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Full Length Research Paper

Qualitative and quantitative analysis of drinking water samples of different localities in Abbottabad district, Pakistan

Anwar Khalid[1], Amir Haider Malik[2], Amir Waseem[1], Shazmeen Zahra[3] and Ghulam Murtaza[4*]

[1]Department of Chemistry, COMSATS Institute of Information Technology, Abbottabad 22060, Pakistan.
[2]Department of Metallurgy, COMSATS Institute of Information Technology, Islamabad, Pakistan.
[3]Institute of Pure and Applied Biology, Bahauddin Zakariya University, Multan, Pakistan.
[4]Department of Pharmaceutical Sciences, COMSATS Institute of Information Technology, Abbottabad 22060, Pakistan.

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The complete analysis of 15 drinking water samples was carried out to develop a data base on the quality of water being consumed in different areas of Abbottabad district. The qualitative and quantitative analysis of water samples of different localities was conducted to determine the exact amount of different pollutants present in water. The drinking water samples were taken from the main water sources where maximum peoples were using them for drinking purpose. The results indicated certain sources of water-borne diseases in drinking water, which are common in the people of a particular area. The results of the present research work showed that drinking water collected from different areas of Abbottabad district was not found to be suitable for human health due to microbiological issues.

Key words: Abbottabad, drinking water, qualitative and quantitative analysis.

INTRODUCTION

The quality of water is a vital concern for mankind, since it is directly linked with human welfare. It is a matter of history that fiscal pollution of drinking water caused water born diseases which wiped out entire population of these cities. At present, the menace of water born diseases and epidemics still booms large on the horizons of developing countries. Polluted water is the culprit in such cases (Nollet, 2000).

Water is the most widely distributed and abundant substances found in nature. The irony is that our planet is a wash with water. 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 ice caps and glaciers, only 1% water is available for portable use; whereas more water goes for irrigation than to drinking sanitation and all other uses (WHO, 2004).

For centuries, human have been disposing off waste products by burning, placing them in streams, storing them on ground or putting them in the ground. Human induced influences on surface water quality reflect not only waste discharge directly into a stream, but also include contaminated surface runoff. The quality of ground water is most commonly affected by waste disposed and land use. One major source of

*Corresponding author. E-mail: gmdogar356@gmail.com. Tel: 923142082826. Fax: 92992383441.

contamination is the storage of waste materials in excavations, such as pits or mines. Water soluble substances that are disrupted, spilled, spread or stored on the land surface may be filled eventually. One cause of water contamination is the disposal of waste materials directly on the land surface. Example includes manure, sludge, garbage and industrial wastes. The waste may occur as individual mounds, or it may be spread over the land. If the waste material contains soluble substances, they may infiltrate similar problems that occur in the vicinity of various types of stockpiles (Jaini, 2003).

During the past two decades, investigators have taken a serious look at the environmental effects of dumps. As rain water infiltrates through trash in dump, it accumulates an ample assortment of chemical and biological substances. The resulting fluid or leachate may be highly mineralized and as it infiltrates, some of the substances it contains may not be removed or degraded (Richardson, 2001). Fertilizers and pesticides are highly toxic and in countless cases, quite mobile in the sub-surface. Numerous compounds, however, become quickly attached to fine-grained sediments, such as organic matter and clay and silt particles. In many heavily fertilized areas, the infiltration of nitrate, a decomposition product of ammonia fertilizer has adversely affected ground water. The consumption of nitrate rich water leads to a disease in infants known as “blue babies” (methemoglobinemia) (Shibukawa, 2004).

According to the State Bank of Pakistan’s report on health, which is part of the Sindh Vision 2030, “Water-related environmental health risks impose the most significant health burden,” the report revealed. It added that the high pollution levels of rivers and groundwater had led to different environmental consequences, such as a reduction in biodiversity, increase in water-related diseases and the decrease in agricultural productivity. Apart from that, the mismanagement of water resources has strong socio-economic repercussions, especially on food security and health (Nairmann, 2004; GoP, 2006).

The extent of enteric diseases in different areas depends upon the extent to which certain water is exposed to contamination. The incidence of typhoid fever, bacillary dysentery, infectious hepatitis and other enteric infections in many countries may transmit through water. Cholera is still a wide spread water carried disease in some developing countries. The University of Ottawa, Canada, during their first visit to Pakistan reported that the annual numbers of cases of water borne infections in Pakistan are close to 3 million, and about 40% occur due to polluted water. FAO and WHO reports reveal that after installation of safe water pipes alone in 30 rural settlements of Japan, communicable intestinal diseases were reduced to 71.5% and that of trachoma by 64% while the death rate for infants and young children fell by 51.7% (GoP, 2006).

The objectives of the present study was to analyze physicochemical and biological parameters of drinking water samples collected from the selective localities of Abbottabad district to assess health impacts linked with the consumption of unsafe drinking water and to suggest possible mitigation measures for the identified problems.

EXPERIMENTAL

Materials

Chemicals involved in all chemicals tests were of analytical grade and were obtained through Pak Chemicals, Abbottabad, Pakistan.

