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# Physico-Chemical and Bacteriological Analysis of Drinking Water of Springs of Sherqilla, District Ghizer, Gilgit-Baltistan, Pakistan

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**NI conducted the research and wrote the mansucript. KA superved the project. MAN and RI assessed samples in lab. MK collected samples. IA analysed the data. MA proofread and edited the article.**

**Key words**
**Bacteriological quality of water of springs, Chemical analysis of water of Gilgit-Baltistan, Physico-chemical analysis of drinking water, Microbiological analysis of water, Physical-chemical analysis of springs water.**

## ABSTRACT

This study was conducted to determine the physico-chemical and bacteriological status of drinking water of Mishto uch (good spring) and Bar (big spring) springs of Sherqilla village, District Ghizer during winter and spring seasons. A total of twenty one samples were collected and analyzed by membrane filtration method. At Misto uch, the mean temperature was 9.7°C and 15.4°C, turbidity was 0.44 NTU and 0.67 NTU, electric conductivity was 147.4 µS/cm and 226.7 µS/cm, total dissolved solids was 99 mg/l and 118 mg/l, pH was 6.8 and 6.8 and total phosphorus was 48.3 µgP/L and 64.3 µgP/L in both the seasons. Whereas Bar spring the mean values in both the seasons were 10.8°C and 16.0°C for temperature, 0.21 NTU and 0.36 NTU for turbidity, 177 µS/cm and 268.8 µS/cm for electric conductivity, 104.8 mg/l and 115 mg/l for total dissolved solids, 6.9 and 6.9 and 58 µgP/L and 94 µgP/L for total phosphorus. *Escherichia coli,* Enterrococci and total bacterial count at the eye of spring of Mishto uch was zero during winter while other sampling sites showed an average of 17.4 CFU/100ml and 55.4 CFU/100ml *E.coli,* 15.4 CFU/100ml and 20.7 CFU/100ml Enterrococci, and 26.4CFU/100ml and 127.7 CFU/100ml TBC in both the seasons at Mishto uch. All the sampling sites of Bar spring did not show *E.coli* and Enterrococci in both seasons, TBC was within range of 7.0 CFU/100ml and 64.3 CFU/100ml in both the seasons. The results will help to improve the quality of drinking water for the community of Sherqilla.



## INTRODUCTION

Water is one of the greatest gifts given by nature to fulfill all the essential requirements of living organisms including growth, maintenance of body and performance of all life supporting activities (Simpi *et al.*, 2011). Water is an important resource for bio-diversity, food security, environmental resources, agriculture and for sustaining all forms of life (Munair, 2003). The availability of safe drinking water plays an important role in human physiology and existence of life on the planet Earth (FAO, 1997).

The main sources of water are seas, oceans, lakes, ponds, wells, rivers, glaciers, icebergs and springs (Dan'azumi and Bichi, 2010; Rajkumar *et al*., 2003; Tamot and Bhatnagar, 1998). Seventy-one percent of Earth's surface is covered by ocean and seas, which provide 96.5% of planet Earth's water. The second and third largest reservoirs of water are ground water and glaciers, each contributing 1.7% to total global need. Fresh water makes up a minute fraction, which is 2.5% of Earth's water, and 99% of all fresh water supplies are found in glaciers and groundwater with nearly a quarter of the world's population relying on these water two sources (Jackson *et al*., 2001).

According to United Nations Development Program, nearly one-sixth of the world's population has access to unsafe sources of drinking water (UNDP, 2006). An estimated 4 billion people die per year, out of which 30% are associated with unsafe drinking water (Montgomery and Elimelech, 2007) and in developing countries, 80% of deaths occurred due to water related diseases, of which 15% are children under the age of five years (Thompson and Khan, 2003; WHO, 2003, 2004; Holgate, 2000).

The presence of pathogenic organisms in drinking water make it unsafe and causes disease. People in developing countries suffer from a number of diseases due to insufficient water supply, bad sanitation and hygiene conditions (World Bank, 2002b). The shortage of safe water and contamination of fresh water has led one-fifth of the urban inhabitants and three-quarters of the rural resident population to be without access to clean water sources (Lloyd and Helmer, 1992).

