EUROPEAN ACADEMIC RESEARCH
Vol. II, Issue 4/ July 2014

ISSN 2286-4822
www.euacademic.org

Impact Factor: 3.1 (UIF)
DRJI Value: 5.9 (B+)

Bacteriological and Chemical Analysis of Drinking Water Samples from Various Household and Public Water Supplies in District Peshawar

GHAZI REHMAN[1]
Department of Microbiology
Kohat University of Science and Technology Kohat
Khyber Pakhtunkhwa
Pakistan
MUHAMMAD DAUD[2]
Department of Microbiology
Kohat University of Science and Technology Kohat
Khyber Pakhtunkhwa
Pakistan
SAADULLAH
Department of Microbiology
Hazara University, Manshera Khyber Pakhtunkhwa
Pakistan
SAJID IQBAL
MUJTABA HUSSAIN
BAHARULLAH
Department of Microbiology
Kohat University of Science and Technology Kohat
Khyber Pakhtunkhwa
Pakistan

Abstract:

The aim of this study was to investigate the chemical contamination and to obtain an index for microbiological organisms present in public water supplies from various regions of Khyber

[1] Corresponding author: ghazirehman89@gmail.com
[2] Corresponding author: Khattaks2010@gmail.com

Pakhtoonkhwa (KPK). Water samples from various parts of KPK were tested and analyzed using different chemical and microbiological parameters. Different samples were brought from all parts of KPK districts. For the analysis of bacteriological contamination, Coliform test using selective media Eosin Methylene Blue were performed to confirm the presence of Escherichia coli. Standard chemical methods were used to assess chemical contamination. Among the investigated chemicals included sulfates, nitrates, nitrites and total soluble solids (TSS). The results revealed that most of the samples did not agree with the rules of the World Health Organization and found contaminated with various chemicals. Among them, the highest coliform count was observed in samples obtained from various hotels that have the most probable number (MPN) of 33 /100 ml, followed by water samples having wells MPN 13/ 100 ml. In addition, water samples from drilled wells were found with MNP low of 0 / 100 ml. In regard to chemical pollution, most of the samples chemical contamination was detected in the limit permitted under the World Health Organization (WHO) and the U.S. Environmental Protection Agency (USEPA).

Key words: Bacteriological, Chemical analysis, Water Samples, Public water

Introduction

Water is one of the essential natural resources given by the creator. In Holy Quran it's stated that "We have kept alive everything from water". So it proves that without water life can't go on. We can live without food for many days or weeks, but without water we can die less than a week [12].

Water is most vital liquid for maintaining the life on the earth. About 97% water is exists in oceans that is not suitable for drinking and only 3% is fresh water wherein 2.97% is comprised by glaciers and ice caps and remaining little portion of 0.3% is available as a surface and ground water for human use .Safe drinking water is a basic need for good health and it is also a basic right of humans. Fresh water

is already a limiting resource in many parts of the world. In the next century, it will become even more limiting due to increased population, urbanization and climate change [13]. Unfortunately, in developing countries (i.e. Pakistan) the drinking quality of water is continuously being contaminated and hazardous for human use due to high growth of population, expansion in industries, throwing away of waste water and chemical effluents into canals and other water sources

All living organisms require a variety of inorganic compounds for growth, repair, maintenance and reproduction and such inorganic compounds are abundant in water. Hence, water plays an essential role in human life. Several studies indicated that consumption of untreated or poorly treated water lead to the outbreak of waterborne diseases such as typhoid, cholera and bacillary dysentery. In our country 70% of the water is seriously polluted and75% of illness and 80% of the child mortality is attributed to water pollution [14]

Water is a basic requirement for all living creatures; among them the most important use is drinking [Park 1997] Water quality get weaken due to increase in population, industrial development and unhygienic conditions in all parts of the world[16]. In Pakistan fresh water sources are glaciers, rivers and lakes but due to low rainfall and snowfall, Pakistan is suffering from water deficit. So to solve this problem, people rely on ground water. It is an important natural resource for various human activities [17]. In developing world water pollution is one of the alarming issues, especially caused by animal waste, industrial, household effluent and heavy metals. High concentration of the heavy metals like arsenic and lead has been found in water both in developed and developing countries [18]

