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Functional status and water quality analysis of fifty-six water purification plants established at Gilgit District, Pakistan

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Abstract

The current study was aimed to check the functional status and water quality analysis of 56 water purification plants established at district Gilgit. Sampling activity for water quality analysis and functional status was checked during the second week of September 2014. Functional status observed by doing onsite field visits and inspecting various parts of the plant. Bacteriological analysis of 22 water samples showed that its quality was very poor, i.e. grossly polluted with fecal matter. Sample taken from Nagral Kulchiniote Girls Middle School Water Purification Plant and Jamia Mosque Soniyar Jaglote showed the highest level of colonies with fecal contamination. Other 20 showed colonies ranged from 9 to 77 in the water being supplied, which is a serious health hazard and can result different water borne diseases like typhoid, diarrhea, and gastroenteritis among masses. Poor sanitary and hygienic conditions around the plant site, leakage in pipes, improper management and malfunctioning of different parts of filtration plants are the main cause of the problem. Fifteen were not operational due to different reasons. Some have damaged supply line pipes, storage tank damage, not installation of filters, lack of water supply connections, compensation issues and job demands from land donors.

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Introduction

Drinking water must be free from components, which may negatively affect the human health. Such components include minerals, organic substances and disease causing microorganisms. A large portion of the population in developing countries go through from health problems linked with either lack of drinking water or due to the presence of microbiological contamination in water. Poor water quality is responsible for the death of an estimated 5 million children in the developing countries. The problem is further provoked by rapid increasing population, which results in poor water quality management (Ali *et al.,* 2014; Haydar *et al.,* 2009).

According to Pakistan Council of Research in Water Resources (PCRWR Report, 2013), federal, provincial and local governments in Pakistan have installed many water purification plants all over the country to provide safe drinking water to public. Sustainable supply of safe drinking water through these water purification plants is an important issue as the efficacy of providing safe drinking water from these plants is dependent on operational and maintenance, capacity of plant operators and water quality monitoring.

The people of Gilgit district faces a number of water related health hazards. These problems arise primarily due to the increasing level of qualitative and quantitative depletion of water resources owing to over utilization. Water Purification Plants have been installed at various locations of the district to reduce the degradation of water quality and to ensure a healthy environment. Purification plants serve drinking water to large urban areas and small rural communities and thus represent an essential service to general public. Although such kinds of technologies have introduced for removing undesirable chemicals, materials, and biological contaminants from raw water, but lack of proper maintenance and monitoring, most of these plants are malfunctioning and water supplied by these plants have serious health hazards including different water borne diseases like typhoid, diarrhea, and gastroenteritis etc. among masses.

The present study was carried out to check the functional status and water quality analysis of 56 water purification plants established at Gilgit district. According to analytical results and inspection of functional status it was found that only nineteen were providing safe drinking water, twenty two plant's water being supplied was unsafe for drinking purposes according to WHO guidelines and NEQS standards while fifteen were not operational due to different reasons lie damaged supply lines, storage tanks, lack of electricity, compensation and job demands from land donors.

Material and methods

Functional status and sampling activity for water quality analysis was carried out during the second week of September, 2014. Functional status was observed by doing onsite field visits and checking different parts of the plant (Fig. 1-4). One sample was taken from each plant site for water quality analysis. The surveillance Program has been prepared according to WHO Surveillance Monograph 1996 and the Sampling Procedure adopted was "Environmental Sample Rules, 2001" by Pakistan Environmental Protection Agency and Ministry of Environment Government of Pakistan. Selected Physio-chemical parameters like temperature, turbidity, and pH were tested on the site while for the microbiological analysis samples were brought to GB Environmental Protection Agency laboratory.

Fig. 1. Fatah Bag WP Leaky overhead water tank.

Fig. 2. Human excreta at DHQ hospital MW Fitration Plant.

Fig. 3. Broken pipeline at Old polo ground WPP, Gilgit.

Fig. 4. Overhead tank without cover at DHQ Hospital.

Measurement of parameters

pH

Potatest pH meter provided by Waq Tech Water Testing Kit was used to measure pH of water samples. First cap of pH meter was removed then "On" button was pressed. Electrode was dipped about 2cm in to the sample. After stirred once let to stabilize reading. pH reading was noted.

Turbidity

Nephrometric Turbidity tubes were used to measure turbidity of water samples. First the three tubes were connected together, then water was poured gradually into the tubes. Looked water from the top of the tube across at bottom of the tube. Read level of water where cross just disappear and recorded the value.

