepared each of separate sets of 10 tubes of Lactose broth (LB). Inoculate each of the 10 tubes of 10 ml double strength LB with 10 ml of the undiluted water sample. These LB tubes along with inverted Durham tubes were incubated at 35 °C± 0.5 °C for 24 and 48 ± 2 hrs after inoculation. Tubes were examined for gas production at the end of 24/48 hrs incubation. Gas production was measured by gas displacement in the inverted vial and also effervescence produced when the tube was gently shaken. Positive tubes with gas formation and turbidity were sub-cultured into BGB (Brilliant Green Lactose bile broth and E.C. Broth having 10ml broth with inverted Durham tubes by means of 3 mm loop. All BGB tubes were incubated at 35 °C and E.C. Broth tubes at 44.5 °C for 48 hrs and examined for gas production. Total coliform and fecal coliform were calculated from MPN tables [10].

Escherichia coli O157:H7

EMB Agar was used for the enumeration of *E. coli*. All the tubes of E.C. broth showing gas were subcultured by streaking on EMB agar plates and incubated at 35 °C for 18-24 hrs. Positive plates contained typical colonies with green metallic sheen were inoculated on PCA slants (plate count agar) and incubated at 35 °C for 18-24 hrs and identified biochemical and also by kits (*E.ColiO157:H7* latex test reagent kit Pro Lab. Canada).

Results

Bacteriological Analysis of Drinking water (Hand pumps)

The Bacteriological analysis results are presented in Table 1. The TPC in hand pump water were taken from Kharai Maira were highest (615 CFU/ml), while lowest value (40 CFU/ml) was detected in sample taken from Alabad ground. The values 50 CFU/ml, 615 CFU/ml, 45 CFU/ml, 48 CFU/ml, 90 CFU/ml, 435 CFU/ml, 60 CFU/ml, 70 CFU/ml and 370 CFU/ml were detected in samples taken from Alabad Ibrahim, Khairai Maira, Umer Khel, Shahbuddin, Sher Abad, Mian Gul Abad, Dakorak, Allabad Mera and Titai Wala respectively. The coliform bacteria (MPN/100 ml) of the locations (Alabd ground, Alabad Ibrahim, Umar Khel, Shahbuddin, Sher Abad, Dakorak and Titai Wala) were <1.1, mans within the range of WHO (Table 4). The fecal coliform bacteria (MPN/ 100 ml) were found within the permissible limit of WHO (Table 4) i.e. <1.1 in Alabad ground, Umar Khel, Shahbuddin, Sher Abad, Dakorak, Allabad Mera and Titai Wala. While fecal coliform bacteria (MPN/100 ml) were calculated 3.6 in Mian Gul Abad, 2.2 in Darughan and 1.1 in Khairai Maira. *E. coli* were present in three locations i.e. Darughan, Khairai Maira and Mian Gul Abad.

Bacteriological Analysis of Drinking water (Direct Water Supply)

The bacteriological analyses of direct water supply drinking water are shown in Table 2. The highest TPC 580 CFU/ml was found in location Gul Feza Matai and lowest TPC 56 CFU/ml was found in sample water taken from Babu Maira. The other TPC values 440 CFU/ml, 340 CFU/ml, 280 CFU/ml and 290 CFU/ml were found in water sample Sultan Banda, Senai, Zeyarat and Shalpin. The coliform bacteria (MPN/100 ml) values were 12, 9.2, 5.1, 6.9 and 5.1 in sample water taken from Gul Feza Matai, Sultan Banda, Senai, Zeyarat and Shalpin respectively. The fecal coliform bacteria values 9.2 MPN/100 ml, 5.1 MPN/100 ml, 2.2 MPN/100 ml, 3.6 MPN/100 ml and 2.2 MPN/100 ml were detected in samples taken from Gul Feza Matai, Sultan Banda, Senai, Zeyarat and Shalpin respectively. *E. coli* was present in samples taken from Gul Feza Matai, Sultan Banda, Senai and Shalpin.