Fecal pathogens such as salmonella, Shigella and E.coli are involved in the fecal contamination of water linked to

excessive nutrient levels in drinking water. In addition to biological contamination heavy metal is present in drinking water which adds pollution to food chain. [21]

In the developing countries more than 60 percent population has no access to pure drinking water [19]. Pakistan has recognized the existence of four major water quality problems such as bacteriological contamination (68%), arsenic (24%), nitrate (13%) and fluoride (5%) in the surface or groundwater sources [20]. Nitrate gets into water body by fertilizers, animal wastes and municipal sewage treatment system.

The aim of this study was to investigate the quality of water in terms of chemical and bacterial contamination and to bring about awareness to the local people about the quality and standard of drinking water.

Materials and Methods

Sample Collection:

Total 100 samples were collected in sterile, labeled bottles in strict hygienic conditions in ice-added container and were promptly transferred to lab for analysis these samples were collected from different areas of KhyberPakhtoonkhwa.

Bacteriological analysis:

For Bacteriological analyses, various tests were performed in a step-wise pattern to confirm the presence of Pathogens in Water samples. Presumptive Coliform Test was applied to determine Most Probable Number (MPN) of Coliform through Multi-tube technique. The samples positive for Presumptive test were again subjected to different tests for confirmation of *E. coli* presence. For this purpose, EMB agar was used to culture the samples. The samples were streaked on agar plates, labeled with a specific source code and incubated for 24-48 hours at 37 C^o. The 24-hours positive samples were again

cultured. Each positive sample was cultured on Lactose broth and Nutrient agar slant and incubated at 37 C^o for 24 hours.

Chemical analysis:

To study the chemical profile of water samples from numerous public water supplies, various quantitative tests were applied.

Statistical analysis

All the treatment of experiment was performed in triplicates. Statistical analysis of the data was conducted by using graph pad prism. The data was arranged and mean value was compared with Standard deviation.

Nitrite in water:

Nitrite, produced by nitrifying bacteria present in water in gaseous state is injurious to health very dangerous minute amount. To quantify Nitrite, 50 ml of the sample was taken in conical flask, 1ml each of Aliosy A (a chemical) and Aliosy B (a chemical) were added to the sample. After 15 minutes, result was recorded which was development of pink color in positive samples.

Nitrate in water:

Nitrates generally occur in trace quantities in surface waters but may attain high levels in some ground waters. To quantify Nitrates in water, 50 ml of sample was taken in a china dish and put on water bath to evaporate all the water. The residue remained below was then treated with Brucine in the presence of an inorganic acid, which gave red chili color of positive reaction.

Total soluble solids (TSS):

It should not be more than 500 mg/liter in a good sample of water. For the purpose, 50 ml water sample was taken in a china dish of 125 ml with known weight and placed in a Hot-air

Oven till the entire sample was evaporated. Weight of the empty china dish was again weighed. Difference between the two weights was found out and calculated as Total Soluble Solids (TSS) contained in water.

Sulphates in water:

To point out Sulphates in water sample 50 ml of the sample was taken in a conical flask of 100 ml. Five ml of 5 percent Barium Chloride solution was added to the contents of the flask. If Sulphates was present the solution became turbid. $BaSO_4$ is produced in the form of precipitate. Now, the sample was filtered and dried in a hot air oven at 105 C^o and weighed as Barium Sulphates. Now Sulphates was calculated as:

Suppose, 50 ml contained Sulphates = x

1cc contains Sulphates = x/50 = b

1000cc contains Sulphates = b X 1000

This gives grams/liter to convert into mg divide it by 1000.

