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Analysis of drinking water quality to investigate reasons behind waterborne epidemic at Ghulmet valley Nagar Gilgit-Baltistan, Pakistan

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Abstract: People of Gilgit-Baltistan especially rural inhabitants face frequent health hazardous because of poor sanitation practices. Bacterial gastrointestinal infections are very common, and sometimes outbreaks occur. The present study was aimed to check reasons behind the water borne epidemic at Ghulmet Nagar Gilgit-Baltistan. Water quality testing along with sanitary inspection of the entire distribution network was carried out during the month of August, 2015. Total twelve samples were taken from intake (water channel), inside water tank, outlet and distribution network for microbiological analysis and to evaluate the shortfalls of water supply system. Waqtech water testing kit was used for microbiological analysis which employs the membrane filtration technique and membrane Lauryl sulphate brute as medium. Results obtained from assessment of different physio-chemical parameters were as follows.

Temperature value fluctuate between 14-18 °C, turbidity levels were 50-100 NTU, pH ranged from 8-8.8, and E. coli (colonies) were 6-27 at different sampling locations. During the inspection it was found that the water intake is insufficient, and not protected, livestock (cows & goats) of local community grazing at intake point. People used to feed water from open channel into main water tank to achieve the demand, agricultural runoff

gets into that water tank, which is the one of the main source of water contamination apart from that overflowing water which gets accumulated around the intake tank from where contaminated stagnant water seeps into main intake source. All the samples taken from water distribution network revealed the highest contamination with E. coli an indicator organism of water borne diseases, falls in category B&C according to WHO guidelines and not fit for human consumption. Presence of this organism in water sample is an indicator of faecal contamination of drinking water source. Upstream animate activities and agricultural runoff around un-protected water intake point (water channel) is one of the main causes of water contamination and water borne epidemics at Ghulmet Nagar.

Keywords: Drinking Water Quality, E. coli, turbidity, epidemic, World Health Organization, Environmental Protection Agency.

INTRODUCTION

Outbreaks of gastroenteritis mainly depends upon a variety of risk factors among children and adults such as contaminated pond water which was used for washing, bathing, drinking and cooking purposes without boiling[1]. It has been reported that more than 1.1 billion children of less than 5 years of age were more vulnerable to this disease. Gastroenteritis infections annually result in 7.6 million deaths in South Asian countries including Pakistan and a number of the Eastern Mediterranean countries. From 2008 to 2015, one million deaths have been recorded in Pakistan alone which reflects the severity and primarily significance of this notorious infection[2].

Drinking contaminated water can cause diarrhea, cholera, dysentery, and various other diseases like Typhoid, Amonebiasis, Jaundice, Enterobacteriaceae, etc.[3]. Acute gastroenteritis or acute watery diarrhea (AWD) cases with or without vomiting; commonly occur in Pakistan during the summer and monsoon seasons. Besides hygienic factors; the contamination of drinking water is mostly found responsible for outbreaks. As compared to winter the water reservoirs tend to become dry or depleted during summer and level of waste increases proportionately. During monsoon, the rain water carrying human and animal waste pollutes the water reservoirs / sources. The climate in the meantime, also favors multiplication of microorganisms in various food items[4].

According to Ministry of Health Pakistan Report 2006[5], Pakistan is a developing country, currently facing the double burden of diseases with infectious diseases contributing to twenty six per cent of the total disease burden. The priority infectious diseases in Pakistan include acute respiratory infections which account for 51% malaria, 16% viral hepatitis, 7.5 % and diarrhea/dysentery 23% of the overall burden of disease[6].

Cholera is an endemic disease in Pakistan and has never been considered a significant cause of diarrhea before 1988[7]. Recent outbreaks of cholera are attributed to poor environment/sanitation condition and consumption of contaminated water and food due to natural calamities which has displaced thousands of population[8,9]. Diarrheal diseases which are transferred by contaminated water are a cause of abnormalities in children. Estimated of annual total deaths from diarrheal diseases ranges from 2.5 to 3.5 million[10].

