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The Current and Critical Drinking Water Quality of Flood Affected Villages of District Charsadda Khyber Pakhtunkhwa (Pakistan)

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Abstract – In this study, drinking water samples were collected from different villages of Nisatta, (District Charsadda) which was affected by a heavy Monsoon flood 2010 were analyzed Bacteriolgically and Chemically. The results were evaluated with WHO drinking water standards. Bacteriolgically TPC were found in the range of 9 X 10^6 -9 X 10^1 cfu/ml. TCB were calculated in the range of >1600–14MPN/100ml. 72% analyzed samples were contaminated with *Escherichia Coli* and *Pseudomonas aeruginosa*. TFC and Shigella were present in all the analyzed samples. *Vibrio cholerae* was present in all samples except one sample. 54% samples were contaminated with Salmonella. 63% samples were contaminated with *Staphylococcus aureus.* Chemically data showed that variation of the investigated parameters in water samples as follows: pH 6.77-7.42, Conductivity (µS/cm) 2200- 492, TDS (mg/L) 1419-320, TSS (mg/L) 16-3, Total Hardness (mg/L) 56 - 556, Calcium (mg/L) 36 - 336, Magnesium (mg/L) 20-260, Total Alkalinity (mg/L) 216 - 732, , Chlorides (mg/L) 14-344, Sulphate (mg/L) 42-270, Sodium (mg/L) 121–357, Potassium (mg/L) 8.0 - 600 and Nitrates (mg/L) 0.16–0.23. P-Alkalinity (mg/L) was not detected. Therefore, the results showed that there was a great contamination in drinking water of the under studied villages.

Keywords – Flood; drinking water Quality; Consumer Health; Pathogenic Bacteria.

1. Introduction

The 2010 Pakistan floods began in July 2010 after heavy monsoon rains affected the Khyber Pakhtunkhwa, Sindh, lower Punjab as well as parts of Balochistan. It is estimated that two thousand people along with close to a million homes have perished so far [1]. The U.N. is concerned that aid is not arriving fast enough, while the World Health Organization reported that ten million people were forced to drink unsafe water [2].

Drinking water supplies have a long history of being infected by a wide spectrum of microbes. Therefore, the primary goal of water quality management from health perspective is to ensure that consumers are not exposed to pathogens that cause disease. Protection of water sources and treatment of water supplies have greatly reduced the incidence of these diseases in developed countries. Therefore, testing the source of water is necessary, especially when there is no water treatment. This is useful as result of the failure of treatment process or as a part of an investigation of serious water-borne disease outbreak [3]. According to a recent UNICEF report, about 800 million people in Asia and Africa are living without access to safe drinking water. Consequently, this has caused many people to suffer from various diseases [4]. The quality of drinking water is of vital concern to mankind, since it is directly associated with human life. Fecal pollution of drinking water causes water-borne diseases, which wiped out entire population of cities [5]. The most serious pollutants in terms of human health worldwide are pathogenic organisms. Altogether, at least 25 million deaths each year are blamed on these water-related diseases, including nearly two-third of the moralities of children under five years old. The main source of these pathogens is from untreated or improperly treated human waste [6]. The poor health status of Pakistan's population is reflected in high infant mortality rate of 12.6% and as low as 7% fertility rates. The scanty hospital's data shows that many of the diseases treated are caused by water borne microbes indicating that a substantial proportion of morbidity in

Pakistan is due to use of polluted water. Gastrointestinal infections resulting in diarrhea show high frequency among children as well as adults, accounting for 25% of patients treated at hospitals and clinics [7,8]. The helping agencies have presumed that a flood victims have faced a new serious risk in the shape of outbreaks diseases, such as: gastroenteritis, diarrhea, and skin diseases due to lack of clean drinking water and sanitation facilities [9]. The present were designed to study the bacteriological and chemical quality analysis of the drinking water of the flood affected areas of District Charsadda and its possible health effects on consumer's health.