Results

The results of the current study revealed that out of 100 samples tested for bacteriological and chemical contamination, hotels water was observed to be more contaminated as compared to other sources in terms of bacteriological contamination. The analyzed water of Khyber Pakhtunkhwa was also contaminated in terms of chemical contamination but was in safe limits. The results are tabulated below showing bacterial and chemical contamination.

Table 1. Fecal coli forms in the water samples

S.no	Source of water	Total samples	Fecal coli form positive
1	Bore water	20	6
2	Well water	20	11
3	Bottled water	20	4
4	Hotels	20	14
5	Tap water	20	12

Table 2.Bacteriological analysis of bore water

S.no	Sample Code	MPN 10ml	MPN 1ml	MPN 0.1ml	MPN result	Fecal Coliform
1	24	0	0	0	0	-
2	25	3±0.5	0	1±0.5	11±0.5	+
3	28	1±0.5	0	0	2±0.1	-
4	43-A	0	0	1±0.5	2±0.1	+
5	44-A	0	0	0	0	-
6	45-C	0	0	0	0	_
7	12	0	1±0.07	3±0.5	7±1	+
8	10-K	0	0	0	0	_
9	11-B	0	0	0	0	_
10	36-D	1±0.5	0	0	2±0.1	-
11	56-M	3±0.5	1	0	11±0.5	-
12	80-K	0	0	0	0	-
13	123-T	3±0.2	0	0	8±0.62	+
14	100-KK	0	0	0	0	-
15	45-B	1±0.27	0	0	2±0.1	-
16	18-N	1±0.07	3±0.5	0	8±0.62	-
17	15-S	3±0.5	1±0.5	0	11±0.5	+
18	28-P	0	0	0	0	-
19	65-H	2±0.1	1±0.5	0	7.6±1.1	+
20	32-BD	0	0	0	0	-

Table 3.Bacteriological analysis of well water

s.no	Sample lab no	MPN 10ml	MPN 1 ml	MPN o.1ml	MPN result	Fecal coli form
1.	Kk1	4±0.6	0	4±0.6	30±1.05	+
2.	Kk2	3±0.5	2±0.1	1±0.5	17±0.6	+
3.	Kk3	0	0	0	0	-
4	Bu 21	3±0.5	0	1±0.5	11±0.5	+
5.	Dik 54	1±0.5	0	0	2±0.1	-
6.	Sw 12	1±0.5	4±0.6	0	11±0.5	+
7.	Psh 2	0	0	0	0	-
8.	Psh 3	1±0.5	2±0.1	4±0.6	15±0.36	+
9.	Kt 45	4±0.6	1±0.5	0	17±0.6	+
10.	Kt 36	4±0.6	2±0.1	1±0.5	26±0.7	+
11.	Kt 47	0	0	0	0	-
12.	Tk 89	0	0	0	0	-
13.	Tk 45	4±0.6	0	0	13±0.2	+
14.	Lm 20	3±0.5	1±0.5	0	11±0.5	+
15.	Lm 21	0	0	0	0	-
16.	Ht 15	0	0	0	0	-
17.	Ns 10	4±0.6	1±0.5	1±0.5	21±1.1	+

18.	Mat 14	2±0.1	1±0.5	0	7±1	+
19.	Mat 16	1±0.5	1±0.5	1±0.5	6±0.3	-
20.	Mat 17	3±0.5	0	1±0.5	11±0.5	-

Table 4.Bacteriological analysis of bottled water

s.no	Sample lab no	Mpn 10ml	Mpn 1ml	Mpn o.1ml	Mpn result	Fecal coli form
1.	Khyber safe	1±0.5	1±0.5	1±0.5	6±0.3	+
2.	Saha purified	0	0	0	0	-
3.	Aqua safe-03	2±0.1	0	0	5	+
4.	Healthy	0	0	0	0	-
5.	Nestle -05	0	0	0	0	-
6.	Aqua fina-06	0	0	0	0	-
7.	Kinley clean	0	0	0	0	-
8.	Premium water	1±0.5	0	0	2±0.1	+
9.	Safa pure-09	0	0	0	0	-
10	Al saudia-10	0	0	0	0	-
11.	Ultra pure-11	0	0	0	0	-
12.	Nestle -A	0	0	0	0	-
13.	Nestle -B	0	0	1±0.5	2±0.1	+
14.	Nestle-c	0	0	0	0	-
15.	Nestle pure life	0	0	0	0	-
16.	Pure drinking water (Tb)	0	0	0	0	-
17.	Sparkletts pure waer	0	0	0	0	-
18.	Life quality water	0	0	0	0	-
19.	BSW water	0	0	0	0	-
20.	Aqua clear	0	0	0	0	-

