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Physico-chemical and bacteriological analysis of drinking water quality of Nomal, Gilgit-Baltistan, Pakistan

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Abstract

This study was undertaken in Nomal Village located in 25 km from Gilgit district. Nomal Valley has an approximate 850 households consisting of 6000 people. The aim of this study was to analyze the state of drinking water quality in Nomal area. Water samples were collected from seven sites in sterilizes bottles. The water samples were immediately subjected to both chemical and biological analysis. The results of these tests were compared with water quality standards of WHO. The water quality parameters namely pH, temperature, turbidity, odor, taste, total hardness, alkalinity and *E. coli* were determined. The data indicated that pH of all samples was 7, turbidity varied from 5-10 NTU and temperature was 9-25°C. The results showed that physical and chemical parameters of drinking water fall within recommended limits of WHO. Biological water quality analysis indicated that channel water was highly contaminated showing the presence of high fecal coliform. The maximum colonies of coliform present in channel-2 (TNTC) too numerous to count and in tap water 93 *E. coli* colonies were examined. It indicated that biologically water is not suitable for human consumption. However, chemical and physical quality of drinking water does not have any health hazard problems this time so for. The water far from the source was much polluted as compared to near to the source. Longer the distance water covers it become more polluted because of anthropogenic interaction.

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Introduction

Nomal valley is located in district Gilgit its geographical coordinates are 36° 4' 23" North, 74° 15' 16" East. There are approximate 850 households consisting of 6000 people. Agriculture is the main source of income and livelihood while some household also depend on livestock. Agricultural land of this valley is mostly plain fertile and suitable for all kind of crops, vegetables and fruits. Nomal valley is very popular for its different varieties of cherry production (Javed, 2001).

The physical parameters of drinking water usually determined are temperature, pH, conductivity, turbidity, total dissolved solids and total soluble solids using field kits (APHA, 1992). Warmer water holds less oxygen due to which we reduce fitness. Such type of water is released from nuclear powers where it emerge with streams warmer the ecosystems. The quality of water necessary for each human use varies as due to variation in water quality. The highest standard quality of water required for drinking and low quality of water acceptable in some industrial processes (Carr and Neary, 2008). Kahlown and Tahir (2002) investigated water quality issues and found that the Groundwater is the major source of drinking and industrial water use. The increased pressure on groundwater may cause lowering of water table in many cities. The water table has fallen down by more than 10 feet in many areas. Water used from lower areas infects human health.

Altaf *et al.* (1992) conducted a study on safe drinking water and its benefits of preventing ground water contamination which shows the importance of the risk and location of contamination and its treatment and diseases caused by contaminated water. Chat well (1989) studied chemical parameters of drinking water quality given specific standards were for water acceptability for human consumption which can be domestic agricultural and industries. Esrey (1985) analyzed and work on reduction of diarrhea. He work on improving water quality and expose to little effects on human health such as sanitation, personal hygiene and increasing water quantity. Robertson *et al.* (2006) designed drinking water quality to enable the provision of clean and safe water for human consumption and protecting human health. He studied acceptable levels of toxicity to either humans or aquatic organisms. Tahir (1989) conducted a study on pollution problems in water supply system of Rawalpindi which show that 76% in Islamabad and 82%in Rawalpindi were contaminated due to bacterial presence. Most of the water samples were found unfit for drinking purpose due to the presence of coliform and *E. coli*. Tyagi *et al.* (2002) studied pollution problems in water supply systems of Islamabad city. The supply systems of city is found fit in some major aspects like alkalinity, hardness, TDS, free CO_2,calcium, ferrous, lithium, manganese, sodium, zinc, nickel, chromium, potassium, sulfate, phosphates and chlorides**.** Tahir (1989) studied pollution problems in water supply systems of Rawalpindi and Islamabad city. The study found that some parameters are fit with respect to alkalinity, hardness, TDS, free CO_2, calcium, ferrous, sodium, zinc, nickel, chromium, potassium,phosphates and chlorides. Keeping all these studies in view the aim of the present study was to investigate the physiochemical and biological quality of Nomal vally, Gilgit.