To reduce the number of diseases and ensure safe distribution of drinking water to the community, it must be

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free of pathogens and physico-chemical contaminations. The World Health Organization (1993) has set standard guidelines or limits for drinking water. If the water parameters are within the limits, water is considered potable.

Pakistan ranked 80th in the world in the accessibility of safe drinking water to its people (Azizullah *et al*., 2011). Over 65% of the total population is believed to have access to safe drinking water (GoP, 2005; World Bank, 2002a; Khan and Javed, 2007; Khan, 2000) and 44% lack such access. Up to 90% of the rural population of Pakistan is without access to safe, drinkable water (The United Nations System in Pakistan, 2003).

According to the Pakistan National Conservation Strategy 1992 and country report of Pakistan in 2000, bad water quality causes 30% of all deaths and 40% of all diseases in the country, and the leading cause of death in newborns and children is diarrhea, a water related disease caused by polluted water (Kahlown *et al*, 2006).

Gilgit-Baltistan, Pakistan, is rich in natural resources, with an area of about 72,971 km$^2$ and at an elevation of 3000 meters (GBPI, 2009-2011). It is covered with lofty mountains and these mountains separate different areas from each other (Ahmed and Shah, 2007). It is home to a population of 1.8 million (PCO, 2008). Gilgit-Baltistan has three divisions: Gilgit, Baltistan and Diamer and includes the districts of Gilgit, Diamer, Hunza, Nagar, Ghizer, Astore, Baltistan and Ghanche. Climatic conditions range from monsoons to the arid and semi-arid desert. The temperature in summer gets as high as 40°C and falls to -10°C in winter (Ahmed and Joyia, 2003).

In Gilgit-Baltistan, precipitation (rainfall), stream flow and springs are the main sources of water. Spring water is available in many areas of Gilgit-Baltistan, as glacier and snow deposits are the main sources of water. Springs make a specific fraction of the hydrosphere. Springs are a natural source of water for human usage that originates from underground water deposits and is protected from environmental contaminations. One of the benefits of spring water is that at the point of origin, water is clean and clear.

The present study was designed to provide more information about the physico-chemical and microbial quality of spring water in the Sherqilla valley of Ghizer district. The study was formatted to determine the physico-chemical and microbial parameters of two springs of Sherqilla valley, District Ghizer. The main goal of this study was to develop baseline data to educate the community and to identify major problems associated with water quality in the study area and to develop a future plan for management and treatment of water to ensure the safe distribution of drinking water to local inhabitants.

## MATERIALS AND METHODS

*Study area*

This study was conducted in the Sherqilla valley, one of the most populated villages in tehsil Punial of the district Ghizer, 38 km west from the centre of Gilgit city. This village is rich with springs and the current study was conducted to analyze the physico-chemical and bacteriological properties of the drinking water of Mishto uch spring, which is located at an elevation of 1993 m and supplies water to Loi Das (Amin Abad), and Bar uch, at an elevation of 1843 m and which supplies water to the Karim Abad (Moss) and Majini Mahla (Ali Abad).

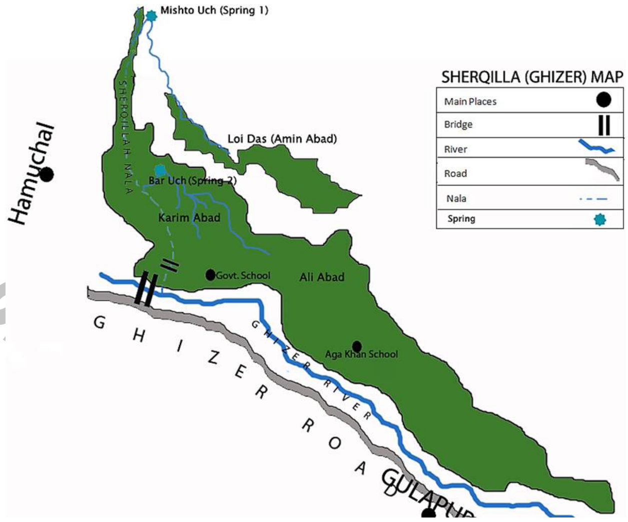


Fig. 1. Spring sites of Mishto uch, Bar and their supply system to various areas.