s.no	Sample labno	Mpn 10ml	Mpn 1ml	Mpn o.1ml	Mpn result	Fecal coli form
1	Jalil kababi 1	4±0.6	3±0.5	1±0.5	33±1.2	+
2	Taraskoon psh	1±0.5	0	0	2±0.1	+
3	Habibi psh	0	1±0.5	1±0.5	4±0.6	+
4	Marcopolo psh	2±0.1	1±0.5	1±0.5	9±0.1	+
5	Kashmir hotel kt	1±0.5	0	0	2±0.1	+
6	Shinwari hotel kt	3±0.5	1±0.5	1±0.5	14±0.9	+
7	Speen Ghar kt	4±0.6	0	0	13±0.5	+
8	Jans hotel kt	0	5±1.1	5±1.1	19±0.89	+
9	Moon hotel kk	1±0.5	1±0.5	1±0.5	6±0.3	+
10	Shahid hotel kk	0	0	0	0	-
11	Super waziristan kk	0	4±0.6	2±0.1	11±0.5	+
12	Zam zam hotel kk	3±0.5	2±0.1	4±0.6	27±0.36	+
13	Pak afghan kt	4±0.6	1±0.5	1±0.5	21±1.1	+
14	Zaman hotel bu	0	0	0	0	-
15	Fish point bu	2±0.1	5±1.1	5±1.1	32±0.77	+
16	Tank hotel dik	0	0	0	0	-
17	Malik hotel dik	4±0.6	0	0	13±0.2	+
18	Zaiqa hotel dik	0	0	0	0	-
19	Gul hotel dik	0	0	0	0	-
20	Babu hotel kt	0	0	0	0	-

Table 5.Bacteriological analysis of hotels water samples

Table 6.Bacteriological analysis of tap water

S.No	Sample lab no	Mpn 10ml	Mpn 1 ml	Mpno.1ml	Mpn result	Fecal coliform
1	102 A	0	1±0.5	1±0.5	4±0.6	+
2	103 B	4±0.6	0	1±0.5	17±0.6	+
3	104 C	3±0.5	0	0	8±0.4	+
4	105 D	2±0.1	1±0.5	1±0.5	9±0.1	+
5	106 E	4±0.6	2±0.1	2±0.1	32±0.77	+
6	107 F	4±0.6	0	0	13±0.2	+
7	108 G	3±0.5	1±0.5	1±0.5	14±0.9	+
8	109 H	1±0.5	1±0.5	0	4±0.6	+
9	110 I	3±0.5	2±0.1	2±0.1	20±1.3	+
10	111 J	1±0.5	0	0	2±0.1	+
11	112 K	1±0.5	0	1±0.5	4±0.6	+
12	113 L	4±0.6	0	0	20±	+
13	114 M	1±0.5	0	0	3±0.5	+
14	115 N	3±0.5	1±0.5	2±0.1	17±0.6	+
15	116 N	0	0	0	0	-
16	117 O	2±0.1	1±0.5	1±0.5	9±0.1	+
17	118 D	3±0.5	1±0.5	0	11±0.5	+
18	119 C	2±0.1	2±0.1	1±0.5	12±0.7	+
19	120 W	1±0.5	1±0.5	1±0.5	6±0.3	+
20	121 B	3±0.5	4±0.6	0	21±1.1	+