Collection of samples

During water quality investigation, the selection of sampling points is more important than actual chemical analysis of water. A successful sampling program entails the selection of sampling points in line with objective of the study. Since various natural and man-made factors are responsible for water pollution. Therefore, there is no general rule that governs the selection of sampling sites. For the purpose of water quality estimation, the selection of sampling sites require, on a prior basis, extensive investigation and field survey of such factors/sources, such as waste discharges, natural and man-made pollutants, chemical treatments, underground water resources, agro wastes, seasonal variations, surface runoff, geographic weathering, etc. In addition, full information on population density around a given water source and behavioral aspects of people is also required.

For this purpose, all different locations/sampling sites were outlined and samples were collected. The samples were collected in polystyrene bottle of 1.5 L capacity. Before sampling, the bottles were washed thoroughly with the detergent, acid (1: 1 HNO_3 and H_2O by v/v) tap water, and then distilled water. Chemical parameters were determined by using standard methods immediately after taking them into the laboratory. Usual preservative methods were used to preserve the samples. The samples were analyzed as soon as it was possible. A total of 15 water samples were collected. The sources and locations of samples are given in Table 1.

Measurement of pH and temperature

The pH of all water samples was measured at the time of collection by using portable battery operated pH meter Model MP220. The calibration was carried out with two standard buffer solution of pH 4.0 and 7.0. The pH of the sample should lie between these values. The sample temperature is determined at the same time. The reading is taken after the indicated value remains constant for about 1 min. After each measurement, the electrode of the pH meter was washed with distilled water and was cleaned with tissue paper.

Table 1. Location of water samples.

Sample number	Source	Location
1	Well water	Hassan town
2	Well water	Gujian
3	Well water	Masjid
4	Well water	Mirpur
5	Well water	Gojri Mera
6	Well water	Phool Gulab
7	Well water	Kahal
8	Well water	Low Mulak Pura
9	Well water	Banda Darzak Khan
10	Well water	Badan Jat Khan
11	Stream water	Narrian
12	Stream	Shah Zaman Colony
13	Stream	Supply
14	Stream	Bilal town
15	Stream	Banda

Total dissolved solids

Solids refer to matter suspended or dissolved in water or wastewater. Solids may affect water or effluent quality adversely in a number of ways. Waters with high dissolved solids generally are of inferior palatability and may lack an unfavorable physiological reaction in the transient consumer. For this reason, there is a limit of 500 mg for some organic substances and dissolved gases. The total dissolved solids (TDS) of the samples was measured using pre-calibrated conductivity meter model InoLab Cond Level 1. Before measurement, the beaker and electrode must be washed several times with the solution under test. The measurement was taken at room temperature. The samples were transferred into beaker in specific volume to dip the electrode, after which the button was pressed and the scale was set before the TDS of each sample was noted.

Electrical conductivity

The conductivity of the samples was measured using pre-calibrated conductivity meter model Inolab Cond Level 1. Before measurement, the beaker and electrode must be washed several times with the solution under test. The measurement was taken at room temperature. The samples were transferred into beaker in enough volume to dip the electrode, after which the button was pressed and the scale was set before the conductivity of each sample was then noted.

Total hardness

1 ml of hardness buffer solution was added to 50 ml of water sample followed by the addition of 1 to 2 drops of indicator. Then, this solution is titrated against versenate solution (EDTA solution) from burette, end point reddish to blue colour. Total hardness is calculated by the following formula:

Total hardness = [Versenate solution (ml) × MI of sample (mg/L)] 1000

Alkalinity

Alkalinity is the measure of hydroxide and carbonate ion content of water sample. Water sample is titrated with standard H_2SO_4 using indicator. Pink color of solution changes to colorless. This is the indication of end point.

Determination of chlorides

This test is for the determination of chloride ions. A solution of potassium chromate is used as indicator. Chlorides are precipitated as brick red in the solution because silver ion reacts with chloride ion forming brick red precipitate of AgCl, end point is the brick red coloration.

Total coliform count

The typical coliform colony has a pink to dark red color with a metallic surface sheen (Khalid et al., 2011a; Khalid et al., 2011b; Farzana et al., 2011). The sheen area may vary in size from a small pinhead to complete coverage of the colony surface. Typical colonies can be dark red or nucleated without sheen. Calculation of the coliform density is as follows:

Total coliform colonies/ 100 ml = [Coliform Colonies Counted/Sample used (ml)] × 100

Table 2. Results of drinking water analysis calcium, chloride, alkalinity and turbidity.

Sample number	Parameter/Sample	Sampling source	Calcium hardness (mg/L)	Chloride (mg/L)	Alkalinity (mg/L)	Turbidity NTU
1	Hassan Town	Well Water	41.6	0.8	120	2.34
2	Gujian	Well Water	192	1.1	322	1.71
3	Masjid	Well Water	104	11.1	296	2.02
4	Mirpur	Well Water	156	1.7	392	16.05
5	Gujri Mera	Well Water	102	1	128	13.08
6	Phool Gulab	Well Water	147	1.6	344	2.43
7	Kehal	Well Water	94	9	236	2.19
8	Lower Malikpura	Well Water	92	13	348	2.81
9	Banda Darzak Khan	Well Water	35	14	288	2.44
10	Banda Jat khan	Well Water	184	26	476	2.7
11	Narrian	Well Water	56	12	316	1.84
12	Shah Zaman Colony	Well Water	88	15	340	2.21
13	Supply	Well Water	80	11	304	20.02
14	Kakul Bilal Town	Well Water	104	17	384	6.60
15	Banda	Well Water	72	8	212	1.98

Turbidity determination

To determine turbidity, turbidimeter (Nephelometer) was used in this experiment, while formazine primary standard was employed to calibrate the nephelometer.