Bacteriological Analysis of Drinking water (Open Wells)

Bacteriological analysis of open well drinking water results are shown in Table 3. The highest TPC value was 728 CFU/ml in Kokari water, while the lowest TPC value was 72 CFU/ml in Dakorak. The other TPC values were 190 CFU/ml, 424 CFU/ml, 552 CFU/ml, 324 CFU/ml and 465 CFU/ml in samples water taken from Sara Chena, Aman Kot, Bandai, Kanju and Saidu Sharif respectively. Kokari drinkin water sample was found >23 coliform bacteria (MPN/100 ml). The coliform bacteria in Sara Chena was 9.2 MPN/100 ml, Dakorak was <1.1, Aman Kot was 23, Bandai was 6.9, Kanju was 2.2 and Saidu Sharif was 5.1. The fecal coliform bacteria were 2.2 in Sara Chena, <1.1 in Dakorak, 16 in Aman Kot, 9.2 in Kokari, 3.6 in Bandai, 1.1 in Kanju and 2.2 in saidu Sharif. *E. coli* were present in five location drinking water sample i.e. Sara Chena, Aman Kot, Kokari, Bandai and saidu Sharif.

Table 1. Bacteriological Analysis of Drinking water (Hand pumps).

S.#	Sample Location	TPC (CFU/ml)	Coliform Bacteria (MPN/100ml)	Fecal Coliform Bacteria (MPN/100ml)	*E. coli*
1	Darughan	250	9.2	2.2	+ve
2	Alabad ground	40	<1.1	<1.1	00
3	Alabad Ibrahim	50	2.2	<1.1	00
4	Khairai Maira	615	3.6	1.1	+ve
5	Umar Khel	45	<1.1	<1.1	00
6	Shahbuddin	48	<1.1	<1.1	00
7	Sher Abad	90	<1.1	<1.1	00
8	Mian Gul Abad	435	6.9	3.6	+ve
9	Dakorak	60	<1.1	<1.1	00
10	Allabad Mera	70	<1.1	<1.1	00
11	Titai Wala	370	2.2	<1.1	00

TPC= Total Plate Count, CFU = Colony Forming Unite, MPN = Most Probable Number, *E. coli* = *Escherichia coli*.

Table 2. Bacteriological Analysis of Drinking water (Direct Water Supply).

S.#	Sample Location	TPC (CFU/ml)	Coliform Bacteria (MPN/100ml)	Fecal Coliform Bacteria (MPN/100ml)	*E. coli*
1	Gul Feza Matai	580	12	9.2	+ve
2	Sultan Banda	440	9.2	5.1	+ve
3	Babu Maira	56	<1.1	<1.1	00
4	Senai	340	5.1	2.2	+ve
5	Zeyarat	280	6.9	3.6	00
6	Shalpin	290	5.1	2.2	+ve

TPC= Total Plate Count, CFU = Colony Forming Unite, MPN = Most Probable Number, *E. coli* = *Escherichia coli*.

Table 3. Bacteriological Analysis of Drinking water (Open Wells).

S.#	Sample Location	TPC (CFU/ml)	Coliform Bacteria (MPN/100ml)	Fecal Coliform Bacteria (MPN/100ml)	*E. coli*
1	Sara Chena	190	9.2	2.2	+ve
2	Dakorak	72	<1.1	<1.1	00
3	Aman Kot	424	23	16	+ve
4	Kokari	728	>23	9.2	+ve
5	Bandai	552	6.9	3.6	+ve
6	Kanju	324	2.2	1.1	00
7	Saidu Sharif	465	5.1	2.2	+ve

TPC= Total Plate Count, CFU = Colony Forming Unite, MPN = Most Probable Number, *E. coli* = *Escherichia coli*.

Table 4. WHO Drinking Water Standards.

S#	Parameters	Standards
1	TPC (CFU/ml)	<100
2	Coliform Bacteria	<1.1
3	Fecal Coliform Bacteria	<1.1
4	E. coli	Nil

Discussion

Heterotrophic plate count bacteria (HPC) are usually applied to calculate the common microbiological value of water (Saiful *et al*., 2010). While elevated HPC determinations have not been initiate to associate with poor health occurrence and no outbreaks have been straight connected to high density of HPC flora in tap water. But high measurements of HPC are a sign of encouraging

circumstances for regrowth of microbes and must be remedied. Regrowth of microbial can support or a basis for decay of pipes, be accountable for unpleasant or stained water, and encourage cream growth (WHO 2002).