The main bacterial microorganisms of concern in contaminated water include Salmonella sp., Shigella sp., Escherichia coli and Vibrio cholera[11]. The presence of faecal coli forms or E. coli has been widely

used as an indicator for the presence of any of these waterborne pathogens [11, 12, 13]. The World Health Organization WHO 2006[14] recommends that no faecal coliform be present in 100ml of drinking water[15]. Presence of E. coli, a common intestinal bacterium indicates presence of faecal contamination and the possibility of contamination by pathogenic microorganisms[11].

Worldwide, more people are dying from poor quality of water per year than from all forms of violence including war and it is estimated that about 26% of all deaths are outcome from contagious diseases caused by pathogenic bacteria[16,17].

Due to contamination and micro-biological impurities majority of the Pakistani citizens have inadequate access to safe drinking water with poor water supply lines and faulty drainage system[18]. Resultantly, this caused many diseases among people[19]. Particularly, biological diseases caused high child mortality rate of 128/ 1000 per year[20]. It is estimated that, in Pakistan, 30% of all diseases and 40% of all deaths are caused by bad quality of water[21].

In Gilgit-Baltistan, Pakistan glaciers are the main source of water and people use surface water from nallah (big streams) and springs for both drinking and irrigation purposes.

The surface water has many chances of water borne disease. The Gilgit-Baltistan of Pakistan is mountainous, and its people face health hazards because of poor sanitation practices, i.e. inadequate sewage treatment or use of latrines, lack of hygiene education, and use of highly contaminated water. Parasitic and bacterial gastrointestinal infections are very common, and sometimes outbreaks occur[22,23].

MATERIAL AND METHODS

Study Area: The study area was Ghulmet Nagar Gilgit-Baltistan to assess the reasons behind the waterborne epidemic among the communities. Sampling activity was carried out during the month of August, 2015. Randomly water samples were collected from the entire distribution network including intake (main source), intake (second source water channel), outlet and five community tapes in pre sterilized bottles of 500ml capacity. Sanitary inspection of the entire distribution network was also carried out to identify the shortfalls of supply system.

Parameters Tested: Some physio-chemical parameters like temperature, colour, turbidity, pH and microbiological parameter (E. coli) were analyzed. Physio-chemical parameters were tested onsite while for microbiological analysis samples were brought to Environmental Protection Agency Laboratory.

Wag Tech Water Testing Kit was used for analysis of water samples which employ the membrane filtration technique and membrane Lauryl suplhate 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.

pH was measured by pH meter and turbidity was measured with turbidity tubes provided with the Waqtech Water Testing Kit. These tubes are graduated with logarithmic scale and cover the range 5 to 2000 NTUs.

RESULTS

Comparative results are given in **Table 1**.

Table 1: showing comparative result of Tested Parameters of the study area

S#	Sampling Points	Parameters Tested						
		Temp °C	Turbidity NTUs	pH	E. coli/100ml	Color	Odor	Taste
1	Source	14	100	8	27	Cloudy	No Object	No Object
2	Storage Tank	18	50	8.1	22	Cloudy	No Object	No Object
3	Outlet	18	50	8.7	26	Cloudy	No Object	No Object
4	Mashkol M HT 1	18	50	8.1	23	Cloudy	No Object	No Object
5	Mashoil M HT 2	18	50	8.4	16	Cloudy	No Object	No Object
6	Mashkol M HT 2	18	55	8.1	9	Cloudy	No Object	No Object
7	Kot M HT 1	18	50	8.4	13	Cloudy	No Object	No Object
8	Kot M HT 2	18	60	8.8	7	Cloudy	No Object	No Object
9	Kot M HT 3	18	50	8.6	11	Cloudy	No Object	No Object
10	Yal M HT 1	18	50	8.3	17	Cloudy	No Object	No Object
11	Kot M HT 2	18	50	8.2	8	Cloudy	No Object	No Object
12	Kot M HT 3	18	50	8.8	6	Cloudy	No Object	No Object

