RESEARCH ARTICLE

Physio-chemical and Biological Analysis of Drinking Water of Barmas and Jutial Water Supply Complexes, District Gigit, Pakistan

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Abstract: A study was carried out to assess the drinking water quality of Barmas and Jutial Water Supply Complexes which has always been essential with reference to the public health importance. Due to its outstanding significance to the consumer its parameters must follow the permissible limits set by international water regulating agencies. Some physico-chemical and biological parameters were examined from source, water tank inlet, water tank outlet, and distribution tank and tape water. Total twenty water samples were collected. One bacteriological (E. coli) and three physicochemical parameters (pH, Temperature and Turbidity) were tested for each sample and compared with WHO guidelines for drinking water. Among the tested characteristics, temperature values of Barmas water supply complex observed between 17-18°C and Upper and Lower Jutial water supply complex observed between 19-21°C, pH values of Barmas and Jutial water supply complexes resulted 7.8 and 7.9, turbidity values of Barmas water supply complex resulted between 10-15 NTU and Upper and Lower Jutial water supply complex resulted between 15-20 NTU. Bacteriological analysis of water samples revealed that 80 percent of the total water samples fall in the category “A” and are safe for drinking and 20 percent of the total samples fall in category “B” (low risk) which are not good for human consumption. Maximum level of microbial pollution observed was 5 cfu/100ml in Lower Jutial water supply complex. The possible causes of contamination as observed were, poor sanitation system, human and animal activities in the surrounding area of source and water reservoirs.

Keywords: Drinking water quality, E. coli, Physico-chemical parameter, Biological parameter

INTRODUCTION

Supply of drinkable water is essential to the development of any country. Clean water sustains a healthy population and it contributes to the quality of life (Al-Mezori and Hawrami, 2011).

Water occupies about 70% of the earth’s surface however it is one of the rarest commodities especially in the developing countries of the world (Agbabiakaa et al., 2012). Where provisions for water and sanitation are insufficient, the diseases that arise from unhygienic food, water and hands are among the world’s leading causes of premature death and serious illness (Doe, 2007). Presently one billion of the world population has lack of access to safe drinking water (WorldBank, 2009). The most common and widespread health risks linked with drinking water in developing countries are of biological origin. The WHO estimates that about 1100 million people globally drink unsafe water, and the greater part of diarrheal disease in the globe (88%) is attributable to insecure water, sanitation, and hygiene (Pindiet et al., 2013).

Gilgit River, Kargah and Jutial Nallahs are main sources of drinking water supply networks in Gilgit city. Kargah Nallah is the main source of water for 70 percent of the Gilgit city, from where water is brought to Barmas Complex and is distributed to different parts of the towns. Jutial Nallah is the main source of
water for Jutial and Khomar area. Source water from Kargah and Jutial Nallah is brought to Jutial and Barmas water complexes through unfenced man made water channel. Urban population settled in Konodass area and Zulfigarabad mostly rely on Gilgit River for drinking & irrigation purposes (Gilgit-EPA, 2012).

The main reason of water related diseases is the presence of pathogenic organism in drinking water. Water born infections such as diarrhoea, Cholera, Typhoid, and Hepatitis are common in Gilgit Baltistan. Various epidemiological studies and hospital records indicates high prevalence of water born infections in the populations, among which children are the most affected group. Microbial pathogens continue to contaminate drinking water supplies and cause waterborne disease outbreaks (Hussain et al., 2014).

Initially in Barmas Water Supply Complex water from source to main water complex was supplied through a 9 km long open water channel. Water flowing through channel was susceptible to all sorts of contamination. Gilgit-Baltistan (GB) Administration took a step in year 2002 towards providing safe drinking water to the citizens of Gilgit by laying 24 inches diameter ductile iron pipe from source to main water complex, which ensures availability of water to Fattah Bagh complex, Amphary tanks, Kashrote, Nagral, Domial, Majini Muhallah and Sonikote areas. Water of Kargah Nallah seems unsafe mainly because of human settlements along nallah banks coupled with agricultural activities. In addition to it the area has also been declared as free grazing land. Resultantly, the water becomes unhygienic for human consumption. Secondly during summer, glaciers melting make the water more turbid as all kind of suspended particles travels from pastures and snow bodies to downstream, which make the water more contaminated and unhygienic. Surface water is likely to be bacteriologically contaminated and more or less turbid. The common water treatment methods broadly used are conventional i.e. Source Pre-Sedimentation, Coagulation Sedimentation, Filtration & Disinfection.