RESULTS AND DISCUSSION

Physical parameters

Temperature

The temperature of the water samples was taken at the spot in February, 2010. Among the samples taken from the different places ranges from 13 to 17°C, while the average temperature of water of Abbottabad district was found to be 14.9°C (Table 2, Figure 1). The maximum permitted standard of drinking water is 25°C.

pH

The pH value of water samples taken from the different places of Abbottabad district ranges from 7.26 to 8.84 and was slightly alkaline (Table 2, Figure 2). The standard of water quality on pH base lies in the range of 6.5 to 8.5. These studies show that some of the water samples exceed the limits set by WHO (Table 1).

Total dissolved solids (TDS*)*

Maximum TDS of well water found in Abbottabad district having value of the 664 mg/L while the minimum TDS value was found to be 198 mg/L in Abbottabad (Table 2, Figure 3). The result showed that the drinking water of Abbottabad district is fit for drinking in terms of TDS.

Conductivity

The results (Table 2, figure 4) reflect that the mean conductivity of drinking water samples of the well water is found to be 683.24 µs/cm. The maximum value of the conductivity of well water is 132.7 µs/cm. The minimum conductivity value is 395 µm/s. The obtained value after analysis when compared with the standard value is 200 µw/s of conductivity.

Result of drinking water analysis

Table 4 shows the sampling site and physical parameters of drinking water samples collected from the wells of Abbottabad district.

Chemical parameters

Calcium hardness

The result of calcium hardness of water samples (Table 2

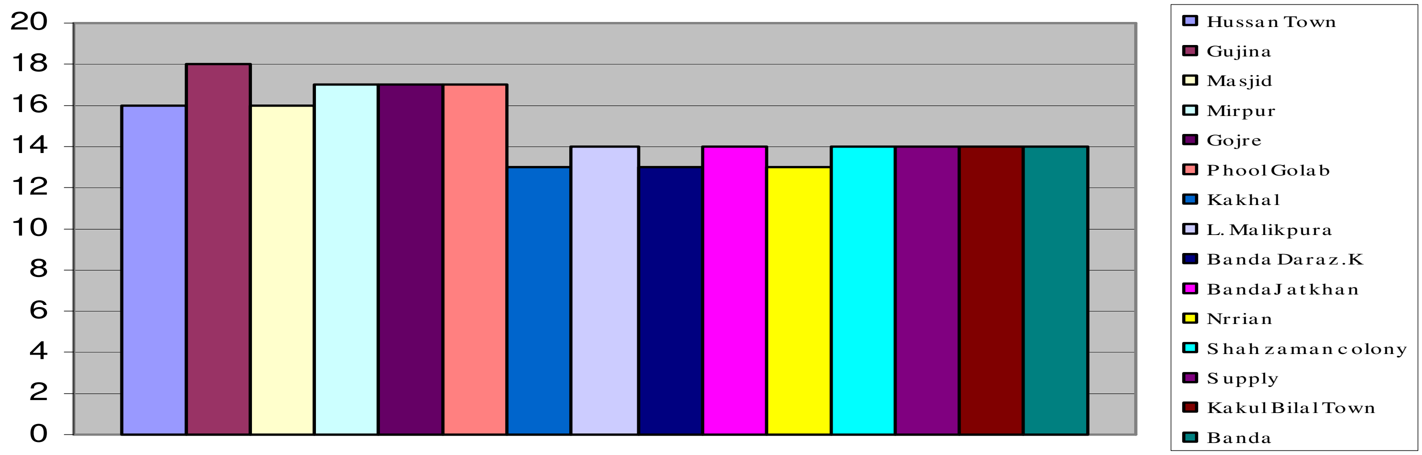

Figure 1. Temperature of drinking water samples collected from wells of Abbottabad district.