2. Materials and Methods

In order to reach out the most vulnerable Affectees in disaster hit Districts Charsadda, PCSIR Laboratories Complex Peshawar selected most affected villages. Theses villages were identified on the bases that were completely inundated by floods.

2.1. Microbial Analysis

Total Plate Count (TPC) was determined by pour plate method. The Most Probable Number (MPN) of Total Coliforms Bacteria were determined by multiple tube fermentation technique. Total Fecal Coliform Bacteria and *E. Coli* were determined by the prescribed methods (APHA 2005). *Pseudomonas aeruginosa* (PA) was determined by taking 250 mL sample and filtered through a 0.45 µm cellulose membrane filter, placed on Pseudomonas CN agar and plates were incubated at 37°C for 48 hours, blue/green colonies were isolated on Plate Count agar at 37°C for 24 hours, and after the oxydase test, the species identification was conducted using standardized identification Biochemical tests [10]. *Vibrio cholerae* (VB) was done by enriching the samples in 1% alkaline peptone water for 6 to 8 hours followed by isolation on Thiosulphate Citrate Bile salt sucrose (TCBS) agar medium [11]. All colonies with different characteristics on M-Endo agar, Xylose Lysine Deoxycholate Agar (XLD) agar and Thiosulphate Citrate Bile salt sucrose Agar (TCBS) were sub cultured onto Nutrient agar (NA) for purification. Enteric bacteria isolated on respective selective or differential media were identified on the basis of their colonial, morphological and Biochemical properties following Bergey's Manual of Determinative Bacteriology, 1994. Detection of *Salmonella* and *Shigella* species were done by the enrichment of water samples on Selenite F broth, followed by isolation of the typical organism on selective medium, Xylose Lysine Deoxycholate Agar (XLD) [11]. The membrane Filtration Technique was employed for the enumeration of Staphylococcus aureus was applied using 100ml drinking water sample by using Baird Parker agar as selective medium. After incubation the Baird Parker agar plates containing filter for 25-48 h at 37°C, circular bright gray to black colonies were picked, purified and sub-cultured on nutrient agar. The confirmed colonies were subjected to Gram-positive cocci in cluster, positive reaction catalase and coagulase test were considered as *Staphylococcus aureus* [12].

2.2. Chemicals Analysis of Water

Number pH was determined by pH meter (Meter delta UK)dure, Conductivity was determined by conductivity Meter (Jenway England), Total Hardness was determined by Chelorometric Titration Methods, Total Alkalinity was determined by Titration methods, Chlorides was determined by Argentometric titration. Sulphate was determined by titration of, Total Solids by evaporation methods, Total suspended solids Filtration through Whattman # 41 filter paper. Total Dissolved Solids was determining TDS in a sample the simple principle of subtracting the TSS of that sample from its [10]. Sodium and Potassium were determined using Flame Photometer (PFP-7 Jenway UK), UV Visible Spectrophotometer (U-2000 Hitachi Japan) was used for the determination of Nitrites [10].

3. Results and Discussion

3.1. Bacteriological Analysis

Bacteriological analysis of bore water of District Charsadda (Nisatta) was shown in Table 1.The highest Total Plate Count (TPC) 9 X 10^6 CFU/ml were found in Sheikh Malee (Nisatta). The lowest TPC 9 X 10^1 CFU/ml were found in Mohallah Kaker (Nisatta). The other TPC results were found that Mohallah Mulyan (Nisatta) was 4.5 X 10^2 CFU/ml, Mohallah Peeran (Nisatta) was 2 X 10^2 CFU/ml, Mohallah Parao (Nisatt) was 2 X 10^2 CFU/ml, Toor Khel (Nisatta) 3 X 10^4 CFU/ml, Mohallah Saddran was 4 X 10^4 CFU/ml, Mohallah Londa (Nisatta) was 1.8 X 10^2 CFU/ml, Sor Pool Kooroona (Nisatta) was 4 X 10^2 CFU/ml, Bhattai Kooroona (Nisatta) was 4 X 10^2 CFU/ml and Peerano Masjid (Nisatta) was 4.5 X 10^2 CFU/ml. According to World Health Organization (WHO) drinking water standard for TPC is 100 CFU/ml, if this limit is exceed than this reported standard the drinking water become unacceptable for drinking purposes.

