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Evaluation of the Quality of Drinking Water of Mardan District, KPK, Pakistan

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Abstract: The quality of drinking water is of vital importance for human being, though most consumers, particularly the young citizens are unaware of the issue. In the present study sixteen samples of drinking water collected from different tube wells of Mardan district were evaluated for physical and chemical quality parameters such as pH, electrical conductivity, total hardness, TDS, TSS, BOD and COD and checked for the sulphates, fluorides, chlorides and nitrates ions. The concentrations of all the constituents of water determined were in the normal range, but conductivity, alkalinity and total suspended particles were out of the WHO standard criteria. It can be concluded that the water samples analyzed in this work were not completely fit for drinking.

Kay words: Water Samples · Mardan District · Tube Well · Physicochemical Characteristics · Quality parameters

INTRODUCTION

Water is the most essential substance for living things and it supports the life processes. The greater portion of all living creatures on earth is composed of water. In the human body 75% of its weight is that of water. Without water it would not have been possible to sustain life on this planet. The total quantity of water on earth is approximately 1.4 trillion cubic meters [1]. Of this less than 1% water present in rivers and ground resources is available to meet our requirement [2]. After air, water is the second primary need for survival. It has a unique property of forming hydrogen bonds due to which it is essential to life. It is an excellent solvent for many materials; thus, it is the basic transport medium for nutrients and waste products in life processes. As a solvent, the properties of water are profoundly affected by its high dielectric constant due to which most of the ionic materials are dissociated in it.Water has its maximum density at 4 °C, a temperature above its freezing point due to which ice floats on it, so that few large bodies of water ever freeze solid. Furthermore the unique temperature-density relationship of water is responsible for its vertical circulation in lakes, a determining factor in their chemistry and biology [3].

Water resources are being contaminated with toxic substances, due to ever increasing environmental pollution, which is a big hazard to living beings. The hazard is caused by discharge of industrial effluents and is an acute problem in Pakistan [4, 5]. In many cities of Pakistan tube wells (ground water) are the main sources of drinking water. Water gets polluted when its condition or composition or both are changed. Domestic and industrial wastes from urban, rural and industrial areas, discharged in the natural water bodies are the major sources of pollution. Mardan is an important city of Khyber Pukhtoon Khwa (KPK) province of Pakistan; therefore process of development here and its suburbs is also fast. The population of Mardan and its suburbs is constantly increasing. This increase in population is

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giving rise to many serious problems, one of which is constant increase in environmental pollution. As a result the sources of water in Mardan and its suburbs are getting polluted day by day. The significance of these constituents to the quality of water depends on many inter-dependent parameters [6]. Evaluation of physical, chemical, biological, bacteriological and radiological characteristic of water assists in determining its quality. Water used for drinking must be free from turbidity, color, odor and objectionable taste as well as from disease causing organisms and inorganic and organic substance, which my produce adverse physiological effects [7].

Many investigators analyzed water samples collected from different regions in India and Pakistan for all the water quality parameters and the results obtained were compared with the limits recommended by WHO and Pakistan Council of Research in Water Resources (PCRWR) [8]. The results were above the limits, which might be due to seepage of domestic sewage and industrial effluents.

The analysis of drinking water from Mardan district will be helpful to create awareness in the people and will provide guidelines to control ground water pollution. Therefore the present study was aimed to determine the physiochemical parameters of drinking water in Mardan district like total hardness; pH, conductance, alkalinity, nitrite, fluorides, chlorides, sulphates and suspended solids.

MATERIALS AND METHODS

Sixteen drinking water samples were collected from different localities of Mardan division, Pakistan. Samples were analyzed for various parameters like pH, conductivity, alkalinity, total hardness, Cl^{1-}, SO_4^{2-}, nitrate, fluorides, TDS, TSS BOD and COD using known methods reported in the literature [9].

RESULTS AND DISCUSSION

Table 1 shows the pH of drinking water of Mardan division, which is in the range of 6.5 to 7.8. The maximum limit of pH for domestic water supply is 5 to 9 [10]. The pH of the solution affects the total ions stability and solubility when they are in low concentration. Most of the samples analyzed had pH within the permissible limit, however some of the samples (i.e. 13-16) which were collected from M.C. (direct), Govt.Post.Grad.College, PRC'S main tank and old Bijlighar were slightly alkaline.