DISCUSSION

Temperature: According to EPA 1976[24], temperature is biologically an important factor, and plays an important role in proper functioning of all living things. The temperature is one of the important factors in aquatic environment since it regulates physio-chemical as well as biological activities[25]. In the current study at source temperature value was 14 °C while rest of the eleven sampling points it was 18 °C **(Fig 1).** Water temperature change naturally seasonally[26]. The observed temperature variation of the sampled water from 9 to 25 °C in a study conducted by Shedayi et al., at 2015[27] drinking water quality of Nomal, Gilgit-Baltistan, Pakistan. Of the seven samples one were at higher side. This deviation from limitation may be because of the timing of the sampling. Ali *et al.*, (2013)[28], found a little fluctuation in temperature values between12.10-13.50 C in a study drinking water quality assessment of selected villages of Nagar valley Gilgit-Baltistan.

Turbidity: According to WHO, 2006[29] turbidity is the measurement of relative clearness of water. Turbidity in water is due to presence of suspended material like clay, silt, and microscopic organisms and it can also be a source of nutrients for microorganisms. Turbidity may specify the presence of disease causing organisms. These organisms include bacteria, viruses, parasites that can cause nausea, cramps, and diarrhea and associated headaches USEPA, 2001[15].

In the current study turbidity levels fluctuated from 50 to 100 NTUs **(Fig 2)**. According to WHO guidelines turbidity of drinking water must be <5NTU while results obtained were exceeding those limits which is in confirmation of another study conducted by Naqvi *et al.*, 2013[30], where turbidity value of the

studied samples were exceeding the WHO guidelines as well as PCRWR values except for samples MF 05, 08, 10, 11, 12, and 14, which had the turbidity values within permissible limits.