Microbiological Analysis

Weq Tech Water Testing Kit was used for microbial analysis. Weq Tech Water Testing kit, which employ the Membrane Filtration Technique and membrane Lauryle Sulphate Broth as medium. A 100ml volume of water was sucked through the membrane (fitted in the sterile membrane unit) with the help of Vacuum Pump. The membrane was then placed on the absorbent pad saturated with Membrane Lauryl Sulphate Broth in sterile Aluminum Petri Dish. The plates were than incubated for 18 hours at 40-44 C. After incubation period all yellow colonies on the membrane were counted and reported in per 100 ml of water.

Results and discussion

Temperature

Temperature is biologically an important factor, which plays an important role in proper functioning of all living things. Microbial load in water will be lower if temperature remains below 15°C (EPA, 1976). It was found that temperature of the samples collected from Purification Plants at Alamdar Chowk Khomer, Army Public School & College, Public School & College Boys wing, Pubic School & College girl's wing, Public School & College Prep Section, Fatah Bagh, and DHQ Hospital Mail Wing, DHQ Hospital

Female wing, SP office, GB Legislative Assembly, Danyore Shingote, Sultanabad, Nomal and KIU ranges from 17, 18, 19, 19, 19, 19, 18, 17, 22, 20, 22, 20, 19, and 21°C respectively (Tables 1, 2).

Table 1. Results of Water Purification Plants Providing Safe Drinking Water.

S#	Sampling Point	Volume Filtered (ml)	Results		Temp °C	pH	Turbi-dity	Colour	Odour	Taste
			E.Coli found	E.Coli/ 100ml						
1	Alamdar Chowk, Khomar Purification Plant	100ml	0 col	0/100ml	17	7.1	<5NTU	Clear	No Obj	No Obj
2	Army Public School & College Jutial Water Purification Plant	100ml	0 col	0/100ml	18	7.6	<5NTU	Clear	No Obj	No Obj
3	Public School & College Jutial (Boys Wing) Water Purification Plant	100ml	0 col	0/100ml	19	7.3	<5NTU	Clear	No Obj	No Obj
4	Public School & College Jutial (Prep Wing) Water Purification Plant	100ml	0 col	0/100ml	19	7.3	<5NTU	Clear	No Obj	No Obj
5	Public School & College Jutial (Girls Wing) Water Purification Plant	100ml	0 col	0/100ml	19	7.3	<5NTU	Clear	No Obj	No Obj
6	Fatah Bagh Water Purification Plant	100ml	0 col	0/100ml	19	7.2	<5NTU	Clear	No Obj	No Obj
7	DHQ Hospital (Male Wing) Water Purification Plant	100ml	0 col	0/100ml	18	7.8	<5NTU	Clear	No Obj	No Obj

Table 2. Results of Water Purification Plants Providing Safe Drinking Water.

S#	Sampling Point	Volume Filtered (ml)	Results		Temp °C	pH	Turbi-dity	Colour	Odour	Taste
			E.Coli found	E.Coli/ 100ml						
8	DHQ Hospital (Female Wing) Water Purification Plant	100ml	0 col	0/100ml	17	7.1	<5NTU	Clear	No Obj	No Obj
9	SP office Konodas Water Purification Plant	100ml	0 col	0/100ml	22	7.6	<5NTU	Clear	No Obj	No Obj
10	GB Assembly Water Purification Plant	100ml	0 col	0/100ml	20	7.5	<5NTU	Clear	No Obj	No Obj
11	Danyore Shangote Billing Sub Station Water Purification Plant	100ml	0 col	0/100ml	22	7.2	<5NTU	Clear	No Obj	No Obj
12	Sultanabad Dispensary Danyore Water Purification Plant	100ml	0 col	0/100ml	20	7.5	<5NTU	Clear	No Obj	No Obj
13	Nomal Jama Masjid Water Purification Plant	100ml	0 col	0/100ml	19	7.7	<5NTU	Clear	No Obj	No Obj
14	KIU Water Purification Plant	100ml	0 col	0/100ml	21	7.6	<5NTU	Clear	No Obj	No Obj