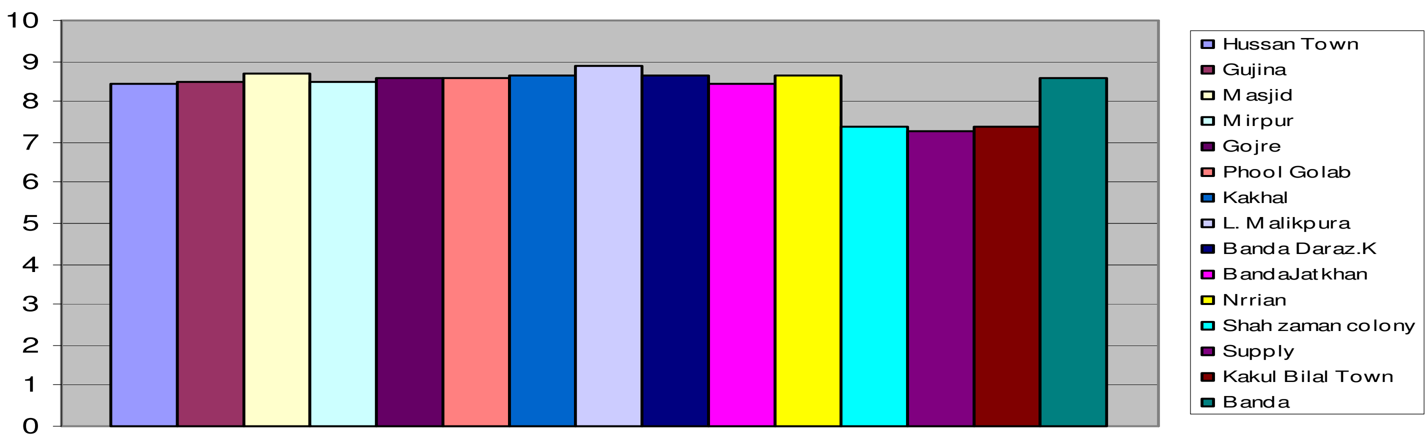

Figure 2. pH of drinking water samples collected from wells of Abbottabad district.

Figure 5) (show that hardness of well water samples is mean and 298.13 mg/L. The minimum value of calcium hardness is 0.160 mg/L found in well wall of Abbottabad and maximum value of calcium hardness is 0.350 mg/L. The results obtained after analysis when compared with the standard values of calcium hardness are found to be less than the permissible limits set by WHO.

Chlorides

The results on chloride of water samples (Table 3 and Figure 6) show that the chloride found in well water sample is 10.44 GIL. Chloride found in water sample was 0.8 g/L, high chloride value in water cause problems in after sewerage. Excess amount also changes the taste of drinking water and make it saline. The maximum range of chloride is 26 mg/L and no sample cross the barrier of WHO, USPH, EC, so the water of Abbottabad district may be considered to be suitable for domestics uses.

Alkalinity

The alkalinity range set by WHO is 500 mg/L. The result on alkalinity of water samples show that the alkalinity

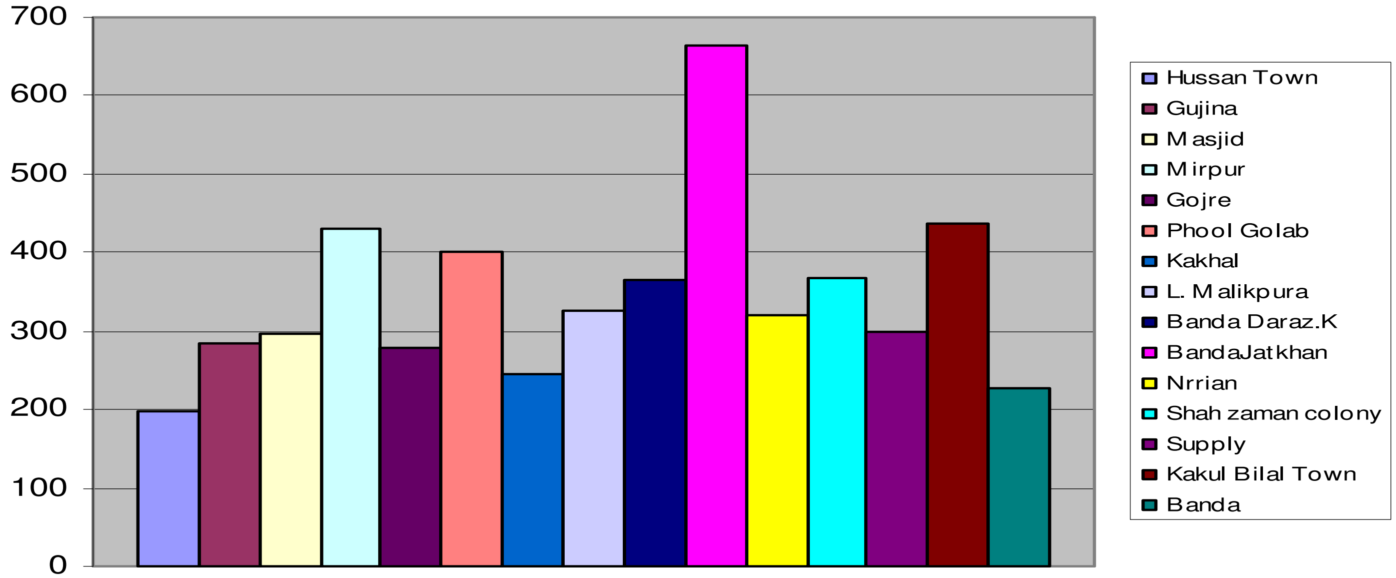

Figure 3. TDS of drinking water samples collected from wells of Abbottabad district.