Materials and methods

The study was conducted along a transect from source to the end of Nomal village. Water samples were taken in sterilized bottles from channel and tap at a distance of 1.5 km. Temperature, odor, taste, turbidity and time were noted for each point. Water samples were taken to laboratory for Bio-chemical analysis. Water temperature-recorded in field using mercury thermometer. Temperature of the water was measured by suspending a thermometer in drinking water about 4 inches below the water surface (John, 1996). pH was measured BY digital mobile pH meter (APHA, 1992). Turbidity of water measure by using turbidity tube. Water samples were collected from different sources of valley in sterilized bottles. Samples were tested and analyzed through Oxfam Del

Agua water testing kit, which employ the membrane filtration technique and lauryl sulphate broth as medium. A known volume (100ml) of water was sucked through the membrane with the help of vacuum pump. The membrane was then placed on the absorbent pad saturated with the lauryl sulphate broth in a sterile aluminum petri dish. These plates were marked and incubated for 16-18 hours at 44°C. After incubation period all yellow colonies were counted and reported against per 100ml of water. Alkalinity and calcium hardness was also measured by standard method.

Results and discussion

Drinking water sources like streams, rivers, lakes, dams contaminated directly or indirectly. The direct contamination is caused by chemicals and disease causing organisms. The sources of contamination may be human and animal wastes discharging mostly into water where pollution causes. Without availability of safe drinking water people cannot have productive lives (Stein, 2000).

The water quality analysis parameters were compared to the WHO guidelines to ascertain if the quality of water were in accordance with appropriate drinking water standards. The Physico- chemical parameters were found to be within recommended limits of WHO standards. Parameters that were found to be slightly out of range were temperature and turbidity. The results of some physical parameters analyzed in the water samples collected are following;

pH (Power of hydrogen)

The pH value for all the sites was recorded as 7. It indicated that pH value of all collected samples fall within in safer limit of drinking water quality in WHO standards (WHO, 1996). For drinking water a pH range of 6.0-8.5 is recommended (Davis, 2002). pH of water can affect the water Hardness. Such water is not suitable for drinking because it causes stomach infections and dysentery. Such quality of water is also not suitable for washing because detergent is totally washed out (Anon, 1992). Jabeen and Shedayi (2011) observed from Sultanabad, Gilgit, Pakistan in which pH values did not meet WHO guidelines; 45% samples had pH values below 6.0.

Temperature

WHO (1996) recommended a temperature of 12 degree C for drinking purposes. The observed temperature variation of the sampled water from 9 to 25 °C. Of the seven samples 1 were on higher side. This deviation from limitation may be because of the timing of the sampling. The temperature of water sources is given in table above. Temperature affects chemical reactions the rate at which algae and aquatic plants photosynthesize the metabolic rate of other organisms. Temperature is important in aquatic life because it can influence the solubility of dissolved oxygen .Water temperatures change naturally seasonally (Schaffer *et al.,* 2001). Water temperature affects the movement of organism. Metabolic rates of aquatic organisms increase as temperature of water increase. Oxygen levels always decrease in warmer water. Optimal temperatures for aquatic life range from 41 - 77 degrees (John, 1996).

Turbidity

The present study showed the maximum turbidity <10 NTU. WHO (1996) Prescribed highest limit 25.0 NTU. Drinking water should have a turbidity of ≤ 5 NTU fit for human consumption (Davis, 2002). The turbidity control of a deep bed rapid sand filter. Filter depends on sources of drinking water such as streams, rivers, lakes, dams, reservoirs and contaminated ground water. The contamination is due to human or animal wastes discharging directly into the wells entering as a result of surface run off by air pollution. Without safe drinking water people cannot survive healthy lives (Stein, 2000). The turbidity in surface waters is due to Clay, Silt, Plankton and Microorganisms (Viswanathan *et al.,* 2006). Turbidity values for all samples were higher than WHO standard in Sultanbad, Gilgit, Pakistan.

Taste and Color

The taste of the water in the study area was found satisfactory and acceptable for human consumption. The water in all the sites was found to be colorless. It indicated that by color wise the water is seemed to be safe and free from impurities. The turbidity cause undesirable taste and color. It also provides biological disinfection. Color of water also is due to humic substances. When water is disinfected with chlorine that water is carcinogenic. Odor problems in water occur due to presence of organic substances. Water supplied to consumers should be free of objectionable taste and odor (Viswanathan *et al.,* 2006).