Average temperature recorded from the samples taken from the purification plants at Shahkarim Hostel, Usmanabad Baseen, Khomar Yarkote, Jagheer Baseen, Shakyote, Khomer yarkote, Zulfikarabad, Sakwar, Jutial Busstand, Agha Mohallah, Nagaral kulchineote, and city park ranges from 22, 20, 20, 21, 24, 18, 18, 18, 24, 18, 21, and 22 °C respectively **(**Tables 3,4). Results Providing Unsafe Drinking Water were recorded from the samples of Kashrote Mohammadi Mohallah, Kashrote Usmania Mohallah, Kashrote Girls High School, Gulsher Colony Konodas, Markaz Colony Konodas, Brgeli Mohallah Khomer Damote, Kazlibash Mohallah, Narway Workshop Konodas, Khari Baseen, Wezra Baseen, Baseen Kote Mohallah, Hyderpura, Jamia Masjid Eidgah Joglote, Jamia Masjid Soniyar Joglote, and Powerhouse Soniyar Joglote respectively **(**Tables 5,6). Temperature examination revealed a little variation in results between 17-22°C. A similar study on drinking water quality assessment in some selected villages of Nagar valley Gilgit-Baltistan recorded a little fluctuation in results between 12.10-13.50 °C (Ali *et al.*, 2013)

Table 3. Results of Water Purification Plants Providing Safe Drinking Water.

S#	Sampling Point	Volume Filtered (ml)	Results		Temp °C	pH	Turbidity	Colour	Odour	Taste
			E.Coli found	E.Coli/ 100ml						
15	Shah Karim Hostel Water Purification Plant	100ml	0 col	0/100ml	22	7.5	<5NTU	Clear	No Obj	No Obj
16	Usmanabad Basin Water Purification Plant	100ml	0 col	0/100ml	20	7.5	<5NTU	Clear	No Obj	No Obj
17	Khomer Yarkot Water Purification Plant	100ml	0 col	0/100ml	20	7.5	<5NTU	Clear	No Obj	No Obj
18	Jagir Baseen Water Purification Plant	100ml	0 col	0/100ml	21	7.0	<5NTU	Clear	No Obj	No Obj
19	Shakiote Water Purification Plant	100ml	0 col	0/100ml	24	6.7	<5NTU	Clear	No Obj	No Obj

Table 4. Results of Water Purification Plants Providing Unsafe Drinking Water.

S#	Sampling Point	Volume Filtered (ml)	Results		Temp °C	pH	Turbidity	Colour	Odour	Taste
			E.Coli found	E.Coli/100 ml						
1	Khomer Yarkot Water Purification Plant	100ml	13 col	13/100ml	18	6.8	<5NTU	Clear	No Obj	No Obj
2	Zulfiqar Abad Water Purification Plant	100ml	23 col	23/100ml	18	7.5	<5NTU	Clear	No Obj	No Obj
3	Sakwar School Mohallah Water Purification Plant	100ml	57 col	57/100ml	18	7.1	<5NTU	Clear	No Obj	No Obj
4	Jutial Bus Stand Water Purification Plant	100ml	77 col	77/100ml	24	6.5	<5NTU	Clear	No Obj	No Obj
5	Agah Muhallah Water Purification Plant	100ml	9 col	9/100ml	18	7.4	<5NTU	Clear	No Obj	No Obj
6	Nagral Kulchinot Girls Middle School Water Purification Plant	100ml	TNT col	TNT/100 ml	21	6.2	<5NTU	Clear	No Obj	No Obj

S#	Sampling Point	Volume Filtered (ml)	Results		Temp °C	pH	Turbidity	Colour	Odour	Taste
			E.Coli found	E.Coli/100ml						
7	City Park Water Purification Plant	100ml	4 col	4/100ml	22	7.6	<5NTU	Clear	No Obj	No Obj

Turbidity

Turbidity is the measurement of relative clarity of water. Turbidity in water is due to the presence of suspended substances like clay, silt, and microscopic organisms and it can also be a source of nutrients for microorganisms (WHO, 2006). Turbidity values examined from all the water purification plants revealed 5 NTUs **(**Tables 1, 2, 3, 4, 5, 6). According to WHO and NEQS turbidity must not exceed 5 NTUs and water having turbidity. Turbidity results of all the samples were within the recommended levels as samples were tested after filtration process. A little fluctuation in the findings of tested samples was observed that varied between 0.20-0.38 NTUs. Maximum turbidity value was found in Nilt tank water while the lowest values were found in Ghulmet tape and tank water in a study "water quality assessment in some selected villages of Nagar valley Gilgit-Baltistan (Ali *et al*., 2013).

