Analysis of Physicochemical Drinking Water Quality Parameters of Ziarat Valley

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Abstract

Quality of water is an important criterion for determining the suitability of water for human consumption. Keeping in view the significance of good quality water for a healthy society, the physic-chemical analysis of the water sources of the Ziarat town was carried out to evaluate their suitability for drinking purpose. A total of 16 drinking water samples were collected from 4 different sources of both surface (City and Wobasar karez) and ground water (Borewell and Tubewell). Four water samples (1 at the source and 3 from the tap) were collected from each source randomly. All the samples were analyzed for various physic-chemical parameters such as, color, odor, taste, temperature, pH, electrical conductivity, total dissolved solids, chloride, total hardness, and total alkalinity using standard procedures of (APHA, 1998). The calculated values were compared with the standards of WHO, all the samples were found below or within the maximum permissible limits of WHO.

Key words: Water quality; Physicochemical parameters; Ziarat valley; WHO

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INTRODUCTION

Natural water is a universal and potent symbol of life. It is one of the most important natural resources (Khan et al, 2013). Every person needs approximately 2 liters of clean drinking water and this amount reaches approximately 12 million m^3/day for the world population (Naji et al., 2011). According to WHO (2004) in total, there is 1400 million billion liters of water, but most of this water is not used for drinking purpose, because 97% is sea water and only 3% is fresh water, out of which 2% is lidged in the polar icecaps and glaciers, only 1% water is available for potable use, whereas more water goes for irrigation than to drinking sanitation and all other use.
(Khalid et al., 2011). Water quality deals with the physical, chemical and biological characteristics in relation to all other hydrological properties. It provides current information on concentration at a given place and time. The chemical parameters must be taken into consideration in the assessment of water quality, such as source protection, treatment efficiency and reliability and protection of the distribution network (Napacho and Manyele, 2010).

Pakistan ranks 80th, out of 122 nations of the world, on the basis of water quality. In Pakistan, drinking water supplies are mainly obtained from surface water sources or the underground aquifers. About 70% of the total drinking water supplies are obtained from underground aquifers. This ratio is further increasing at present. Water quality in Pakistan is deteriorating mainly as a result of disposal of the municipal and industrial wastewater, without proper drainage flow from agricultural areas (Khan et al., 2012). In Pakistan, there is scarcity of water particularly in rural areas. The available water is of very poor quality. At the present situation, in case of urban areas only 80% and in case of rural areas only 11% of the population has access to the piped water supply whereas in most of the areas the population is dependent on irrigation water for their domestic needs rather than drinking water (Ahmad et al., 2012). Water pollution in Pakistan is increasing rapidly by micro-organisms, agro-chemical wastes, municipal wastes and industrial wastes. According to a UNICEF report 20 to 40 percent beds are occupied in the hospitals of Pakistan by the patients suffering from water-related diseases (Mahwash et al., 2013).
In this research paper an attempt has been made to evaluate the physicochemical parameters of drinking water from both (ground and surface) water sources of the municipal area of Ziarat town and to compare the calculated values with the standards of WHO.

MATERIALS AND METHODS

Study Area

Ziarat district located at 30° 26′ 20" N, 67° 50′ 39" E with an altitude of 2453 meters (8050 feet), the total area is about 1,489 sq. km mostly mountainous

area,. Ziarat and positioned over 2449 meters above sea level. The municipal area of Ziarat town was selected for the collection of water samples. It is entirely commercial and residential area, population of the town is nearly ten thousand.

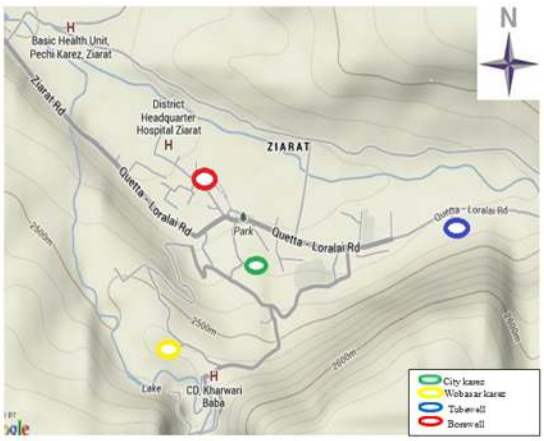

Figure 1: Map of the study area of Ziarat town, showing the sampling points of drinking water.