All the examined samples were found highly contaminated with Total Coliform Bacteria (TCB) and the results were reported that the highest TCB i.e. >1600 MPN/100ml were found in villages Mohallah Mulyan (Nisatta), Toor Khel (Nisatta), Mohallah Saddran (Nisatt), Sheikh Malee(Nisatta), Mohallah Londa (Nisatta) and Sore Pool Kooroona (Nisatta). The TCB of Peerano Masjid(Nisatta) was 920 MPN/100ml, 23 MPN/100ml TCB were found in Mohallah Peeran, Mohallah Parao and Bhattai Kooroona (Nisatta). TCB of Mohallah Kaker (Nisatta) was 14 MPN/100ml. All analyzed samples were highly contaminated (100%) with Fecal Coliform Bacteria (TFC). The study of Khan 1999 [13] on the fecal coliform contamination in the Kabul River and its tributaries showed that it was highly contaminated with these bacteria and these water can neither be considered safe for human consumption not for irrigation purposes. *E. Coli* were absent in Mohallah Mulyan (Nisatta) and Sheikah Malee. The other analyzed samples were highly contaminated with +ve results of *E. Coli*. The bacterial species *Escherichia Coli* is one of the most common inhabitants of the human intestinal tract and is probably the most familiar organism in microbial world. Its presence in water or food is an indication of fecal contamination. It can cause of urinary tract infections, and certain strains produce enterotoxins that cause traveler's diarrhea and occasionally cause very serious food born disease [14]. All samples were contaminated with Pseudomonas aeruginosa except three samples Sheikh Malee, Mohallah Londa and Bhattai Kooroona, Nisatta) in which

Pseudomonas aeruginosa was absent. *Vibrio cholerae* results were more alarming which states that all water were contaminated except one sample Bhattai Kooroona absent *Vibrio cholerae*. The sampes collected from villages Mohallah Mulyan, Mohallah Peeran, Mohallah Parao, Sheikah Malee, Mohallah Lonada and Bhattai Kooroona have showed a +ve results of Salmoneela and the rest of villages i.e. Mohallah Kaker, Toor Khel, Mohallah sadran, Sore Pool Kooroona and Peerano Masjid were found free from Salmonella. The results data observed that all the analyzed samples were +ve shigella contamination. The study of Zahie *et al* 1964 [15] on bacteriological analysis of drinking water of Karachi showed that these water contain *E. Coli*, Salmonella, Shigella. 64% analysed samples have TCB and 39% samples contained E.coli. Water stored in the reservoirs gave higher total count and lesser MPN in comparison to that collected directly from taps. The highest *Staphylococcus Aureus* contamination (1 X 10^6 CFU/ml) were found in Sheikh Malee, the lowes were found in Peerano Masjid, the other results were found moderately value and reported 2 X 10^1 CFU/ml was found in Sore Pool Kooroona, 1 X 10^3 CFU/ml was in Mohallah Sadran, 3 X 10^1 CFU/ml was in Mohallah Londa, 4 X 10^1 CFU/ml was in Toor Khel and 60 CFU/ml was found in Mohallah Mulyan. The locations Mohallah Peeran, Mohallah Parao, Mohallah Kaker and Bhattai Kooroona found no SA in the drinking water of these villages.