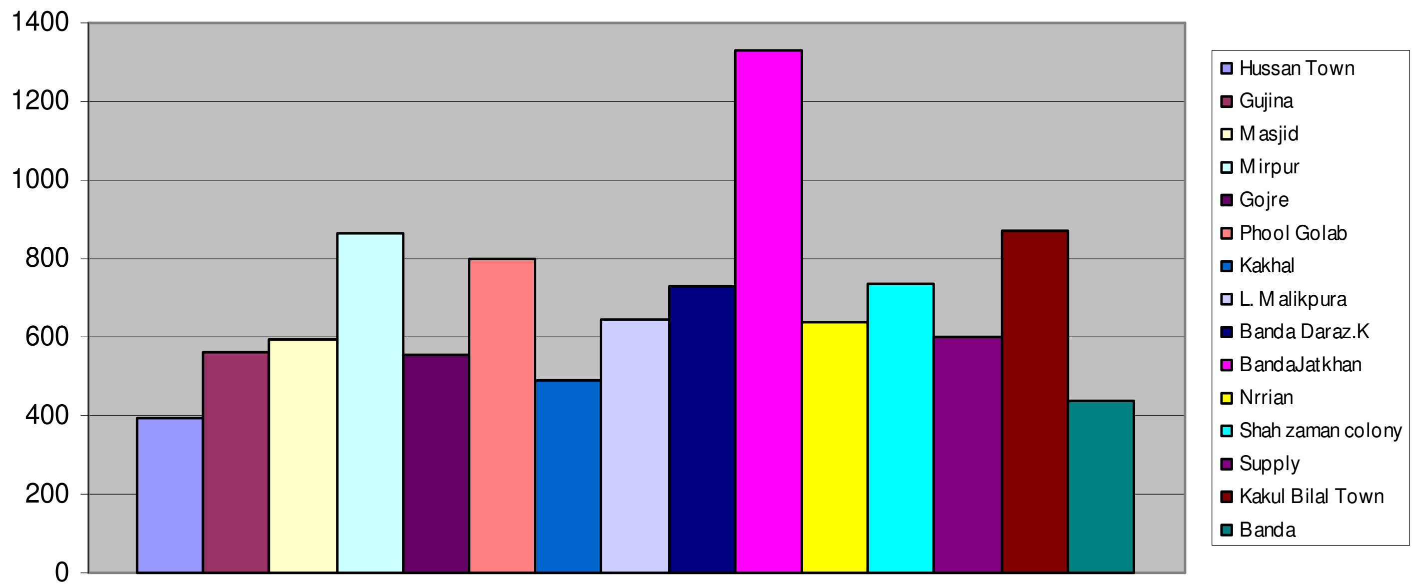

Figure 4. Showing conductance of drinking water samples collected from wells of Abbottabad district.

found in well water sample is 300.4 mg/L, minimum alkalinity found in Abbottabad district water sample was 120 mg/L (Table 3 and Figure 7). The maximum range of alkalinity is 476 mg/L.

Turbidity

The turbidity range set by WHO is 5 NTU. Minimum turbidity found in Abbottabad district water sample was

Table 3. Results of drinking water analysis for total coliform count.

Sample number	Parameter/Sample	Sampling source	Total coliform count (nil 100 ml)
1	Hassan town	Well Water	15
2	Gujian	Well Water	500
3	Masjid	Well Water	5
4	Mirpur	Well Water	80
5	Gujri Mera	Well Water	0
6	Phool Gulab	Well Water	600
7	Kehal	Well Water	0
8	Lower Malikpura	Well Water	303
9	Banda Darzak Khan	Well Water	230
10	Banda Jat khan	Well Water	158
11	Narrian	Well Water	500
12	Shah Zaman Colony	Well Water	220
13	Suply	Well Water	0
14	Kakul Bilal town	Well Water	600
15	Banda	Well Water	100

Table 4. Sampling site and physical parameters of drinking water samples collected from wells of Abbottabad district.

Sample number	Sampling site	Temperature (°C)	pH	TDS (mg/L)	Conductance (µs/cm)
1	Hussan Town	16	8.43	198	395
2	Gujina	18	8.51	283	564
3	Masjid	16	8.69	296	592
4	Mirpur	17	8.5	431	864
5	Gojre	17	8.58	279	558
6	Phool Golab	17	8.58	400	798
7	Kakhal	13	8.63	244	488
8	L. Malikpura	14	8.86	325	648
9	Banda Daraz.K	13	8.64	364	728
10	BandaJatkhan	14	8.45	664	1327
11	Nrrian	13	8.65	319	637
12	Shah zaman colony	14	7.39	368	738
13	Supply	14	7.29	300	597
14	Kakul Bilal Town	14	7.37	437	874
15	Banda	14	8.60	226	440

1.74 NTU (Table 3 and Figure 8). The maximum range of turbidity is 20.02 NTU.

Biological parameters

Total coliform count

The total coliform count range set by WHO is nil 100 ml^{-1}. Minimum total coliform count found in Abbottabad district water sample was 15/100 ml (Table 4 and Figure 9). The maximum range of total coliform count is unlimited (Table 3).