Sample Collection and Analysis

Total of sixteen drinking water samples were collected randomly from both surface (city and Wobasar karez) and ground water (Borewell and Tubewell) sources. Four samples were collected from each source one from main point and 3 samples were collected from Consumer taps of the same source. Sampling locations were selected from the main population zone by standard procedure of APHA, in clean, sterilized polythene (1.5L) bottles, labeled with collection point, date and time, kept at 4°C. Various physical parameters such as color, odor, taste, temperature and pH were determined at the point of sample collection. Electrical conductivity, total dissolved solids by EC meter, total hardness by complex metric titration, total alkalinity by acid base titration and chloride by Argentometric titration (APHA, 1998). Water samples were analyzed in triplicates and mean result was calculated. All the chemicals used for the preparation of solutions were of AR grade and pre calibrated instruments were used for analysis. (Shyamala et al., 2008; Khalid et al., 2011; Saeed et al., 2012; Napacho and Manyele, 2010). The respective calculated values stated in the Table 1 and 2 .All the results were compared with the standard limits prescribed by WHO.

RESULTS AND DISCUSSION

The analytical results of physical and chemical drinking water quality parameters of each source are presented in Table no 1, 2 and 3. The obtained results of each parameter were compared with the recommended values of World Health Organization (WHO, 2011).

Color, Odor and Taste

In the assessment of drinking-water quality for the physical parameters, the sensations of taste and odor are complementary. Drinking-water should ideally have no visible color. Color in drinking-water is usually due to the presence of colored organic matter (primarily humic and fulvic acids) associated with the humus fraction of soil (WHO, 2011). In the present investigation, color, odor, and taste of all the water samples, was measured qualitatively and all the samples were found to have normal taste, odor and clear appearance (table 2) indicating the absence of colloidal substances, suspended and decomposed vegetation.

Temperature

Temperature is a measure of the degree of hotness or coldness of a substance. Its determination is important because of its effect on other physical phenomena such as rate of biochemical and chemical reactions in the water body; reduction in solubility of gases and implications of tastes and odors of water (Olajire and Imeokparia, 2000). The measured results show that temperature of the surface water samples were in the range of 12 to 21.3°C (table 2). In ground water samples it was found in the range of 11 to19.06°C (table 2). The variation in water temperature might be due to the rate of chemical reactions and the nature of biological and most of the microbiological reactions and their important processes taking place in aquatic system (Ali et al., 2012). All the samples were in the desirable range of WHO. The lower values of water temperature observed in the present study could be attributed to the early winter months prevailed during the period of analysis.

Table I: standard values for physicochemical drinking water quality parameters.

Parameters	Units	WHO Standards
pH	---	6.5 – 8.5
Temperature	°C	25°C
Electrical conductivity	µs	500-1200 µs
Total dissolved solids	mg/L	500-1000 mg/L
Chloride	mg/L	250 mg/L
Total hardness as $CaCO_3$	mg/L	500 mg/L
Total alkalinity	mg/L	500mg/L

Table 2: Estimated values of physical parameters in drinking water samples of Ziarat Valley

Study area (code)	Color	Odor	Taste	Temp. (°C)	pH	EC (µs)	TDS (mg/L)
$C.K_S$	CL	OL	U	19.6	7.3	744	483
$C.K_{T1}$	CL	OL	U	21	7.8	753	485
$C.K_{T2}$	CL	OL	U	21.3	7.8	749	491
$C.K_{T3}$	CL	OL	U	21.2	8.1	766	497
$W.K_S$	CL	OL	U	12.3	7.1	401	280
$W.K_{T1}$	CL	OL	U	19.8	8.2	281	181
$W.K_{T2}$	CL	OL	U	19.8	7.5	332	332
$W.K_{T3}$	CL	OL	U	20	7.8	388	388
$B.W_S$	CL	OL	U	11.5	7.3	539	352
$B.W_{T1}$	CL	OL	U	19.06	7.9	512	332
$B.W_{T2}$	CL	OL	U	18.6	8.2	449	292
$B.W_{T3}$	CL	OL	U	19	8.1	493	320
$T.W_S$	CL	OL	U	13	7.3	593	385
$T.W_{T1}$	CL	OL	U	15	7.4	832	541
$T.W_{T2}$	CL	OL	U	18	8.2	763	495
$T.W_{T3}$	CL	OL	U	16.5	7.3	880	572

$C.K_S$ = City karez source sample
$C.K_{T1}$ = City karez tap water sample1
$C.K_{T2}$ = City karez tap water sample2
$C.K_{T3}$ = City karez tap water sample3
$W.K_S$ = Wobasar Karez source sample
$W.K_{T1}$ = Wobasar karez tap water sample1
$W.K_{T2}$ = Wobasar karez tap water sample 2
$W.K_{T3}$ = Wobasar karez tap water sample 3
EC: Electrical conductivity
CL: color less
TDS: Total dissolved solids
OL: odor less
Temp: Temperature
U: unobjectionabl
$B.W_S$ = Bore well source sample
$B.W_{T1}$ = Bore well tap water sample1
$B.W_{T2}$ = Bore well tap water sample2
$B.W_{T3}$ = Bore well tap water sample3
$T.W_S$ = Tube well source sample
$T.W_{T1}$ = Tube well tap water sample 1
$T.W_{T2}$ = Tube well tap water sample2
$T.W_{T3}$ = Tube well tap water sample3

pH

pH is the hydrogen ion activity and a measure of acidity and alkalinity in aquatic (Jayalakshmi et al., 2011). The highest calculated value of the pH was 8.2 (table2) in the tap water samples of Wobasar karez, Tubewell and Borewell. pH values obtained from both ground and surface water sources were slightly alkaline in nature Drinking water with a pH level above 8.5 could indicate that the water is hard. Hardness can cause aesthetic problems, such as an alkali taste to the water (Napacho and Manyele, 2010). pH of all the water samples measured was in the permissible range of 6.5-8.5 prescribed by WHO and water from source and consumer tap was found suitable for drinking purpose in terms of its pH values .