Table 1. Bacteriological analysis of bore water of District Charsadda (Nisatta)

Name of village	**[1]TPC**	**[2]TCB**	**[3]TFC**	**[4]EC**	**[5]PA**	**[6]VB**	**[7]S**	**[8]S**	**[9]SA**
4. Moh: Mulyan	5. 4.5 X 10^2	6. >1600	+	-	+	+	+	+	60
7. Moh: Peeran	2 X 10^2	8. 23	+	+	+	+	+	+	Nil
9. Moh: Parao	2 X 10^2	10.23	+	+	+	+	+	+	Nil
11.Moh: Kaker	9 X 10^1	12.14	+	+	+	+	-	+	Nil
13.Toor Khel	3X10^4	14.>1600	+	+	+	+	-	+	4 X10^1
15.Moh Saddran	4 X 10^4	16.>1600	+	+	+	+	-	+	1 X 10^3
17.Sheikh Malee	9 X 10^6	18.>1600	+	-	-	+	+	+	1 X 10^6
19.Londa	1.8 X 10^2	20.>1600	+	+	-	+	+	+	3 X 10^1
21.Sore Pool Kooroona	4 X 10^2	22.>1600	+	-	+	+	-	+	2 X 10^1
23.Bhattai Kooroona	4 X 10^2	24.23	+	+	-	-	+	+	Nil
25.Peerano Masjid	4.5 X 10^2	26.920	+	+	+	+	-	+	1 X 10^1

+ = Detected, - = Not Detected, **[1]TPC=** Total Plate Count, **[2]TCB=** Total Coliform Bacteria, **[3]TFC=** Total Fecal Coliform Bacteria **[4]EC=** Escherichia Coli, **[5]PA=** Pseudomonas aeruginosa, **[6]VB=** Vibrio cholera, **[7]S=** Salmonella Spp / 25 ml, **[8]S=** Shigella **[9]SA=** Staphylococcus aureus.

Table. 2 WHO Standards of Drinking Water

S#	**Bacteriological parameters**	**WHO Standards**
1	Total Plate Count (CFU/ml)	<100
2	Total Coliform Bacteria (MPN/100ml)	<1.1
3	27.Total Fecal Coliform Bacteria	<1.1
4	28.*Escherichia Coli* (O157: H7)	Nil
5	*29.Pseudomonas aeruginosa*	Nil
6	*30.Vibrio cholera*	Nil
7	31.*Salmonella Spp* / 25 ml	Nil
8	*32.Shigella*	Nil
9	*33.Staphylococcus aureus*	Nil

Table. 3. Chemical Analysis of Water Samples (Nisata, District Charssada)

Parameters	Units	Moh. Mulyan	Moh. Peeran	Moh. Parao	Moh. Kaker	Toor Khel	WHO standard for drinking water
pH	-	7.41	6.87	7.00	7.35	6.77	6.50-8.50
Conductivity	µS/cm	913.00	1580.00	1364.00	610.00	2160.00	-
Total Dissolved Solids (TDS)	mg/L	600.00	1015.00	890.00	390.00	1379.00	1000.00
Total Suspended Solids (TSS)	mg/L	5.00	9.00	4.00	3.00	7.00	5.00
Total Hardness as $CaCO_3$	mg/L	144.00	420.00	292.00	136.00	556.00	500.00
Calcium as $CaCO_3$	mg/L	92.00	260.00	172.00	92.00	307.00	250.00
Magnesium as $CaCO_3$	mg/L	52.00	160.00	120.00	44.00	252.00	150.00
Total Alkalinity as $CaCO_3$	mg/L	280.00	580.00	528.00	228.00	588.00	500.00
P-alkalinity as $CaCO_3$	mg/L	Nil	Nil	Nil	Nil	Nil	30.00
Chloride as Cl^{-1}	mg/L	100.00	204.00	70.00	40.00	344.00	250.00
*Sulphate as SO_4^{-2}	mg/L	91.00	84.00	72.00	88.00	255.00	250.00
Sodium as Na^{+1}	mg/L	202.00	262.00	226.00	137.00	275.00	200.00
Potassium as K^{+1}	mg/L	20.60	11.90	9.30	19.60	600.00	75.00
Nitrite as NO_2^{-1}	mg/L	0.19	0.17	0.23	0.19	0.18	0.10