*Sampling procedure*

Twenty-one water samples were collected from the two springs from November 2013 to May 2014 during winter and spring. Twelve samples were obtained from the eye of the spring in Bar, three samples each from the source, inlet and outlet of the water reservoir and from distribution (tap water). Nine samples were collected from Mishto uch spring, including three samples from the source, three samples from the junction where spring water combines with glacier water, and three each from distribution (house). Elevation and temperature were measured on the spot sample collection using GPS and a mercury thermometer, respectively. Samples for physico-chemical analysis were collected in polyethylene bottles, which were thoroughly rinsed thrice with the water before sampling. Samples for microbial analysis were collected directly from the springs in sterilized bottles from a depth of 20 to 30cm below the water surface. This was done to avoid contamination deposited by air on the water surface, to avoid touching the bottom, and to prevent contaminating the samples by touching hands. While sampling from the distribution system (tap), the tap was cleaned from outside and opened fully to let water run to waste for at least 3 minutes. Bottles were filled completely and their caps were tightened. Samples were kept in the dark and refrigerated at about 2-8°C, pending laboratory analysis, to avoid any chemical reaction. Samples were taken to laboratory and cultured within a few hours of their collection.

*Physico-chemical parameters*

Collected water samples were analyzed for the following physical, chemical and biological parameters: conductivity (µS/cm), pH, turbidity (NTU), total dissolved solids (mg/l), total phosphorous (mg/l), reactive orthophosphate (mg/l), total bacterial count (CFU/100ml) and identification of *Escherichia coli* and Enterococci.

*Bacteriological analysis*

Water samples collected for bacteriological analysis were cultured on Chromogenic X-Glu agar (Biolife, Italy), Slanetz and Bartley agar (Biolife, Italy), Bile Esculin Azide agar (BEA (Biokar diagnostics)) and Yeast Extract agar (BIOM lab, Malaysia). Standard Membrane Filtration technique was used for the enumeration of *Escherichia coli* (incubated at 40°C for 24 h) and Enterococci (incubated at 36°C for 44 h) while Pour Plate technique was used for total bacterial count (incubated for at 22°C 72 h).

*Physical analysis*

Temperature was measured at the point of sample collection with the help of a mercury glass thermometer. Turbidity was determined by using Nephelometric tube. Electric conductivity and total dissolved solids were measured by a digital conductivity meter (AD3000, ADWA).

*Chemical analysis*

UV Spectrophotometer (UV 23000II, model) was used to determine the concentration of total phosphorus and reactive orthophosphate by the following methods:

*Reactive orthophosphate*

Glassware (50ml Duran bottle blue cap GL32) was rinsed thoroughly with de-ionized and ultrapure water. Three blank samples were prepared along with test samples using 25 ml of ultra-pure water in the place of test samples. 25 ml of sample was pipetted into a 50 ml polypropylene Erlenmeyer flask and 0.75 ml of reagent mix was added, mixed and let to stand for 2-3 min before 0.75 ml of reducing solution II was added. The mixture was allowed to sit for 15 min for colour to develop. Spectrophotometric determination was performed and a spectrophotometer was zeroed by using de-ionized water without reagents. Then it was calibrated with each blanked solution and the mean absorbance values of three blank samples were calculated. After calibration, the concentration of phosphorus in the water samples collected from sampling points was calculated, subtracting the blank mean absorbance from each sample's absorbance to calculate the total phosphorus concentration (Malcolm and Wong, 1990).

*Total phosphorus*

Glassware was rinsed thoroughly with de-ionized water. 25ml of water sample was pipetted into 50ml Duran bottles and 3.5ml of oxidizing solution (Reagent I) was added. Next, the bottles were placed in an autoclave at 120$^{o}$C for 30 minutes. After autoclaving, the bottles were allowed to cool at room temperature. 0.75mL of reagent mix II was added to autoclaved samples, let to sit for 2-3 min before 0.75mL of reducing solution III was put in samples and colour developed after 15 min. Again, a spectrophotometer was calibrated and readings of three blank solutions were noted before calculating the mean absorbance of other samples concentration of each water sample (Pote and Danial, 2001; Rowland and Haygrath, 1997).