Electrical Conductivity (EC)

It is a measurement of water's capacity for carrying electrical current (Jayalakshmi et al., 2011). The EC of the surface water (city and Wobasar karez) was varying from 281 to 766 µs and ground water (Borewell and Tubewell) was in between 449 to 880 µs (Table 2) at 25°C. The estimated values of EC among all water samples fall in prescribed limits of 500-1200 µs the samples were within the limits of WHO.

Total Dissolved Solids

TDS is the calculation of inorganic salts and minute amounts of organic substances present in water solution or a measure of dissolved matter (salts, organic matter, minerals, etc.) in water (Ali et al., 2012). The maximum value of TDS among all the sixteen water samples was 572 mg/L in tap water sample of Tubewell and the minimum value was 181 mg/L (table 2) in Wobasar karez tap water. The WHO standard value for TDS in drinking water is 500 mg/L minimum as desirable and 1000 mg/L is the standard maximum permissible limit (Jothivenkatachalam et al., 2010).

Chlorides

Chloride is one of the major inorganic anion in water. In potable water, the salty taste is produced by the Chloride concentrations (Gyamfi et al., 2011). The chloride content of all drinking water samples lied in between 52-97 mg/L (table 3). The level of chloride concentration was found lower in all the samples from main source and a little higher value was observed in consumer tap water and it was found that chloride concentration of all water samples was below the permitted range of 250 mg/L of WHO.

Total Hardness

TH is the parameter of water quality used to describe the effect of dissolved minerals of (mostly Ca and Mg), determining suitability of water for domestic, industrial and drinking purposes and attributed to presence of bicarbonates, sulphates, chloride and nitrates of calcium and magnesium

(Singh et al, 2010). The observed values of total hardness as mg/$CaCO_3$ in surface water samples were in the range of 278 – 411mg/L (table 3) and the And the values of ground water samples varied from 301 - 425mg/L (Table 3). All the four sources of drinking water were falling within the maximum permissible range of 500 mg/L by WHO.

Table 3: Estimated values of chemical parameters in drinking water samples of Ziarat town

Study Area (code)	Chloride (mg/L)	Total Hardness (mg/L)	Alkalinity (mg/L)
C.K_S	52.11	395	343
C.K_{T1}	54.59	411	360
C.K_{T2}	54.59	406	346
C.K_{T3}	54.59	497	343
W.K_S	54.59	398	210
W.K_{T1}	69.48	296	156
W.K_{T2}	80.89	278	176
W.K_{T3}	87.34	323	220
B.W_S	62.53	325	276
B.W_{T1}	82.38	301	246
B.W_{T2}	97.27	276	226
B.W_{T3}	74.44	303	283
T.W_S	67.49	308	283
T.W_{T1}	94.29	403	336
T.W_{T2}	85.85	325	266
T.W_{T3}	82.38	425	340

Total Alkalinity

Alkalinity of water is defined as the ionic concentration, which can neutralize the hydrogen ion, or the capability of water to neutralize a strong acid is called alkalinity; hence alkalinity of water is due to existence of bicarbonates, carbonate and hydroxide compounds of calcium, sodium and potassium (Jothivenkatachalam et al., 2010).

The phenolphthalein alkalinity value was zero indicating the absence of any hydroxyl ions. Bicarbonate alkalinity is expressed as total alkalinity (Jothivenkatachalam et al., 2010; Ahmed et al, 2012). The recommended value of total alkalinity is 500 mg/L (table I). In the present study, the amount of total alkalinity as mg/$CaCO_3$ was found in the range of 160 – 360mg/L (Table 3).

The maximum value was observed in tap water of City karez and the minimum value were found in Wobasar karez tap water (Table 3).

CONCLUSION

Based on the results of the analysis for the quality of ground and surface water samples collected from four different drinking water sources of Ziarat town, it is concluded that the physical parameters including color, odor, taste, temperature, pH, EC and chemical parameters such as chloride, TH and total alkalinity of all the samples collected right from the sources or consumer's tap were found within the permissible limits set by WHO, 2011.

Overall the drinking water quality of Ziarat town was reasonably good and does not show any alarming level of contamination.

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