Conductivity: The conductivity (k) values for water samples were given in Table 1 (column-3). Generally natural water possesses low conductivity but contamination increases its level of conduction [11]. For all the samples, the values of conductivity were in the range of 572-888µS/cm. All the samples bear conductivity values above the maximum permissible level recommended

Table 1: Physical parameters of the collected water samples

Sample ID	pH	Conductivity (µS)	T Hardness (mg/l)	T. alkalinity (mg/l)	TSS (mg/l)	TDS (mg/l)	BOD (mg/l)	COD (mg/l)
1	7.0	888	220.8	144	89	296	3.50	2.00
2	7.5	750	153.6	140	2	242	4.39	5.00
3	6.9	572	240	152	5	176	2.39	5.00
4	7.2	695	240	168	69	230	2.37	8.00
5	6.5	805	331.2	160	71	254	4.37	7.00
6	7.1	650	211.2	148	68	185	4.12	3.00
7	7.1	703	292.8	168	68	217	5.10	4.00
8	7.0	690	321.6	156	49	202	4.50	5.00
9	7.1	708	350.4	152	62	196	5.12	5.10
10	6.7	865	427.2	180	57	235	6.10	4.10
11	7.2	875	427.2	180	53	288	5.08	5.00
12	7.0	722	355.2	152	41	222	6.10	4.OO
13	7.8	683	326.4	144	66	221	5.45	5.00
14	7.8	768	336	136	56	226	5.00	5.10
15	7.6	758	312	156	29	240	6.10	6.00
16	7.8	718	283.2	128	38	248.1	6.00	5.00

Sampling ID means the area name; 1: Jana bad, tap 27, 2: Sheikh maltoon town, 3: Labour colony (sugar mill), 4: Sarwar abad, 5: Bagh colony, 6: Dang baba, 7: Eid gah, 8: D.H.Q Hospital, 9: Azizullah khan house Pirano daga, 10: Thopo chowk area in PRC, 11: Thopo chowk, 12: Gaju khan, 13: M.C (direct), 14: Govt.Post.Grad.College, 15: PRC'S main tank, 16: Old bijlighar

TSS: Total Suspended Solid

TDS: Total Dissolved Solid

BOD: Biological Oxygen Demand

COD: Chemical Oxygen Demand

Table 2: Anion concentration of collected water samples

Sample ID	Nitrates (mg/l)	Chlorides (mg/l)	Sulphates (mg/l)	Fluorides (ppm)
1	0.04	87.97	103.86	0.67
2	0.06	61.9	74.18	0.81
3	0.08	22.99	19.78	0.56
4	0.05	21.99	44.51	0.85
5	0.05	31.99	59.35	0.62
6	0.07	27.99	39.56	0.67
7	0.04	27.99	49.45	1.33
8	0.03	38.98	54.40	0.53
9	0.06	52.98	39.56	0.46
10	0.05	49.98	98.91	0.67
11	0.07	34.98	89.02	0.46
12	0.09	34.98	74.18	0.45
13	0.08	61.98	54.40	0.61
14	0.04	33.98	84.08	0.82
15	0.05	40.98	39.56	1.2
16	0.03	40.98	74.18	0.62

Sampling ID means the area name; 1: Jana bad, tap 27, 2: Sheikh maltoon town, 3: Labour colony (sugar mill), 4: Sarwar abad, 5: Bagh colony, 6: Dang baba, 7: Eid gah, 8: D.H.Q Hospital, 9: Azizullah khan house Pirano daga, 10: Thopo chowk area in PRC, 11: Thopo chowk, 12: Gaju khan, 13: M.C (direct), 14: Govt.Post.Grad.College, 15: PRC'S main tank, 16: Old bijlighar

Table 3: WHO water quality standards [17]