*pH*

A digital pH meter (AD 1020, ADWA) was used to measure pH of water samples. Before use, the pH meter was calibrated with relevant buffer solutions.

## RESULTS

*Physical analysis of drinking water*

*Mishto uch*

Table I shows the results of physical parameters of drinking water of Mishto uch spring at its various sampling points. Temperature recorded at the eye of the spring was 9.7°C in winter and 15°C in spring. At the junction where Mishto uch water combines with glacier water, the temperature showed 9.5°C in winter and 15°C in spring while distribution system samples taken from a house storage container were 10°C and 16°C in winter and spring, respectively.

Substantial variation in turbidity was found between the seasons at the spring source of Mishto uch, at a level of 0.26 NTU in winter and 0.91 NTU in spring. Slight variation, 0.85 NTU and 0.87 NTU in winter and spring, was found at the junction of the spring with glacier water. Similarly, 0.19 NTU in winter and 0.22 NTU in spring was recorded in the house storage container.

**Table I.- Physical parameters analyzed for the drinking waters of Mihsto uch and Bar sprinig.**

| Location | Sampling points | Winter | | | | Spring | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Temp (°C) | Turbidity (NTU) | EC (µS/cm) | TDS (mg/l) | Temp (°C) | Turbidity (NTU) | EC (µS/cm) | TDS (mg/l) |
| Mishto uch | Spring eye | 9.5 | 0.26 | 151 | 97 | 15 | 0.91 | 227 | 116 |
| Mishto uch | Junction with glacier water | 9.5 | 0.85 | 148 | 99 | 15 | 0.87 | 223 | 118 |
| Loi Das | Distribution system (House) | 10 | 0.19 | 143 | 101 | 16 | 0.22 | 230 | 120 |
| Mean | | 9.7 | 0.44 | 147.4 | 99.0 | 15.4 | 0.67 | 226.7 | 118.0 |
| Bar | Spring eye | 10 | 0.18 | 177 | 31 | 16 | 0.27 | 278 | 34 |
| Bar | Inlet of reservoir | 11 | 0.32 | 162 | 136 | 16 | 0.43 | 242 | 141 |
| Bar | Outlet of reservoir | 11 | 0.14 | 187 | 117 | 16 | 0.31 | 268 | 145 |
| Karim Abad | Distribution system (Tape) | 11 | 0.21 | 182 | 135 | 16 | 0.42 | 287 | 140 |
| Mean | | 10.8 | 0.21 | 177 | 104.8 | 16 | 0.36 | 268.8 | 115 |

NTU, nephelometric turbidity unit; µS, micro semen; mg/l, milligram per liter; EC, electrical conductivity; [1] Temp, temperature, TDS, total dissolved solid.



Fluctuation was found in the conductivity values in the eye of the spring and at its various distribution systems. Levels of 151 µS in winter and 227 µS in spring were detected at the eye of the spring while at the junction, it was 148 µS in winter and rose to 223 µS in the spring. In the distribution system, 143 µS and 230 µS was recorded in both seasons.

TDS in the spring source had a mean value of 97 mg/l in winter and 116 mg/l in spring, while in junction it was 99 mg/l in winter and rose to 118 mg/l in spring. Similarly, the average of 101 mg/l and 120 mg/l was found at its distribution system during both the seasons.

*Bar spring*

Table I also shows the physical parameters of drinking water of Bar spring at the eye of the spring and at various points in its distribution system. At source, the temperature was 10°C in winter and 16°C in spring while in distribution system, including the inlet, outlet of the water reservoir and in the tap it was 11°C in winter and 16°C in spring. There was no change in temperature at various sampling points.

There was variation in turbidity at various points of sampling. At the source it was 0.18 NTU in winter and 0.27 NTU in spring. At the inlet of the water reservoir, it was 0.32 NTU in winter and 0.43 NTU in spring, 0.14 NTU in winter and 0.31 NTU in spring at the outlet and 0.21 NTU and 0.42 NTU in winter and spring, respectively, in the distribution system.

Similarly, the conductivity showed much variation in both the seasons. In winter, it was 177 µS/cm and rose up to 278 µS/cm in spring. In the inlet of the water reservoir, it was 162 µS/cm in winter and rose up to 242 µS/cm in spring. Similarly in the outlet of the reservoir it was 187 µS/cm in winter and 268 µS/cm in spring. In the distribution system, it was 182 µS/cm in winter and 287µS/cm in spring.