Conclusions

The results of the present research work show that

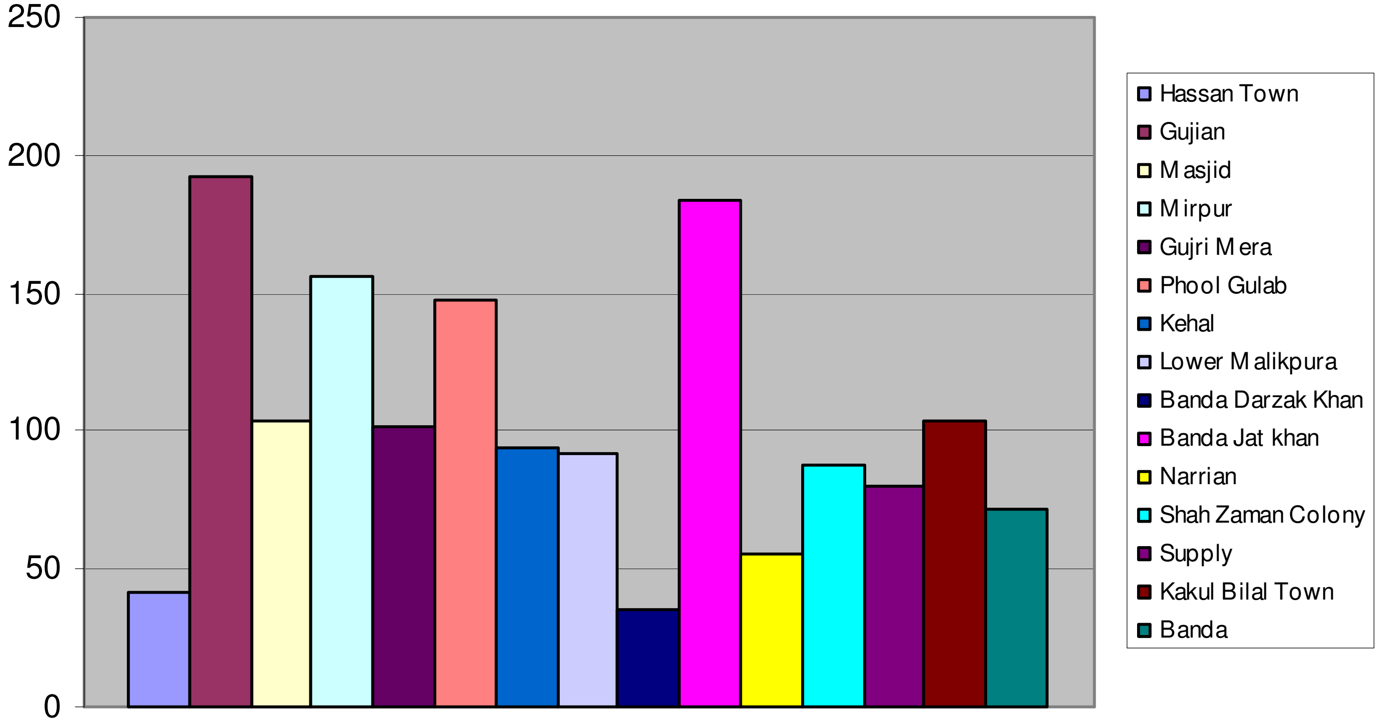

Figure 5. Calcium hardness of drinking water samples collected from wells of Abbottabad district.