Table 7.Chemical analysis of bore water

S.no	Nitrate (mg/l)	Nitrite (mg/l)	Total Soluble Solids (TSS)	Sulphates (mg/l)
1	0.99	0.025	10	4.67
2	0.60	0.011	8	5.11
3	0.09	0.021	20	4.67
4	0.28	0.007	52	5.67
5	0.19	0.006	120	5.01
6	0.11	0.007	45	8.01
7	0.22	0.015	02	6.11
8	0.42	0.036	230	3.67
9	0.44	0.027	150	8.02
10	0.31	0.013	420	3.33
11	0.24	0.006	65	6.11
12	0.20	0.011	300	6.67
13	0.23	0.114	320	7.67
14	0.18	0.018	105	5.01
15	0.29	-	400	8.02
16	0.60	-	165	6.11
17	0.42	0.013	180	3.67
18	0.11	0.021	120	-

19	0.15	0.015	65	2.51
20	-	0.12	32	6.23

Table 8.Chemical analysis of well water

S.No	SO4 mg/l	NITRATE mg/l	NITRITE mg/l	TOTAL SOLUBLE SOLIDS
1	0.5	0.32	-	20
2	2.5	0.98	-	48
3	3.10	0.52	0.012	32
4	8.52	0.21	0.033	56
5	1.77	1.03	0.05	89
6	5.6	0.336	0.068	120
7	4.25	0.58	-	410
8	2.3	0.46	0.23	210
9	5.23	0.65	-	325
10	8.36	2.11	0.078	650
11	2.33	0.15	0.021	21
12	9.10	1.32	0.045	65
13	7.25	1.21	0.065	34
14	1.5	0.54	0.023	152
15	6.41	0.69	-	140
16	7.12	-	-	65
17	3.33	0.32	0.015	365
18	2.56	0.89	0.054	250
19	4.98	0.99	-	654
20	1.77	0.12	-	100

Table 9.Chemical analysis of bottled water

S.No	SO4 mg/l	NITRATE mg/l	NITRITE mg/l	TOTAL SOLUBLE SOLIDS
1	0.01	0.23	0	20
2	0	0	0	12
3	0	0.12	0.001	8
4	0	0	0.021	15
5	0	0	0	0
6	0	0	0.21	23
7	0	1	0.2	32
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0.36	0.25	50
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0

16	0	0	0	0
17	0	0	0	0
18	0	8	0.056	42
19	0	1	0	20
20	0	0	0	0

Table 10.Chemical analysis of hotels water

S.NO	SO4 mg/l	NITRATE mg/l	NITRITE mg/l	TOTAL SOLUBLE SOLIDS
1	1.2	0	0	23
2	0	0	0	14
3	0	0.12	0.001	8
4	0	0	0.021	15
5	0	0	0	0
6	0	0	0.21	23
7	0	1	0.2	32
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0.36	0	50
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0.56	42
19	0	1	0	20
20	0	0	0	0

Table 11.Chemical analysis of tap water

S.No	SO4 mg/l	NITRATE mg/l	NITRITE mg/l	CHLORIDE mg/l	TOTAL SOLUBLE SOLIDS
1	0	0	0	29	30
2	0	0	0	6	6
3	0	0.12	0.001	6	10
4	0	0	0.021	25	32
5	0	0	0	0	0
6	0	0	0.21	0	5
7	0	1	0.2	20	24
8	0	0	0	2	4
9	0	0	0	21	26
10	0	0	0	0	0
11	0	0.36	0	0	7
12	0	0	0	0	0

13	0	0	0	6	8
14	0	0	0	10	15
15	0	0	0	54	70
16	0	0	0	32	50
17	0	0	0	12	35
18	0	0	0.56	45	55
19	0	1	0	21	40
20	0	0	0	0	0

Discussion

Out of the 100 samples collected from various area of Khyber Pakhtunkhwa 48% of the samples were positive for fecal coliform. Among which samples taken from Hotels were more contaminated as compared to other sources. Our findings were in agreement with the findings of Nawab *et al.,* 2013 who observed 43.5% of the samples to be fecally contaminated in the areas Mohamand agency and Kohat. [1]