Turbidity results showed the suitability of tested water samples for drinking purposes. A similar study on physio-chemical and bacteriological drinking water quality analysis of Sultanabad, Gilgit by Jabeen & Shedayi (2011), found very high turbidity values. Source sample showed value of 256 NTU, tank water it was 169 NTU and house tape it was 259NTU.

pH

pH is the intensity of acid or alkaline conditions of a solution; naturally all waters are slightly alkaline which results in the presence of carbonates (Wright *et al.,* 1996). pH values from Alamdar Chowk Khomer, Army Public School & College, Public School & College Boys wing, Pubic School & College girl's wing, Public School & College Prep Section, Fatah Bagh, and DHQ Hospital Mail Wing, DHQ Hospital Female wing, SP office, GB Lagislative Assembly, Danyore Shingote, Sultanabad, Nomal and KIU water purification plant ranges from 7.1, 7.6, 7.3, 7.3, 7.3, 7.2, 7.8, 7.1, 7.6, 7.5, 7.2, 7.5, 7.7, and 7.6 respectively (Tables 1, 3). pH results of examined samples fluctuated between 7.00-7.93. pH value of 7.5, 7.5, 7.5, 7, 6.7, 6.8, 7.5, 7.1, 6.5, 7.4, 6.2, and 7.6 have found in water purification plant of Shahkarim Hostel, Usmanabad Baseen, Khomar Yarkote, Jagheer Baseen, Shakyote, Khomer yarkote, Zulfikarabad, Sakwar, Jutial Busstand, Agha Mohallah, Nagaral kulchineote, and city park respectively (Tables 5,7).

Water purification plants at Kashrote Mohammadi Mohallah, Kashrote Usmania Mohallah, Kashrote Girls High School, Gulsher Colony Konodas, Markaz Colony Konodas, Brgeli Mohallah Khomer Damote, Kazlibash Mohallah, Narway Workshop Konodas, Khari Baseen, Wezra Baseen, Baseen Kote Mohallah, Hyderpura, Jamia Masjid Eidgah Joglote, Jamia Masjid Soniyar Joglote, and Powerhouse Soniyar Joglote have recorded pH values ranging from 7.5, 7.4, 7.5, 7.2, 7.2, 6.5, 7.5, 6.8, 8.4, 7.1, 7.1, 6.9, 7.1, 6.2, and 7.2 respectively (Tables 5,6). Highest pH value was determined in Gulmet channel water and lowest value was found in Thole water tank sample in a study "drinking water quality assessment in some selected villages of Nagar Gilgit-Baltistan" by Ali *et al.* (2013). A similar study on "water and wastewater quality survey in seven urban centers of Gilgit-Baltistan" by EPA (2013), found pH values within the recommended limits as per NEQS and WHO guidelines.

Table 5. Results of Water Purification Plants Providing Unsafe Drinking Water.

S#	Sampling Point	Volume Filtered (ml)	Results		Temp °C	pH	Turbidity	Colour	Odour	Taste
			E.Coli found	E.Coli/ 100ml						
8	Kashrot Mohammadi Muhallah Water Purification Plant	100ml	55 col	55/100ml	23	7.5	<5NTU	Clear	No Obj	No Obj
9	Kashrot Usmania Muhallah Water Purification Plant	100ml	33 col	33/100ml	23	7.4	<5NTU	Clear	No Obj	No Obj
10	Kashrot Girls Higher Secondry School and College Water Purification Plant	100ml	27 col	27/100ml	22	7.5	<5NTU	Clear	No Obj	No Obj
11	Gulshair Colony Konodas Water Purification Plant	100ml	7 col	7/100ml	19	7.2	<5NTU	Clear	No Obj	No Obj
12	Markaz Colony Konodas Water Purification Plant	100ml	3 col	3/100ml	22	7.2	<5NTU	Clear	No Obj	No Obj
13	Khomer Damote Birgili Muhallah Water Purification Plant	100ml	1 col	1/100ml	20	6.5	<5NTU	Clear	No Obj	No Obj
14	Kazalbash Muhallah Water Purification Plant	100ml	4 col	4/100ml	20	7.5	<5NTU	Clear	No Obj	No Obj

Table 6. Results of Water Purification Plants Providing Unsafe Drinking Water.