- the analytical uses of EDTA (1958)

Table. 4. Chemical Analysi of Water Samples (Nisata, District Charssada)

Parameters	Units	Moh. Saddran	Sheikh Malee	Londa	Sore pool Kooroona	Bhattai Kooroona	Peerano Masjid	WHO standard for drinking water
pH	-	6.83	6.83	7.42	6.86	6.97	7.35	6.50-8.50
Conductivity	µS/cm	2200.00	2200.00	492.00	1690.00	1430.00	1159.00	-
Total Dissolved Solids (TDS)	mg/L	1410.00	1410.00	320.00	1075.00	915.00	740.00	1000.00
Total Suspended Solids (TSS)	mg/L	16.00	16.00	4.00	9.00	5.00	5.00	5.00
Total Hardness as $CaCO_3$	mg/L	516.00	516.00	56.00	464.00	260.00	188.00	500.00
Calcium as $CaCO_3$	mg/L	336.00	336.00	36.00	220.00	148.00	112.00	250.00
Magnesium as $CaCO_3$	mg/L	180.00	180.00	20.00	244.00	112.00	76.00	150.00
Total Alkalinity as $CaCO_3$	mg/L	628.00	628.00	216.00	732.00	436.00	284.00	500.00
P-alkalinity as $CaCO_3$	mg/L	Nil	Nil	Nil	Nil	Nil	Nil	30.00
Chloride as Cl^{-1}	mg/L	142.00	142.00	14.00	206.00	100.00	72.00	250.00
*Sulphate as SO_4^{-2}	mg/L	270.00	270.00	42.00	145.00	98.00	44.00	250.00
Sodium as Na^{+1}	mg/L	230.00	230.00	121.00	357.00	257.00	209.00	200.00
Potassium as K^{+1}	mg/L	140.00	140.00	8.50	102.00	8.00	60.20	75.00
Nitrite as NO_2^{-1}	mg/L	0.17	0.17	0.16	0.16	0.21	0.18	0.10

* the analytical uses of EDTA (1958)

A leading cause of gastroenteritis is staphylococcal food poisoning, an intoxication caused by ingesting an enterotoxin produced by *Staphylococcus Aureus*. staphycocci are comparatively resistant to environmental stress. They also have a fairly high resistance to heat; vegetative cells can tolerate 60°C for half an hour. Their resistance to drying and radiation helps them survive on skin surfaces. These bacteria are often an inhabitant of the nasal passages, from which it contaminates the hands. It is also a frequent cause of skin lesions on the hands. From these sources it can readily enter in food. If the microbes are allowed incubate in the food, a situation called temperature called temperature abuse, they produced and released the enterotoxin into the foods. S. aureus produces several toxins that damage tissues or increase the microorganism's virulence. The production of the toxin of serological type A (which is responsible for most cases) is often correlated with the production of an enzyme of that coagulates blood plasma. Such bacteria called coagulase positive. The toxin quickly triggers the brain's vomiting reflex center; abdominal cramps and usually diarrhea then ensue [14].

The water supplies in different areas of Peshawar, Nowshera and Charsadda was studied by Misal Khan *et al* 2000 [16] revealed that before flood these sites (Jalozai, Akora Khattak, Pabbi, Charsadda) were highly contaminated with TPC, TCB and *E. Coli*. After flood in these areas drinking water were more highly contaminated at the results of these highly contamination the diseases like Malaria, Cholera, Typhoid, Hepatitis, dysentery, skin diseases and Eye disease are common in the visited areas. Drinking water quality forecast of Peshawar valley on the basis of sample data were studied by Salim and Fazlullah 2001 [17] calculated that water all sources are well in the WHO recommended standards and fit for supply to consumer. While moving within the distribution system the same water becomes unfit for human consumption due to gradual fall in quality due to mixing of wastewater entering the distribution line through leakage.