Barmas Complex has found that water from Kargah Nallah is directly being supplied distributed to the community without having any standard treatment process. At Barmas complex neither there is any proper water treatment system nor sufficient water storage capacity available to meet the water requirement of the population. Existing capacity of Barmas complex is 64000 gallons, whereas inflow capacity of ductile iron pipe is 12 cusecs that is equal to 6.6 million gallons per day; however as per PC-I prepared by National Engineering Services (NES) Pakistan for construction of treatment works at Barmas and Jutial during 1988, according to it the average daily demand in 2010 will be 9.46 gallons per day. NES Pak has proposed two pipe lines of 24 inches diameter to supply raw water from Kargah Nallah to Barmas complex by the year 2005 to meet the water requirement. NES Pak also recommended rapid gravity filters and centrifloc clarifier at Barmas and Jutial for, it requires less space and can easily be constructed on available space at Barmas and Jutial.

A scheme titled “Improvement of water tank at Barmas Gilgit” has been approved for a total cost of 39.926 million during 2007-08 to enhance the storage capacity of Barmas complex. However, there is lack of information about quality of water as no rapid gravity filter and clarifier are provided, which shows that quality is not main concerned of the executing department.

Water from JutialNallah is being supplied to upper Jutial complex through 16 inches diameter G.I pipe and the same is being directly supplied to the community without having any proper treatment to water. JutialNallah too is free grazing spot where upstream human, animal and illegal agriculture residues contribute considerably to the contamination of water. In summer season, large scale snow and glacier melting augments to water turbidity, which causes water unfit for human consumption.

It is highly awful that water comes into lower Jutial complex through an open channel of 1800ft length from JutialNallah. Waste water from agriculture lands, bathrooms, kitchens coupled with animal and human residue seeps in
to the open channel and dissolves with water in its way to lower complex. All these impurities make the water hazardous for human use.

In view of this, there is need to assess drinking water quality of these sources. Therefore, the present study was attempted to elucidate the screening of water quality and assess the bacteriological quality of drinking water and potential sources of water pollution in Barmus and Jutial water supply complexes, Gilgit.

**MATERIALS AND METHODS**

**Study Site**

The current research was conducted in Gilgit city (Fig.1). It is the most populous urban center in Gilgit-Baltistan. The city attracts many tourists and business entrepreneurs because of its spectacular natural beauty and resources. Thus it is imperative that the city should maintain healthy and friendly environment.

![Fig.1. Map showing study areas.](image)

**Sampling Procedure**

The methodology adopted for water sampling was Random Sampling. Total 20 water samples were collected from sources, water tank inlets, distribution tanks, water tank outlets and house taps from Barmas Water Supply Complex and Jutial Water Supply Complex in June and July 2013. Water samples were collected in sterilized bottles and prior to filling the sample bottles were rinsed two to three times with the water to be collected. The collected samples were transferred to the GB-EPA for physicochemical and microbial study. The volume of tested water samples were 100ml. Samples were tested and analyzed before five hours after collection of samples for microbial study.

**Parameters Tested**

Physicochemical and biological parameters were tested following the standard protocols of GB-EPA (2012). All the analysis was carried in GB-EPA laboratory.

**Measurement of parameters**

**Turbidity**

The turbidity of the samples was measured in Turbidity Units by using the turbidity tube provided with the Del-Agua water testing kits. These turbidity tubes are graduated with a logarithmic scale and cover the range 5 to 2,000 NTUs.

**pH values**

The pH values were determined using the calibrated pH meter, at the laboratory. The probe was rinsed with distilled water and immersed in the samples. Readings were recorded after stabilization.

**Determination of E. coli**

The membrane filter technique was used to test relatively large numbers of samples. Following the testing protocols, a known volume of water (100ml) 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 (2ml) per sample in sterile Aluminum Petri dish. The plates were than incubated for 18 hours at 44ºC. After incubation period results were checked.

**Statistical analysis**

All the statistical computations were used following the software SPSS version 13.0.
RESULTS AND DISCUSSION

The present study was carried out to assess the quality of drinking water of Barmas and Jutial water supply complexes for some physico-chemical and biological parameters (temperature, turbidity, pH and E. coli). Presence of fecal coliform in aquatic environments may indicate that the water has been contaminated with the fecal material of humans or other animals. Fecal coliform bacteria can enter rivers and other water sources through direct discharge of waste from mammals, human sewage, birds, storm runoff and agricultural waters. Large quantities indicate a higher risk of pathogens, which cause ear infections, dysentery, typhoid fever, viral and bacterial gastroenteritis and hepatitis A. To resolve the spread of the infectious diseases via water, WHO published International Guideline values for drinking water. According to WHO guidelines (2011), the fecal contamination levels of drinking water must be 0 E. coli / 100 ml for safe drinking water. As said by WHO, the water can be divided into four groups with reference to the contamination levels.

Over all Twenty (20) samples were collected from source, water tank inlets, water tank outlets, distribution tank and house taps. Bacteriological water quality results revealed that 80 percent of the total water samples fall in category “A” and are safe for drinking and 20 percent of the total samples are biologically contaminated and fall in category “B” (low risk) which are not suitable for human consumption. Maximum level of pollution found was 5cfu/100ml in lower Jutial water supply complex. The possible causes of contamination as observed were, poor sanitation system, human and animal activities in the surrounding area of source and water reservoir.