The total heterotrophic bacteria count (THBC) analysis also known as "total count" "plate count" is certain to give an estimation of the sum number of microbes in a water sample that will growth into colonies during a time of incubation in a nutrient. This analysis determines a broad group of microbes counting pathogens and opportunistic germs (Esomonu *et al*., 2012). Elevated THBC may perhaps be a sign of deprived common natural quality of drinking water (USEPA, 2003). The maximum limit for portable water is generally 500 CFU/ml (Esomonu *et al*., 2012). According to Dezuane (1990), water with quantification less than 100 CFU/ml must be measured "portable" and values 100 to 500 CFU/ml "questionable". For that reason, all the water sources from district Swat have questionable water quality.

The maximum plate count is analytic of the occurrence of elevated organic and dissolved salts in the water. The main sources of these microbes in water are human and animal wastes. These sources of microbial contamination include pasture, surface runoff and other ground areas where animal wastes are deposited. Further sources comprise leakage or release from septic tanks, manure management services and normal mud/plant microbes (EPA, 2002). These pollutants are reflected in the maximum microbial density found in this study. The bacterial load was high in well water close to decline discarding spot as compared to well water far away. Commonly, underground water is supposed to be the purest known (Shittu *et al*., 2008) due to the cleansing properties of the earth though, it can also be polluted. Groundwater are found to be polluted due to decline dump sites, animal wastes, nearness to bathroom facilities, inappropriate building, shallowness, manure and diverse individual actions in the region of the well (Bitton, 1994).

E. coliO157:H7 an enteric strain which causes blood diarrhea and this illness leads to the difficulty called hemorrhagic colitis. This disease causes the kidney breakdown (hemolytic uremic syndrome HUS). While further related diseases included chronic perforation, coma, coma, liver disorder, seizures and heart attack muscle infections (Pommerville, J.C., 2006).

It has been prearranged that the microbial density in potable drinking water should be zero in 100 ml of water sampled (WHO, 2003). The finding of microbes of fecal source in the current study revealed that the water was not secure and might serve up as a latent basis for the conduction of these microbes to persons who drink these water.

Majority of the well water studied were without protective covers and buckets used in taking water from all the wells from all locations were left carelessly on the ground after fetching water and were not the wells they can seeps down and pose potential health problems to those using the water from the wells.

Numerous factors could perhaps add to this situation of district Swat. The site of toilets and /or septic tanks near to the superficial wells could be one of the reasons contributing to pollution of the shallow wells. This raises the threat of pollution of the water sources as coliforms travel from the pit latrines to the wells. The WHO advises that the distance between such pit latrines or septic tanks and shallow wells be at least 30m. Other factors counting age of the well, topography, well-toilet orientation and overall hygiene could therefore also play a role in determining microbial pollution of the wells (Romulus *et al*., 2012). In this study it was scrutinized that the majority wells were not accurately protected thus exposing them to pollute from organisms wastes as well as surface runoff. Community health interventions to develop the water quality with chlorination, use of ceramic filter technology, boiling and as well as developing the whole hygiene inside the inhabited locality should be instituted. Developing hygiene has been revealed to have better impacts as it leads to improve the water quality at the source (Esrey, 1996). Additional interventions should also comprise giving technological recommendation on appropriate well building counting installation of well citing, pumps, decommissioning unsanitary wells and supervising.

Conclusion

Bacteriological quality of drinking water showed that contamination of the water was rising frighteningly and that it has shaped severe risk to human health and surroundings. These outcomes obviously indicate that the quality of the water consumed in district Swat is serious to control communicable diseases and additional healthiness issues. Urgent act was taken by local administration, municipals and union council society to manage these microbes which were present in these drinking water sources and also alert the public of the localities regarding the significance of safe drinking water.

Acknowledgment

The authors are thankful to Mr. Faqir Hussain (Senior Laboratory Technician) Food Microbiology Section of PCSIR Laboratories Complex Peshawar, KPK-Pakistan for their help during sampling collection.