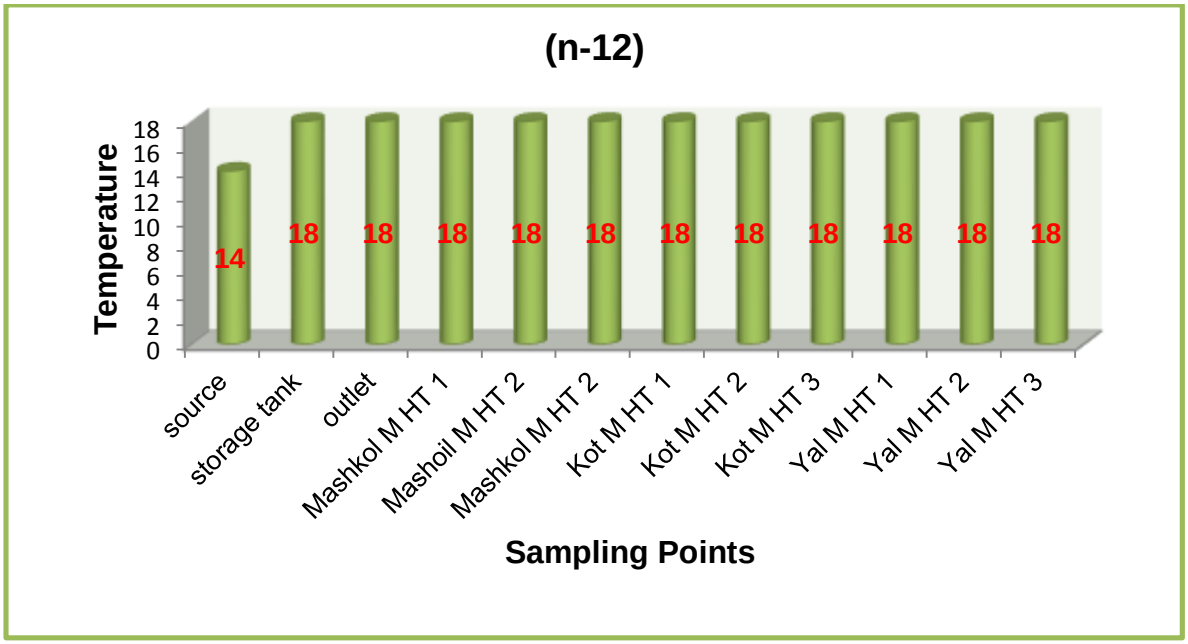

Figure 1: showing temperature values of sampling points

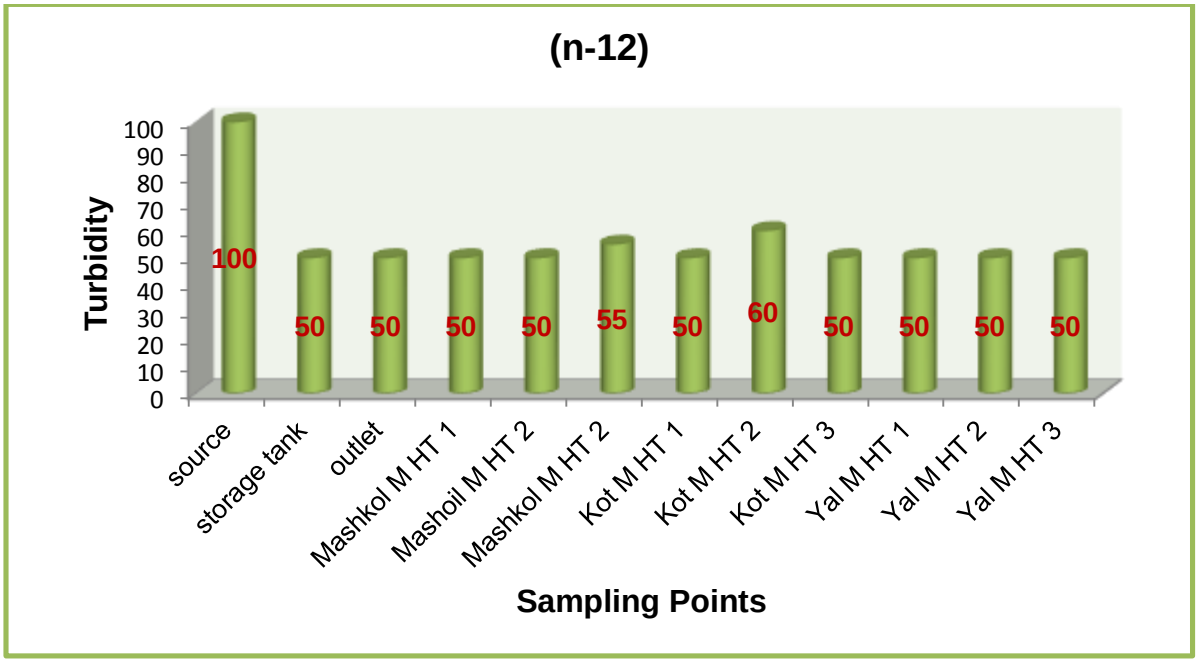

Figure 2: showing turbidity level of sampling points

Bacteriological analysis: Total coliform bacteria and faecal coliform Escherichia Coli (E. coli) are two types of faecal indicator bacteria. Several bacteria can be classified as coliform, and are commonly found in soil, on the surface of leaves, in decaying matter, and can grow in water distribution mains WHO, 1996[31]. In different regions of the world E. coli was also isolated from drinking water sources. Similar studies were carried out by Franciska *et al*., 2005[32] analyzed the quality of drinking water from private water supplies in Netherlands. Total 144 samples were collected for bacteriological analysis. Their results show that 10.9% samples were contaminated due to E. coli and Enterococci presence. Hanan & Shan, 2010[33] found faecal coliform (E. coli) in 17 of the total samples yielding a percentage of 38.63 % thus giving a rough picture of waterborne diseases that might arise from this much high count, as about 90% people in Punjab suffer from such ailments. Number of colonies ranged from 6-27 **(Fig 3)**. Most of the samples collected in the current study fall in category B & C according to WHO guidelines, could hence be considered unsafe for human consumption and cause of waterborne epidemic which, is in conformity with similar studies conducted by Hussain *et al.*, 2008[34]; Aziz, 2005[35]; Tahir *et al.*, 1998[36]. According to Mehmood *et al.*, 2013[37], E. coli was detected on samples A5, B1, B3 and B5. The presence of E. coli indicated that water was unsafe for human consumption and presence of these microbes led to different diseases that are easily seen in different communities in twin cities.