The TDS has fluctuation in both the seasons at various sampling points. At the eye of the spring, it was 31 mg/l in winter rose up to 34 mg/l in spring. In the inlet of the water reservoir, it was 136 mg/l in winter and 141 mg/l in spring and in outlet it was 117 mg/l in winter and 145 mg/l in spring. While at distribution, it was 135mg/l in winter and 140mg/l in spring.

*Chemical analysis of drinking water*

*Mishto uch*

Table II represents the findings of chemical analysis of drinking water from Mishto uch of Sherqilla valley. The pH at the eye of the spring of Mishto uch was 6.8 in winter and in spring and it remained the same at the junction of spring water with glacier water and in the distribution system during both seasons.

There was large fluctuation in the values of reactive orthophosphate at various sampling points. At the eye of the spring it was 28 µg P/l in winter and 63 µg P/l in spring. At the junction, 31µgP/l and 43µgP/l were noted in both the seasons and in distribution system, it was 19 µgP/l and 43µgP/l in the winter and spring seasons.

The total phosphorus in the collected samples also showed variation. In the eye of the spring it was 46 µgP/l in winter and 78 µgP/l in spring. At junction point 48 µgP/l and 59 µgP/l and in distribution 51µgP/l and 56µgP/l were observed in both the seasons.

*Bar spring*

Table II shows the chemical parameters of drinking water from Bar spring. It can be clearly observed that the pH from different sites of the same location gave similar results. The detected pH value at the spring source of Bar was 6.5 in both the winter and spring seasons. However, a slight variation was seen at the inlet of the water reservoir, 7 in winter and 7.1 in spring. Similarly, at the outlet of water reservoir, 7, and in the distribution, 7.2, were observed in both the winter and spring seasons.

Typical values for reactive orthophosphate of the water samples collected from the spring eye of Bar spring was 41µgP/l in winter and became 44µgP/l in spring. In the inlet of the water reservoir, it measured 26µgP/l in winter and 48µgP/l in spring. In the outlet, it measured 22µgP/l in winter and 41µgP/l in spring, while in distribution system it was 21µgP/l in winter and 41µgP/l in spring.

Water samples analyzed for total phosphorus showed great variations. Samples taken from the spring source showed 57µgP/l of total phosphorus in winter and rose up to 134µgP/l in spring. 89µgP/l in winter and 101µgP/l in spring were found in the inlet of water reservoir. Similarly, 39µgP/l and 50µgP/l at the outlet and 47µgP/l and 91µgP/l in the distribution system were observed in winter and spring.

*Bacterial analysis of drinking water*

*Mishto uch*

Table III represents the bacterial analysis of drinking water quality of Mishto uch and its various distribution systems. High numbers of *E. coli* were found at various points of sampling. No *E. coli* and Enterrococci were detected in winter at the eye of the spring while 3 CFU/100ml of *E. coli* and 1 CFU/100ml of Enterrococci were present during the spring season. At the junction with the glacier water, the *E. coli* count were 33 CFU/100ml in winter and 79 CFU/100ml in spring. At the distribution system (house storage) 19 CFU/100ml and 84 CFU/100ml of *E. coli* were present in winter and spring, respectively. Numbers of Enterrococci found at the junction were 20 CFU/100ml in winter and 31 CFU/100ml in spring. While in distribution system 26 and 30 CFU/100 ml Enterococci in the winter and spring seasons.