For analyzed water of Khyber Pakhtunkhwa the highly contaminated source was the hotels and restaurants which were found fecally contaminated. Our findings were nearly similar to as he found 74 percent of the hotels samples to be fecally contaminated

High levels of Coli form bacteria were present in water samples which were taken from both source and point of use. Total Coli form counts in most cases were > 34 CFU/100mL, in our study .This was not in accordance with the accepted WHO standard (0 CFU). Water from deep boreholes is normally free of pathogenic microbiological contaminants. For analyzed water of Khyber Pakhtunkhwa bore holes samples bacterial growth was not observed. This was similar to the findings of Zvidzai *et al,*.2007, where most of the bore hole samples were not contaminated.[2]

The nitrates are within the safe limits according to the EPA and WHO. The value recommended by WHO is between 40 - 50 mg/l. For the analyzed water of Khyber Pakhtunkhwa the values ranged from 0-8 mg/l, which is an allowable limit. Our

findings were in agreement with the findings of Soomro *et al* . 2011 as his report showed that water of KPK was not contaminated with nitrates. [11]

The level of chloride is just below the safe drinking standard. The standard is 250 mg/l. Our findings were in accordance with the standards of WHO,1996; APHA 1998; PCRWR, 2005; WHO, 2006).Previous findings for chloride were observed to be higher as conducted by Khan *et al.,* 2012.[8,9,10,6]

Total Soluble Solids

It's the expression of the organic pollution of water. Allowable values of TSS ranges between 500 and 1500 mg/l. For analyzed water of Khyber Pakhtunkhwa, the values of TSS were between 0 and 654 mg/l for the majority of sources examined. Our findings were not in agreement with Khan *et al.,* 2012 and A.R khan et al ., 2000, as they conducted similar studies in Kohat and Mardan respectively as they found the values to be higher than our study.[5]

Sulphates

The Sulphates in water represent agricultural pollution. The value allowed by the USEPA is ≤ 250 mg/l. For water of the Khyber Pakhtunkhwa, the values of sulphates were between 0 and 9.10 mg/l, with the high values reported coming from well water source (0 – 9.10 mg/l). In all the cases, water of Khyber Paktunkwa is not polluted according to their Sulphates content. This was not in accordance with the similar study conducted by saeeda *et al.,* 2010 in which they reported the Hand pumps water source to be more concentrated with sulphates.

Chlorides

The Chlorides in water are known to come from rainwater. In water of Khyber Paktunkwa, the values obtained were between

0 and 54 mg/l. This water is thus low in chlorides and of good quality with respect to chlorides. Our findings were in agreement with the findings of saeeda *et al.,* 2010 and were not in agreement with the findings of khan *et al.,* 2012 as chloride concentration was higher in their samples.[4,5]

Conclusion

It is concluded that most of the water sources were all unacceptable Total coliform count and all water sources were positive for presumptive coli form count had E.coli showing fecal contamination of water sources, and we recommend regular disinfection of drinking water sources, periodic bacteriological appraisal of drinking water sources, and construction and distribution of piped water. Besides this the water sources were chemically contaminated as well. The chemical contamination should be removed by having good industrial waste management practices.

Acknowledgment

We are thankful to the Department of Microbiology Kohat University of Science and Technology, Khyber Pakhtoonkhwa, Pakistan for providing the research facility. We are thankful to Dr. Mirina Sakhi, Basreen Akhtar and Saima khan for finalizing the data and doing the Statistical data.