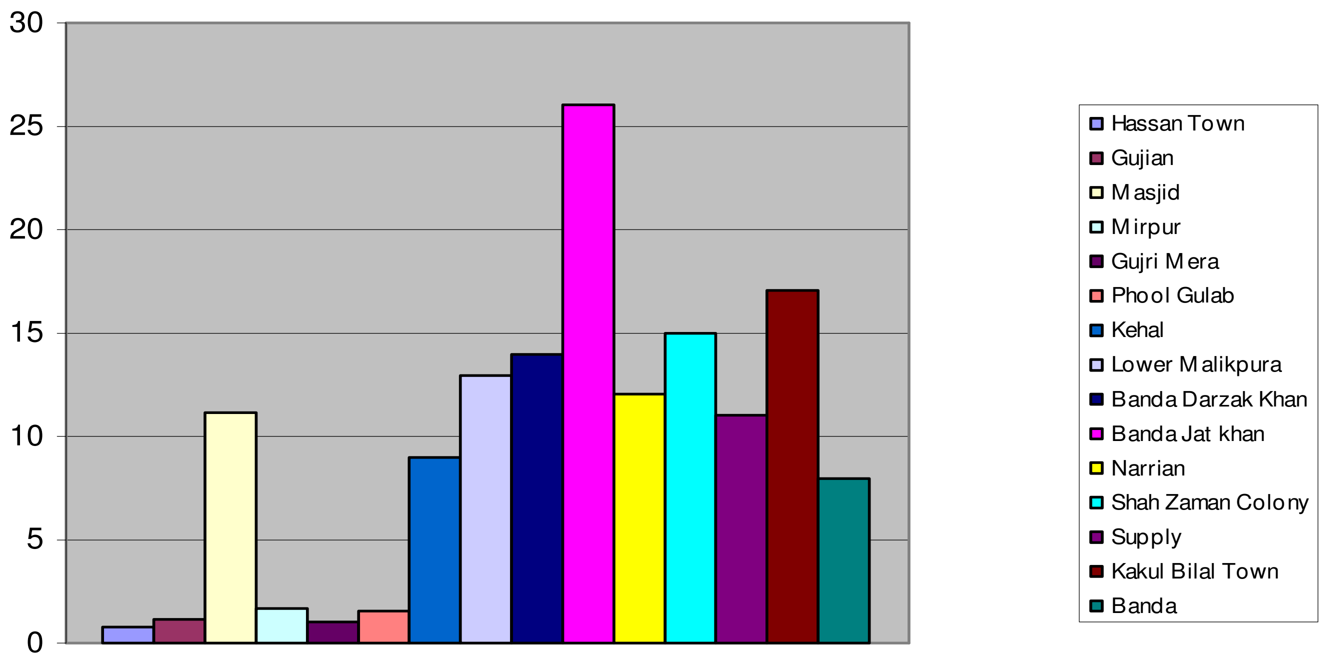

Figure 6. Chloride content of drinking water samples collected from wells of Abbottabad district.

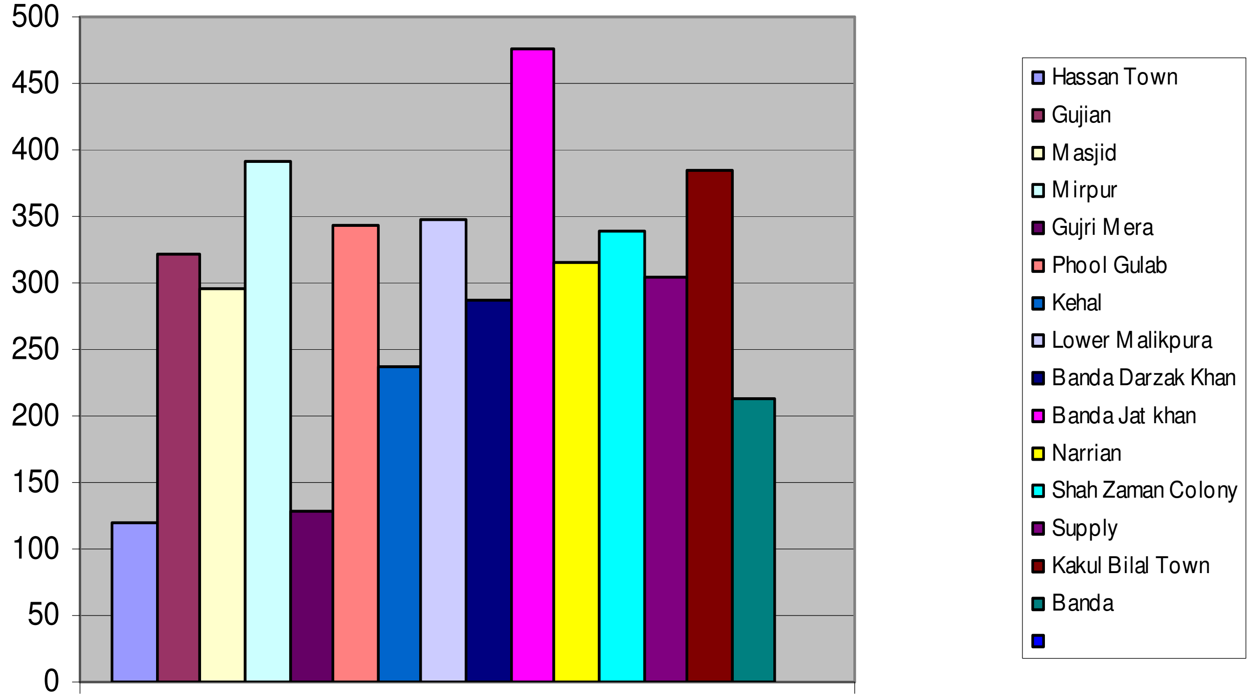

Figure 7. Alkalinity of drinking water samples collected from wells of Abbottabad district.