**Table II.- Chemical parameters analyzed for the drinking waters of Mishto uch and Bar sprinig.**

| Location | Sampling points | Winter | | | Spring | | |
|---|---|---|---|---|---|---|---|
| | | pH | Reactive $PO_4$ (µg P/L) | Total phosphorus (µg P/L) | pH | Reactive $PO_4$ (µg P/L) | Total phosphorus (µg P/L) |
| Mishto uch | Spring eye | 6.8 | 28 | 46 | 6.8 | 63 | 78 |
| Mishto uch | Junction with glacier water | 6.8 | 31 | 48 | 6.8 | 43 | 59 |
| Loi Das | Distribution system (House) | 6.8 | 19 | 51 | 6.8 | 43 | 56 |
| Mean | | 6.8 | 26 | 48.3 | 6.8 | 49.6 | 64.3 |
| Bar | Spring eye | 6.5 | 41 | 57 | 6.5 | 44 | 134 |
| Bar | Inlet of reservoir | 7.0 | 26 | 89 | 7.1 | 48 | 101 |
| Bar | Outlet of reservoir | 7.0 | 22 | 39 | 7.0 | 41 | 50 |
| Karim Abad | Distribution system (Tape) | 7.2 | 21 | 47 | 7.2 | 41 | 91 |
| Mean | Mean | 6.9 | 27.5 | 58 | 6.9 | 43.4 | 94 |

**Table III.- Bacteriological parameters (CFU/100ml) analyzed for the drinking waters of Mishto uch and Bar spring Sherqilla, District Ghizer.**

| Location | Sampling points | Winter | | | Spring | | |
|---|---|---|---|---|---|---|---|
| | | *E. coli* | Enterococci | Total bacterial count | *E. coli* | Enterococci | Total bacterial count |
| Mishto uch | Spring eye | 0 | 0 | 23 | 3 | 1 | 66 |
| Mishto uch | Junction with glacier water | 33 | 20 | 14 | 79 | 31 | 87 |
| Loi Das | Distribution system (House) | 19 | 26 | 42 | 84 | 30 | 230 |
| Mean | | 17.4 | 15.4 | 26.4 | 55.4 | 20.7 | 127.7 |
| Bar | Spring eye | 0 | 0 | 0 | 0 | 0 | 19 |
| Bar | Inlet of reservoir | 0 | 0 | 0 | 0 | 0 | 104 |
| Bar | Outlet of reservoir | 0 | 0 | 6 | 0 | 0 | 14 |
| Karim Abad | Distribution system (Tape) | 0 | 0 | 22 | 0 | 0 | 120 |
| Mean | | 0 | 0 | 7.0 | 0 | 0 | 64.3 |

Total bacteria count (TBC) showed great fluctuations in both seasons at the examined sites of Mishto uch spring. TBC at the spring eye was 23 CFU/100ml in winter and 66 CFU/100ml in spring. The junction point showed 14 CFU/100ml and 87 CFU/100ml of TBC in winter and spring, respectively. However, the distribution system gave 42 CFU/100ml and 230 CFU/100ml of total bacteria in both seasons.

*Bar spring*

Table III also shows the bacterial analysis of drinking water of Bar spring Sherqilla. There were no *E. coli and* Enterrococci at different water sampling sites of Bar spring in both winter and spring. Total bacteria count (TBC) showed great variation among different sampling points. No bacteria were counted at the spring eye in winter while 19 CFU/100ml of TBC was found in spring. Again, the inlet of water reservoir of Bar spring was nil in winter and a huge number of TBC were noted in spring *i.e.* 104 CFU/100ml. TBC detected at the outlet of reservoir were 6 CFU/100ml in winter and 14 CFU/100ml in spring. Similarly, 22 CFU/100ml were present in the distribution system in winter, which increased dramatically to 120 CFU/100ml in the spring.

**Table IV.- Permissible limits set by WHO Standards (1993) for drinking water quality.**

| S. No. | Parameters | Standard guidelines of WHO |
|---|---|---|
| 1 | Temperature | <25°C |
| 2 | Turbidity | <5NTU |
| 3 | Conductivity | 1,000µS/cm |
| 4 | TDS | <600mg/l |
| 5 | pH | 6.5-8.2 |
| 6 | Reactive orthrophosphate | 10-50mg/L |
| 7 | Total phosphorus | 5mg/l |
| 8 | *E. coli* | 0/100ml |
| 9 | Enterrococci | 0/100ml |
| 10 | Total bacterial count | 0/100ml |

## DISCUSSION

The quality of water is related to mortality and morbidity because water is life and without water nobody can survive. For survival, drinking water must not contain components which have hazardous and deleterious effects on human health, such as disease causing microorganisms, minerals and organic materials (Haydar *et al.*, 2009). Most of the people in developing countries suffer from diseases related to either an inadequate supply of drinking water or bad quality of water (Leeuwen, 2000). Physico-chemical properties such as temperature, pH, total dissolved solid, electrical conductivity, and dissolved oxygen indicate the quality of water or the ability of water to support the microbial growth. These characteristics are important parameters for screening water quality (APHA, 1998).