Author for Correspondence:
[1]Farhat Ali Khan, Sarhad University of Science and Information Technology Peshawar
Email: farhatkhan2k9@yahoo.com

References

1. Aziz Ahmed, Tarique Mahmood Noonari, Habibullah Magsi, Amanullah Mahar. 2013. Risk Assessment of Total and Faecal Coliform Bacteria From Drinking Water Supply of Badin City, Pakistan. Journal of Environmental Professionals Sri Lanka, 2(1): 52-64.
2. Shawky, Z.S. and Saleh, A. R. 2007. Evaluation of the Microbial Quality of the River Nile Waters at Damietta Branch,, Egypt. Egyptian Journal of Aquatic Research. 33(1): 301-311.
3. Fleisher, J.M.; Kay, D.; Wyer, D. and Godfree, A.F.: 1998, Estimates of the severity of illness associated with bathing in marine recreational waters contaminated with domestic sewage. International Journal of Epidemiology 27: 722-726.
4. Sultan, A., Siraj, A., and Fazalullah K.B. 2008. Drinking Water Quality of Swat District. Journal of Chemical Society of Pakistan. 30(1): 1-10.
5. Muhammad S.A,. S. Lateef and G. M.S. 2010. Bacteriological Quality of Drinking Water in Lahore. Biomedica, 26: 66 – 69.
6. Javid Ali, Naseem Ullah, Farhat Ali Khan, Zia-ur-Rahman, Israr Ahmad, Said Hassan and Irshad Ahmad 2013. Bacteriological Quality Analysis of Drinking Water of Rural Areas of Peshawar, Pakistan. American-Eurasian J. Agric. & Environ. Sci., 13 (9): 1202-1206, 2013.
7. Pommerville, J.C., 2006. Alcamo's Fundamentals of Microbiology. 7 edition. Jones and Bartlett publishers USA, pp: 325-326.
8. Saiful, I., H. A. Begum, N. Y. Nili. 2010. Bacteriological Safety Assessment of Municipal Tap Water and Quality of Bottle Water in Dhaka City: Health Hazard Analysis. Bangladesh J Med Microbiol, 04 (01): 9-13.
9. World Health Organization. Guidelines for Drinking Water Quality, 2nd ed. Vol 1: Microbiological Methods. World Health Organization, Geneva 2002.
10. Wealth Health Organisation (2003). Emmerging Issues in Water and Infectious Disease, World Health Organization, Geneva, Switzerland.
11. USEPA (United States Environmental Protection Agency) (2003). Drinking Water Quality Standards. Edstrom Industries, Waterford, Wisconsin.
12. Esomonu O. C., A. O.C. and I. C. Emeka. 2012. Enteric pathogens and diarrhea disease potentials of water sources in Ahiazu Mbaise, Eastern Nigeria. Journal of Public Health and Epidemiology. 4(2):39-43.
13. DeZuane J (1990). Handbook of Drinking Water Quality Standard and Controls, Van Nostrand Reinhold, New York.
14. EPA, (2002). US Environment Protection Agency, Safe Drinking Water Act Ammendment http:// www. epa. gov/safe water /mcl. Html.
15. Gordan, M.; Fair and John, Gever, G. (1996). Water supply and Waste Removal in: Waste supply and Waste Removal In: Waste Engineering Vol. John Wiley and Sons. pp 220-236.
16. Shittu, O.B., Olaitan, J.O. and Amusa, T.S. 2008. Physico-Chemical and Bacteriological Analyses of Water Used for Drinking and Swimming Purposes in Abeokuta, Nigeria. African Journal of Biomedical Research, 11: 285 – 290.
17. Bitton, G. (1994). Waste Water Microbiology. Gainesville, New York Wiley- Liss. 118p.
18. World Health Organization (2011). Guidelines for Drinking Water Quality. 4TH Edition. WHO press, 564pp. ISBN 978 92 4 154815.
19. Esrey SA (1996). Water, waste, and well-being: a multi-country study. American Jnl. Epidemiol., 143: 608-623.
20. Romulus, A., M. Muthangya., E. Mutuku., K. Mutati., M. Munguti., C.M. Musyoka. 2012. Physico-chemical and bacteriological quality assessment of shallow wells in Kitui town, Kenya. Journal of Environmental Science and Water Resources. 1(2): 27 – 33.

1/12/2014