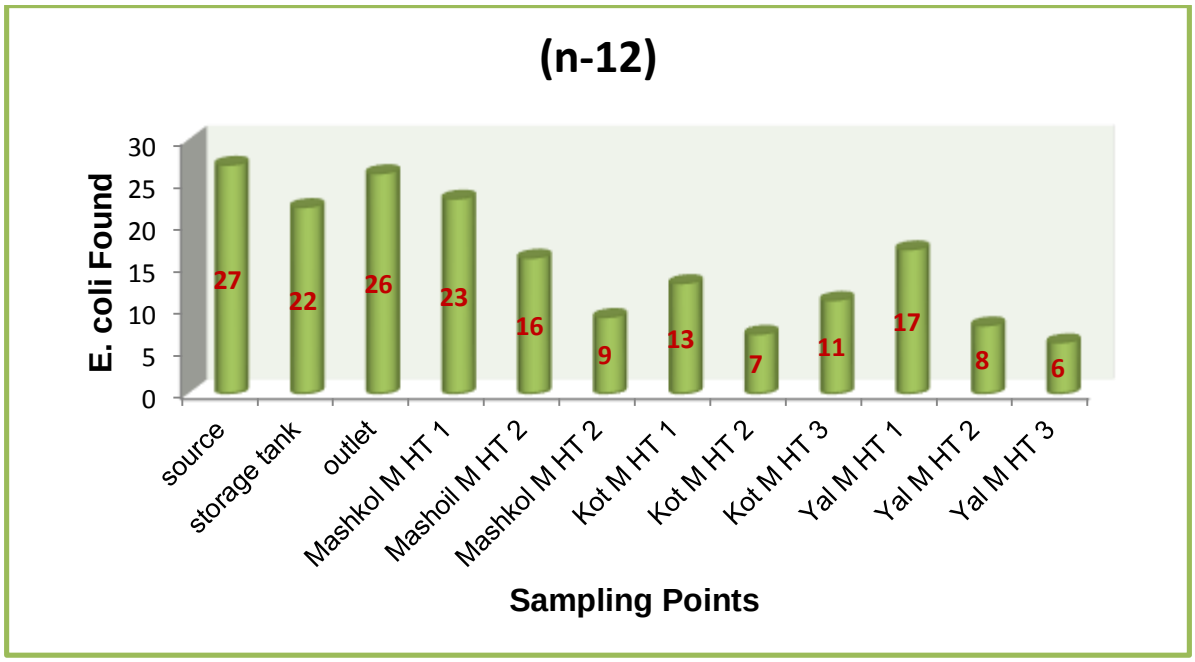

Figure 3: showing number of E. coli found in different sampling points

pH: pH is most important in determining the corrosive nature of water. Lower the pH value higher is the corrosive nature of water. pH was positively correlated with electrical conductance and total alkalinity Guptaa 2009[38]. The pH level in the current study fluctuates between 8 to 8.8 **(Fig 4)** which was within the prescribed limits of WHO (6.5-8.5).