S#	Sampling Point	Volume Filtered (ml)	Results		Temp °C	pH	Turbidity	Colour	Odour	Taste
			E.Coli found	E.Coli/ 100ml						
15	Norway Workshop Konodas Water Purification Plant	100ml	3 col	3/100ml	22	6.8	<5NTU	Clear	No Obj	No Obj
16	Khari Baseen Water Purification Plant	100ml	4 col	4/100ml	19	8.4	<5NTU	Clear	No Obj	No Obj
17	Warza Baseen Water Purification Plant	100ml	7 col	7/100ml	17	7.1	<5NTU	Clear	No Obj	No Obj
18	Basin Kot Muhallah Water Purification Plant	100ml	5 col	5/100ml	20	7.1	<5NTU	Clear	No Obj	No Obj
19	Domial Haider pora Water Purification Plant	100ml	9 col	9/100ml	22	6.9	<5NTU	Clear	No Obj	No Obj
20	Jama Mosque Eidgah Jaglot Water Purification Plant	100ml	5 col	5/100ml	22	7.1	<5NTU	Clear	No Obj	No Obj
21	Jama Mosque Soniyar Jaglot Water Purification Plant	100ml	TNT col	TNT/ 100ml	23	6.2	<5NTU	Clear	No Obj	No Obj
22	Power House Phase 1 Soniyar Jaglot Water Purification Plant	100ml	5 col	5/100ml	20	7.3	<5NTU	Clear	No Obj	No Obj

E. coli

Some coliform bacteria known as fecal coliform are only present in fecal material. The most common member of this group being Escherichia coli (abbreviated as E. coli) in the Family Enterobacteriaceae named Escherichia (Genus) coli (Species). These organisms may be separated from the total coliform group by their ability to grow at elevated temperatures and are associated only with the fecal material of warm-blooded animals. In the present study out of 56 monitored plants microbiological analysis of 19 were free from fecal contamination (Tables 1, 2, 3). Twent-two samples showed the highest number of colonies ranging from 9-77 (Tables 4, 5, 6). Samples taken from water purification plants at Khomar Yarkote, Zulfikarabad, Sakwar, Jutial bus stand, Agaha Mohallah, Nagaral Kulchinote, and City Park showed 13, 23, 57, 77,9, TNT, and 4 colonies respectively (Table 7). Results providing unsafe drinking water were found in samples taken from water purification plants at Kashrote Mohammadi Mohallah, Usmania Mohallah Kashrote, Gulsher Colony Konodas, Markaz Colony Konodas, Bargli Mohallah Khomar, Kazlibash Moahallah, Narway workshop Konodas, Baseen Khari, Wazra Baseen, Kot Mohallah Baseen, Hyderpura, Jamia Masjid Eidgah Joglote, Jamia Masjid Soniyar Joglote and Power house Soniyar Joglote (Tables 5,6).

According to EPA (2013), the bacteriological water quality results of Gilgit town showed that almost all water supply networks have fecal contamination and is not fit for human consumption as per NEQS and WHO guidelines. Other researchers Ahmad *et al.* (2012), also reported "risk assessment by bacteriological evaluation of drinking water of Gilgit-Baltistan" twenty-one villages use water from the nallahs and fecal contamination was from 4-500 cfu at the source, 1-1350cfu in the beginning of the distribution system, 44-TNTC in the end of the distribution system. In most of the springs the bacteriological quality of drinking water was good at source and it becomes contaminated as it becomes in contact with animals. Most of the nallahs water was contaminated at source.

Conclusion

A total, fifty-six water purification plants were monitored. Analytical results of all the purification plants were compared with WHO guidelines and National Environmental Quality Standards permissible limits for drinking water. Out of them only nineteen plants were operational and providing safe drinking water, fifteen plants were not operational due to different reasons. Some purification plants have damaged supply line pipes, storage tank damage, not installation of filters, lack of water supply connections, compensation issues and job demands from land donors. Twenty-two water purification plants at various locations have shown prevalence of bacteriological contamination. Nagral Kulchiniote Girls Middle School Water Purification Plant and Jamia Mosque Soniyar Jaglot Water Purification Plant have shown the highest number of colonies while others have shown 9-77 colonies in the water being supplied. According to National Environmental Quality Standards and World Health Organization guidelines for drinking water these results falls in C and D categories which have very high risk and unsafe for drinking purposes. Other physio-chemical parameters like temperature, turbidity and pH were found within the prescribed limits set by NEQS and WHO.

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