REFERENCES:

APHA. American Public Health Association. 1998. *Standard methods for the examination of water and waste water*. 20th edition. United State of America. [9]

Berger, P.S. and R.K. Oshirio. 2002. "Source water protection." *Microbiology of Source Water* 2967-2978 [12]

Bryant, S.D. 2004. "Lead-contaminated drinking water in the public schools of Philadelphia." *Journal of Toxicology and Clinical Toxicology* 42: 287-294 [18]

Food and agriculture organization (FAO). 2010. "Natural resources and water management, water unit." United Nation Organization. [16]

Jackson R. B. et al. 2001. *Water in Changing World. Issues in Ecology*, 9. Washington, DC: Ecological Society of America, 1-16. [13]

Khan, A. R., Ibrar Ul Haq, Waqar A. Khan, M. Akif, Mumtaz Khan, and M. Riaz. 2000. "Quality characteristics of potable water of Mardan city (Pakistan) and Surrounding Areas." *Journal of Chemistry and Sociology* 22(2) [5]

Khan, M., Ihsanullah, Sharafat T., Mehmud F., and Sattar A. 2000. "Occurrence of pathogenic microorganisms in food and water supplies in different areas of Peshawar, Nowshera and Charsadda." *Pakistan Journal of Food Sciences* 10(3-4):31-34. [19]

Muhammad, A.T. and Hifza, R. 2008. "Distribution of nitrate in the water resources of Pakistan." African Journal of Environmental Science & Technology." 2(11):397–403. [20]

Naeem, K., Hussain, S. T., Javid, H., Nargis, J., Shabir, A., Riaz, U., Zain, U., and Abdus, S. 2012. "Physiochemical evaluation of the drinking water sources from district Kohat, Khyber Pakhtunkhwa, Pakistan." *International Journal of Water Resources and Environmental Engineering* 4(10): 302-313. [3]

Nawab, A., Ayaz, A., Jauhar, S., Farman, U., Waheed, U., AND Zia, U.R. 2013. "Biochemical and microbiological evaluation of the water samples collected from different areas of district Kohat and Mohamand Agency, Pakistan." *Pure Applied Journal of Biology* 2(3): 96-103. [1]

Park, K. 1997. In: *Text book of Preventive and Social Medicine*. Jabalpur: Banarsidas Publication. [15]

PCRWR. 2005. Pakistan Council of Research in Water Resources. Islamabad, Pakistan. Workshop to finalize National Drinking Water Quality Standards, 01-04 March, 2005. Health Services Academy, Ministry of Health, Pakistan. [10]

Prasad, B.G. and T.S. Narayana. 2004. "Subsurface water quality of different sampling stations with some selected parameters at Machilipatnam town." *International Journal of Environment and pollution Techniques* 3(1): 47-50. [17]

Saadullah, Hidayatullah, M. Daud, B. Akhtar, Imran K., Ghazi, R., Maqsood, Q., Arshad, Q., Waqar, Y., Allah, N., Sajad, A., Zenat, F. K., Mirina, S., and Muhammad, M. 2014. "Bacteriological and Physico-Chemical Analysis of Irrigation Water Sources of Kohat, Pakistan." *International Journal of Advancements in Research & Technology* 3(3). [21]

Saeeda, Y., Amir, Z. and Owais, M. 2013. "Physico-chemical characteristics of potable water of different sources in District Nowshera: A case study after flood – 2010." *Journal of Himalayan Earth Sciences* 46(1): 83-87. [4]

Soomro, Z. A., M. I. A. Khokhar, W. Hussain and M. Hussain. 2011. "Drinking Water Quality Challenges in Pakistan." World Water Day April. 17-28. [11]

WHO. 2006. *World Health Organization' Guidelines for drinking-water quality*. First addendum to 2nd edition: Recommendations 1. Geneva. [6]

WHO. World Health Organization. 1986. "Health impact of acidic deposition and Science." *Total Environment* 52: 157-187. [7]

WHO. 1996. *World Health Organization' Guidelines for drinking water quality, health criteria and other supporting information.* 2nd edition. Geneva. 2. [8]

Zoeleman, B.C.G. 1980. Oxford. Pergaman Press. U.K. [14]

Zvidzai, C. 2007. "Microbial community analysis of drinking water sources from rural areas of Zimbabwe." *African Journal of Microbiology Research* 1(6): 100-103. [2]