The causative agent of cholera, one of the most serious gastrointestinal diseases in the world. It is slightly curved, gram-negative rod with a single polar flagellum. Cholera bacilli grow in the small intestine and produce an exotoxin, cholera toxin that causes host cells to secrete water and electrolytes, especially Potassium. The results in watery stools containing masses of intestinal mucus and epithelial cells called rice water stools from their appearance. As much as 12 to 20 liters (3 to 5 gallons) of fluids can be lost in a day and sudden loss of these fluids and electrolytes causes shock, collapse and often death. The blood lacking fluids may become so viscous that vital organs are unable to function properly. Violent vomiting generally also occurs. The microbes are not invasive and a fever is usually not present. Untreated cases of cholera may have a mortality rate of 50%, although with proper supportive care it is usually less than 1% today. The diagnoses are based upon symptoms and culturing of *Vibreo cholerae* from feces [14]. The 52% of drinking water sample have Coliform bacteria and 73% samples (38% of the total supply mostly collected from the poorly drained areas of Charsadda City studied carried out by Misal *et al* 2000 [16].

33.1. Chemical Analysis

Chemical analysis of drinking water samples of Nisatta (District Charsadda) were shown in Table 3 & 4. The lowest pH of the analysed samples was 6.77 (Torkhel Mohallah) and the highest pH was 7.42. According to WHO pH was according to the permissible limits. The highest conductivity (µs/cm) was 2200 (Mohallah Sadran) and the lowest conductivity (µs/cm) was 492 (Londa). Total Dissolved Solids (TDS) of Mohallah Sadran was found 1410 mg/L and the lowest was 320mg/L in Londa. Total Hardness as CaCO3 (mg/L) result showed that Torkhel Mohallah and Mohallah Sadran was 556 and 516 respectively, which exceed than WHO during water standards (500 mg/L). Total Suspended Solids (TSS) of Mohallah Sadran was 16 mg/L which was the highest of all analysed samples samples, the same locality samples was also a highest TDS result. The lowest TSS 3 mg/L was found in Kaker Mohalah. The highest Calcium as $CaCO_3$ was calculated 336 mg/L and in Sadran Mohallah. The lowest Calcium as $CaCO_3$ was 36mg/L in Londa. The two locality sample Mohallah Pirano and Sadran did not fulfilled the WHO drinking water criteria 250 mg/L. The WHO standard of drinking water for Magnesium as $CaCO_3$ is 150 mg/L. The three localities Torkhel, Sorpol and Pirano Mohallah Magnesium as $CaCO_3$ were 252, 244 and 160 mg/L. These locality water samples were not fit for human consumption according to WHO standard. The highest Total Alkalinity as $CaCO_3$ was 732mg/L whereas the WHO limits 500 mg/L. The Sodran, Torkhel, Perano and Parao locality water samples Total alkalinity was also exceed and results were 628,588, 580 and 528 respectively. The lowest Total alkalinity was 216mg/L. P alkalinity as CaCO3 was not detected in all the analyzed samples. The Chlorides in one sample locality Torkhel was found 344 mg/L which was exceed than WHO drinking water standard 250mg/L. The lowest chloride 14 mg/L was found in Londa village. The highest Sulphate was detected 270 mg/L in Sodran village while the WHO standard was 250 mg/L. he lowest Sulphate concentration was 42mg/L in Londa village. Torkhel village water sample was also unfit for human consumption because of exceed WHO standard limit (255mg/L). The Sodium concentration of analysed samples showed that the highest concentration was observed in Sorpol Korona 357 mg/L and the lowest was 121 mg/L in Londa. The WHO drinking standard standard for Na was 200mg/L. The sample of Sheikh Mali and Mohallah Kaker lie within the permissible limit of WHO (Na standard). The highest Potassium 600mg/L was calculated in Torkhel, while lowest 8 mg/L was observed in Batae, only two samples were unfit for drinking purposes due to high concentration of Nitrite as compared to WHO standards.

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