Source Water

Three water samples from water sources were analyzed for bacteriological contamination as per categories set by WHO for drinking purposes (Fig.2). Out of three water samples 66.66 percent of total samples have no contamination levels as 0. E.coli/ml and desirable for human consumption. Remaining 33.33 percent fall in category B which indicates low risk and not fit for human consumption.

Water Tank Inlets

Two samples were taken from inlets out of these samples 100 percent of water samples falls in category “A”. According to WHO Guidelines, which are fit for human consumption (Fig.3).

![Fig.3. Inlet Water Analysis of Barmas and Jutial Water Supply Complexes recorded in 2013.](image)

Water Tank Outlets

Two samples were taken from outlets out of these samples 100 percent water samples falls in category “A”. According to WHO Guidelines, which are fit for human consumption (Fig.4).
Three Water samples were collected from Barmus and Jutial Water Supply Complexes out of these 66.66 percent water samples falls in category “A” fit for human consumption and 33.33 percent samples falls in category “B” not fit for human consumption (Fig.5).

**Tap Water Quality**

10 samples from tape water have been analyzed for fecal contamination. Out of 10 water samples 80 percent of total water samples fall in category “A” and found to be fit for human consumption as per WHO guidelines set for drinking water quality whereas 20 percent of the total water samples contaminated which falls in category “B” (low risk) not fit for human consumption (Fig.6).

**pH**

The pH is a measure of the acid-base equilibrium in waters. The pH of most raw water sources lies within the range 6.5-8.5. No scientific link to health issues has been established yet with pH values, however, corrosion in water mains and maintaining of specific chemical water treatment requires adjustment in pH values accordingly. pH values from Barmas tape water, water tank inlet, water tank outlet, distribution tank and source found 7.9 while the pH values from Upper and Lower Jutial water source, water tank inlet, water tank outlet and distribution tank found 7.8 (Fig.7). The pH values of Barmas and Jutial water Supply complexes meeting WHO standards.
Fig. 7. pH Level in Barmas and Jutial water supply complexes recorded in 2013.

**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 micro-organisms. The turbidity values examined from Barmas water source, water tank inlet, distribution tank, water tank outlet and tape water found 15 NTUs, 15 NTUs, 10 NTUs, and 10 NTUs respectively while the turbidity values from upper Jutial water source, water tank inlet, distribution tank, water tank outlet and tape water found 20 NTUs, 20 NTUs, 15 NTUs, 15 NTUs and 15 NTUs respectively and Lower Jutial water source, distribution tank and tape water found 20 NTUs, 20 NTUs and 15 NTUs respectively (Fig.8). According to WHO (2011), turbidity must not exceed 5 NTUs and water having turbidity less than 1.00 NTUs is excellent for domestic consumption. High turbidity cause problems during purification (flocculation and filtration) and increases the treatment expenses. It also diffuses light and hence lowers the rate of photosynthesis and may cause plants death.

Out of twenty water samples no any sample has recommended turbidity levels, turbidity of all the samples was beyond the WHO guidelines. The lowest turbidity value found was 10 NTUs in Barmas water tank inlet, distribution tank and tape water. Maximum turbidity value found was 20 NTUs in Upper and Lower Jutial water sources and in Upper Jutial water tank inlet. The main reason for this...
was due to the presence of suspended substances like clay, silt and microscopic organisms.

**Temperature**

Temperature is biologically an important factor which plays a vital role in proper functioning of all living things. WHO has provided no guideline and standards for temperature of drinking water, however, it has been suggested that the temperature of drinking water must be less than 15°C because warm water holds less oxygen content.

Examination of Barmas source water, water tank inlet, distribution tank, water tank outlet and house tape for temperature resulted 17°C, 18°C, 18°C and 18°C respectively. Examination of Jutial source water, water tank inlet, distribution tank, water tank outlet and tape water test for temperature observed 19°C, 19°C, 21°C and 21°C. Temperature examination revealed a fluctuation in results between 17-21°C. Highest value 21°C was determined in Upper Jutial water tank outlet and tape water (Fig.9). Variation in temperature might be due to the rate of chemical reactions and the nature of biological processes taking place in aquatic system.

**CONCLUSION**

Biological results of this study illustrate that 80 percent of water samples are free from fecal contamination and 20 percent of water samples are biologically contaminated and are not good for human consumption. This warns to protect us against water born infection and suggests boiling the water before use. The pH and Temperature values of Barmas and Jutial water supply complexes were satisfactory while the turbidity level of both water supply complexes was higher as compared to WHO guidelines (WHO, 2011).

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**REFERENCES**


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