Escherchia coli (E. coli)

The results shown in the fig. 1 indicated all the samples having E. *coli* ranging 18 to 158 colonies/100ml were unsafe for drinking purpose as the WHO (1996) guidelines recommend 0/100ml for drinking purpose. The results were similar to that of Jabeen and Shedayi (2011) in which the observed Channel water contaminated than tap water. Approximately 50% of the water samples failed to meet drinking water guideline of zero *E. coli*/ 100 ml in Sultanabad, Gilgit, Pakistan.

E. coli in water means presence of dangerous bacteria in water and it indicates pollution. The coliform present in form of group includes a number of bacteria's, *Aero-bacter erogenes*, *Aero-bacter cloacae*. *Escherichia coli* causing infections directly to genito-urinary tract, typhoid fever, para-typhoid fever, dysenteries and cholera (Anon, 1992). Waterborne diseases are caused by water contamination due to which pathogenic viruses, bacteria or protozoa are present in polluted water. These pathogens are directly transfer to humans when used for drinking, preparing food, or other domestic purposes. Contaminated drinking-water is cause of diseases such as cholera, typhoid, viral hepatitis A, Diarrhea, dysentery etc. Humans also cause water to become contaminated with substances such as lead, nitrates and pesticides are merging in water and become dangerous for humans (Hrudey, 2004). Diarrheal diseases which are transferred by contaminated water are a cause of abnormalities in children's. Estimates of annual total deaths from diarrheal diseases ranges from 2.5 to 3.5 million (Kosek *et al.,* 2003). Malick *et al.* (1998) studied the drinking water quality of Karachi. Results showed that presence of Coliform bacteria in the main distribution lines. It indicated that water got contaminated from the surrounding leaky pipelines. Secondly the presence of fecal Coliform in the water of branch lines feeding to consumers and stand posts, confirmed the mixing of sewage into drinking water lines making it unfit for drinking purposes.

Chemical analysis

Chemical parameters of water quality cause toxic chemicals in industrial activities and high risk to human life. The main reasons that respondents did not drink tap water sources are improper treatment and unpleasant mouth feel (Chung and Lee, 2007).

Water Hardness

According to WHO standards if water hardness ranges from 0-50 it is soft, if the value is between 50-150 it is moderately hard when hardness value rises from 150-300 then it is hard. The above samples analyzed showed that 70% is soft and 30% is moderately hard water and therefore fit for human consumption. The results were showing lesser values as compared to the calcium hardness ranged 160-200mg/l from Sultanabad (Jabeen and Shedayi, 2011), Gilgit, Pakistan. Water hardness is a calcium and magnesium cation concentration in a water sample. The concentration of metallic ions react with anions to produce scales, when water is evaporated this characterization is confined to di and trivalent metals particularly calcium and magnesium and sometime aluminum and iron. Large values of hardness are undesirable for economic reasons in many industries and must be removed before the water is suitable for use. Levels above 500 mg/L hardness are undesirable for domestic use and most drinking water supplies average about 250 mg/ℓ (Anon, 1992). Ali and Ahmed (1994) also observed

same values for Calcium hardness in assessing water quality from different cities of Punjab i.e. in between 100-200 mg/L. Hardness below 300 mg/L is considered potable but beyond this limit produces gastrointestinal irritation. Anon (1992) Studied many chronic disease particularly cardiovascular disease, hypertension and mental disorders which are mostly caused by water hardness.

Alkalinity

Alkalinity is the measurement of the water's ability to neutralize acids (RISC, 1998). Alkalinity levels within a water body often indicate the presence of carbonate, bicarbonates, or hydroxides and results are expressed in terms of an equivalent amount of calcium carbonate. High alkalinity values can result in excessive hardness and high concentrations of sodium salts. Water with low alkalinity has little capacity to buffer acidic inputs and is susceptible to acidification; however, values over 20 mg/L have been determined to have low sensitivity. The standard desirable limit of alkalinity in water is 120 mg/L. The maximum permissible level is 40mg/l. Water with low alkalinity less than 75 mg/L especially some surface waters changes in pH due to dissolved gasses.