According to Ahmed *et al*. (2012), the population of Gilgit Baltistan is scattered in the form of villages. All places or villages have their own water resources like precipitation, stream flow, springs, *etc*. These water resources are used for drinking as well as irrigation purpose. In the current study, all the water samples collected from the Mishto uch and Bar springs of Sherqilla valley analyzed the physico-chemical and bacteriological properties of water. The quality of water used for drinking purposes revealed that some of the chemical and microbial parameters are exceeding those outlined by WHO standards. The physical parameters like temperature, conductivity, and total dissolved solid for all the collected water samples during winter and spring seasons were within the permissible limits set by WHO (1993).

During this investigation, there was slight variation in the temperature of sampling points of Mishto uch and Bar springs. The temperature of Mishto uch samples was in a range of 9.5°C-16°C while Bar has 10°C-17°C, although it is important to note that Mishto uoch is at a high elevation compared to Bar. This slightly higher temperature may be due to degree of shade over the spring sites of Mishto uch (Ekhaise and Anyansi, 2005).

The electrical conductivity of all tested samples ranged from 143µS/cm-287µS/cm. The WHO (1993) suggested limits of 1000µS/cm for electrical conductivity was not exceeded by any of the collected water samples under study. Generally, geology of the area through which water flows affects the electrical conductivity of water (APHA, 1992). These results corroborate with the results of Akubuenyi *et al*. (2013) where conductivity was found in a range of 5.30-24.7µS/cm in cross river state, Nigeria and Kirubavathy *et al*. (2005) in Erode District, Tamil Nadu during the assessment of quality of water of the Orthupalayam reservoir.

Values of water sample TDS parameters fall within the desirable limit of 500mg/l (WHO, 1993). TDS were present in range of 31mg/l-145mg/l as it is the sum of concentration of cations and anions that shows the density of water and reduces the solubility of different gases in water (Soni *et al.*, 2013).

In the terms of turbidity, all water samples showed very low values from 0.14NTU to 0.91NTU. These values were within the standard of 00- 5NTU prescribed by WHO.

The pH values of all the collected samples were within the range of 6.5 -7.2.

Chemical parameters like reactive orthophosphate were present in a range of 21µgP/L-48µgP/L at the sampling sites of Bar spring in both Winter and Spring. While in Mishto uch spring, it ranged from 19µgP/L - 63µgP/L. All the sampling points of Mishto uch and Bar spring tested for reactive orthophosphate were within the desirable limits of WHO, except the spring source of Mishto uch which showed a slightly elevated value in spring. Total phosphorus was present in a range of 39µgP/L - 134µgP/L at both springs in both winter and spring and were higher than permissible limits of WHO (1993).

According to WHO (1993) there should be no microorganisms in 100ml of drinking water. In the springs, the total bacterial counts were observed even in the eye of the spring. As according to the standard guidelines of WHO, 0 CFU/100ml of TBC is suitable for drinking. This result is in agreement with the study of Odeyemi *et al*. (2011) who conducted a study on the water samples of an artesian bore-hole, spring and hand dug well located at Oke-Osun, Ikere-Ekiti, Nigeria and found TBC in a range of 76.9 CFU/100ml. The eye of the Bar spring should be protected from any type of approach of humans and animals to provide safe drinking water to the community of Sherqillah.

## CONCLUSION

In the current study, it is concluded that the quality of water of Mishto uch and Bar spring are potable as their physico-chemical characteristics are within the limits of WHO guidelines. The quality of water from a bacteriological point of view was not satisfactory as the total bacterial counts of *E. coli* and Enterrococci exceeded the WHO permissible limits, thereby affecting the human health.

## RECOMMENDATIONS

It is recommended that precautions should be taken to provide safe supply of drinking water to the communities to protect the eyes of both the springs and their distribution systems. The community of users utilizing both springs' water should be provided with hygiene education so the community may play an active role in improving the cleanliness of their water storage containers.

*Statement of conflict of interest*

The authors declare no conflict of interest.

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