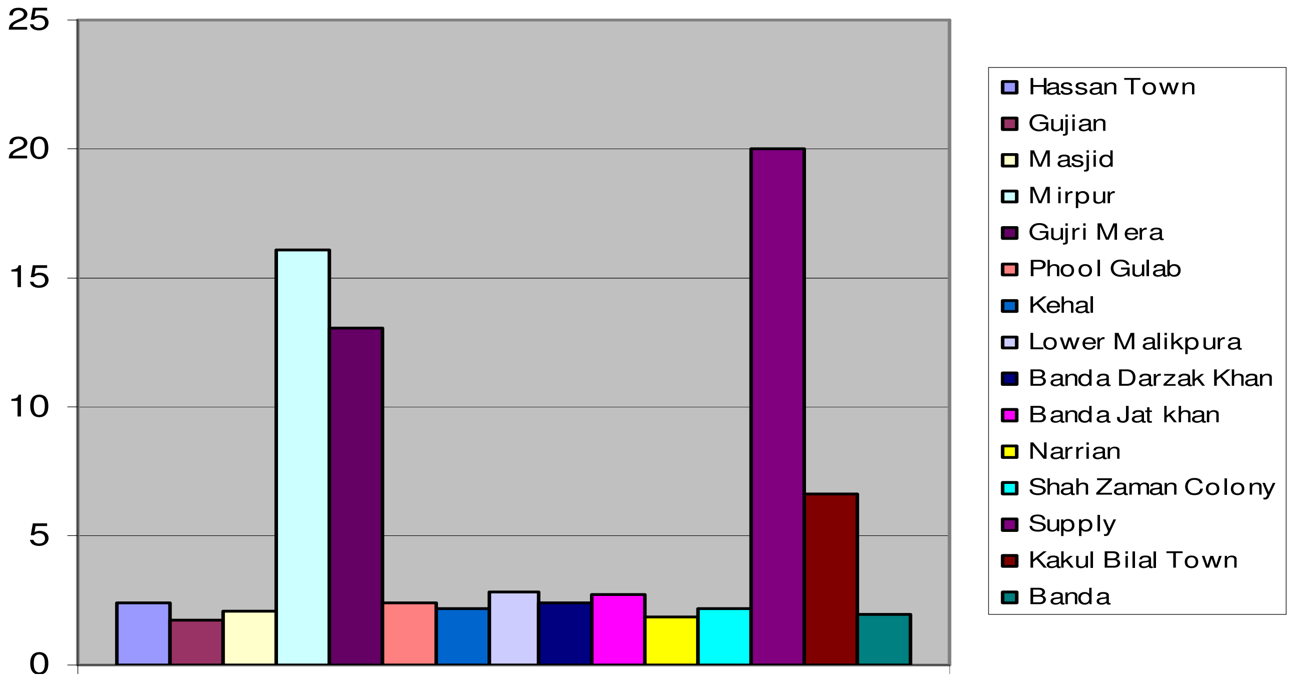

Figure 8. Turbidity of drinking water samples collected from wells of Abbottabad district.

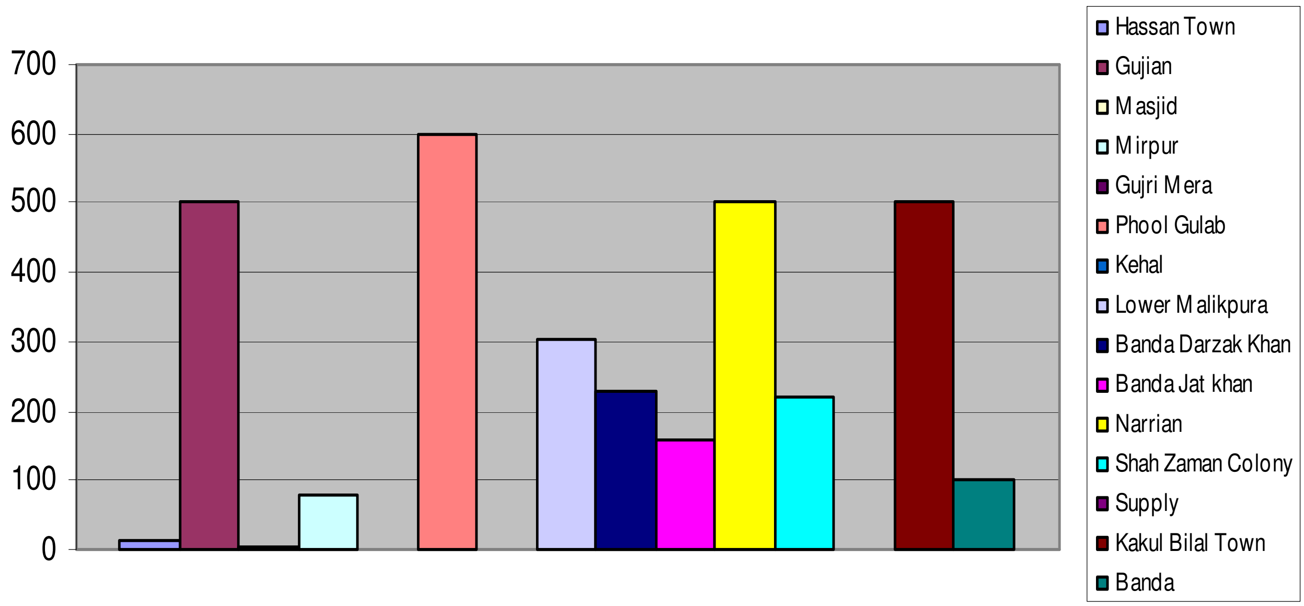

Figure 9. Showing total coliform count of drinking water samples collected from wells of Abbottabad district.

drinking water collected from different areas of Abbottabad district was not found to be suitable for human health due to microbiological issues. The following are the main suggestion/recommendations to coop the problems of water shortage/crises.

1. Water can be quite safe after boiling, while developing the right attitude towards hygienic environment is quite tedious.
2. X-Rays water filler can be used for clarifying water form microorganism.
3. If the contamination level is high, the user should demand for proper chlorination, but this process needs the hands of an expert chemist, as extra chlorination is harmful to human health.
4. Efficient system for garbage collection and its disposal outside the city areas.
5. Sewerage waste treatment.
6. Recycling of waste into useful products, such as fertilizers.
7. Education of people through media about the protection of environment.

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