Table 1. Physical parameters of waters.

S.No	Sampling Sites (Time)	pH	Temp. °C	Turbidity NTU	Taste	Color
01	Source (11:40)	7	9	<10	Acceptable	Color less
02	Channel 1 (11:55)	7	10	<10	Acceptable	Color less
03	House Tap 1 (12:00)	7	14	<10	Acceptable	Color less
04	Channel 2 (12:15)	7	25	<10	Acceptable	Color less
05	House Tap 2 (12:22)	7	10	<5	Acceptable	Color less
06	House Tap 3 (12:45)	7	15	<5	Acceptable	Color less
07	Channel 3 (12:55)	7	14	<5	Acceptable	Color less

Table 2. Level of water hardness.

S.No	Sampling sites	Volume ml	Dilution Factor	CaCO3 mg/l	Volume ml	Dilution Factor	Alkalinity mg/l
01	Source	20ml	5x	100	40ml	4x	40
02	Channel 1	30ml	5x	80	40ml	2x	40
03	House Tap 1	25ml	5x	90	30ml	4x	30
04	Channel 2	20ml	5x	95	35ml	3x	35
05	House Tap 2	25ml	5x	90	30ml	4x	30
06	House Tap 3	20ml	5x	80	30ml	4x	30
07	Channel 3	25ml	5x	90	35ml	3x	35

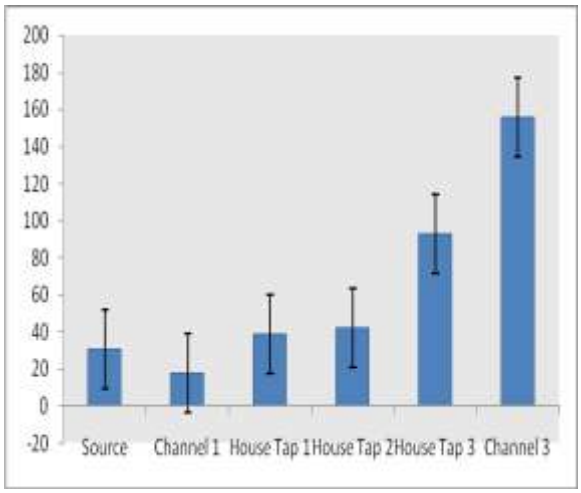

Fig. 1. *E. coli* assessment of Water.

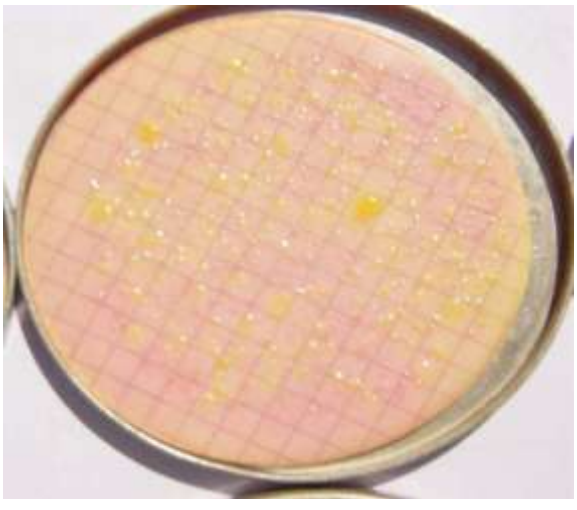

Fig. 2. Colonies of *E.coli* on Petri dish.

Conclusion

The present investigation has led us to conclude that the quality of water samples subjected to study was acceptable from majority of physico-chemical parameters while as the biological standards the water needs to be treated before using it for human consumption. All the seven samples of drinking water studied were contaminated with *E. coli*. Biological parameters failed to meet the WHO drinking water standards of zero *E.coli per* 100ml water making them unsuitable for human consumption.

Recommendation

It is strongly recommended to supply water to the area in rubber pipes and water treatment plants should be installed at accessible localities. Awareness among the people and use of chlorination method should also be introduced.

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