These results are also in accordance with the studies conducted by Farooq *et al.*, (2008)[39] and Hashmi *et al.*, (2009)[40] in which the pH values varied from 7.02 to 7.30 and 7.03 to 7.73 in Westridge and Tech Bata

in Rawalpindi. According to a study conducted by Inamullah & Alam, (2014)[41] pH values measured at different locations were within the range of WHO standards. However, the range of pH values was from 6.6 and 7.75 with an average of 7 at level one and from 6.7 to 7.68 with an average of 7.04 at level two.

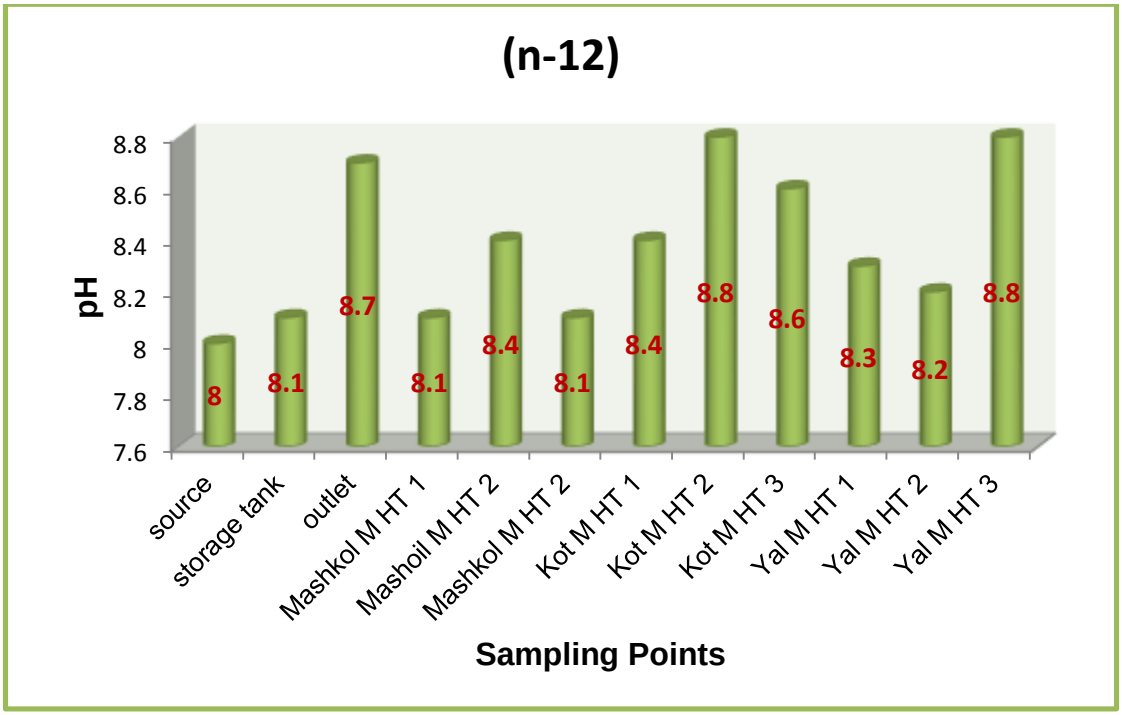

Figure 4: showing pH level in different sampling points

CONCLUSION AND RECOMMENDATIONS

Sanitary inspection and microbiological analysis of the entire distribution network revealed that upstream animate activities and agricultural run-off around un-protected water intake point (water channel) is one of the main causes of water contamination and water borne epidemics at Ghulmet Nagar.

In order to minimizing such kind of outbreaks in future following recommendations are suggested:

- Water intake (piped water) must be protected in order to avoid contamination.
- Intake should be cleaned periodically to avoid accumulation of silt.
- Water storage tank should be protected and control valve must be installed to avoid continuous flow/discharge of water.
- Water from small channels should not feed into main water storage tank to compensate the demand.
- During peak season main water storage tanks should be de contaminated using chlorine twice a year. Sufficient amount of chlorine should be stored at community water supply systems in order to avoid future water borne epidemics. Upstream near water supply system intake animate activities should be prohibited.

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