Analytic	Standard
1. Electrical conductivity	400 µ mhos/cm.
2. pH	6.5- 9.2
3. Total dissolved solids	500 mg/l
4. Total suspended solids	5 mg/l
5. Chlorides as Cl^-	250 mg/l
6. Nitrates as NO_3^-	0.1 mg/l
7.Total hardness as $CaCO_3$	500 mg/l
8. Calcium as $CaCO_3$	250 mg/l
9. Magnesium as $CaCO_3$	150 mg/l
10. Sulfate as SO_4^-	250 mg/l
11. Sodium as Na^+	250 mg/l
12. Potassium as K^+	12 mg/l
13. Total alkalinity	30- 500 mg/l
14. Fluorides	0.5/1- 1.5 mg/l
15. Phenolphthalein alkalinity	30 mg/l
16, Biological Oxygen Demand	2 mg/l
17. Chemical Oxygen Demand	5 mg/l

by the WHO (Table 3). Out of these samples No. 3, 4, 6, 8 and 13 (Labour colony, Sarwarabad, Dang baba, D.H.Q. hospital and M.C. direct) had values slightly higher than normal values of conductivity while the remaining had very high values of conductivity. The high conductivity values represent the presence of high concentration of dissolved salts in these samples.

Total Hardness: The values of total hardness of the samples were given in Table 1 (Column-4). The WHO maximum permissible level for hardness is 500 mg/l [12]. The table shows that the hardness of the samples ranges from 153.6-427.2mg/l and all below the maximum permissible level for hardness but still they were considerably higher than the WHO desirable level of 100 ppm [13]. That is why; the factors contributing to total hardness must be controlled.

Total Alkalinity: The determined data for total alkalinity were shown in Table-1 (column-5) indicating the m-alkalinity range of 128-180mg/l for the samples, lying below the WHO maximum permissible level of 500mg/l but substantially higher than its WHO desirable level of 30mg/l [14]. This data again indicates the presence of high concentrations of alkaline salts in the drinking water of these areas.

Total Suspended Solids: It is the proportion of total solids retained by a filter. The values of TSS ranged from 2-89mg/l as shown in the Table 1 (column-6). The WHO recommended value for TSS is 5 mg/l [15] . It means that these water resources were having abnormally higher levels of suspended solids. Jana bad had the highest amount of TSS among the samples collected.

Total Dissolved Solids: Dissolved solids in excess are objectionable in drinking water because of the possible physiological effect, unpalatable mineral taste and corrosion. The TDS values were given in Table-1 (column-7) ranging from 176 to 296 mg/l, all were below the WHO maximum permissible level of 500 mg/l [16]. However, sample No.3 and 9 had very low TDS values.

Looking at the data relating to solids it was evident that it is the abnormally higher level of TSS that is responsible for higher values of TSS and not the TDS.

Biological Oxygen Demand: The determined data for biological oxygen demand were shown in Table-1 (column-8) indicating that the BOD range of 2.37-6.10mg/l for the samples was lying over the WHO maximum permissible level of 2-3 mg/l. The presence of high concentrations of BOD (6.10 mg/l) in these areas indicates that this water is not good for drinking.

Chemical Oxygen Demand: The determined data for chemical oxygen demand were shown in Table-1 (column-9) indicating that the chemical Oxygen demand of two examined samples was 7.00 and 8.00 mg/l, lying over the WHO maximum permissible level of 5 - 5.5 mg/l. The presence of high concentrations of COD (7.00 to 8.00 mg/l) in these areas indicates that this water isn't fit for drinking purposes.

Nitrates: The nitrate values were shown in Table-2 (column-2). The positive result for qualitative test and negative result for quantitative test clearly indicated the presence of very small amount of nitrates that could rightly be called as trace amount, in these samples. This concentration was taken as lower than the WHO standard of 0.1mg/l for nitrates.

Chlorides: Chlorides were present in all the samples of water. The values for chloride concentrations were given in Table-2 (column-3) indicating a range of 21.99-87.97mg/l in these samples. All these values were well below the WHO maximum permissible level of 250 mg/l for chloride concentration of potable water (Table 3). The result showed that as for as the chloride concentration is concerned, the water of these areas is safe for human consumption.

Sulphates: Sulphates in domestic water contribute to permanent hardness. The data for sulfates in the samples were given in Table-2 (column-4). The range of sulfates concentration in the samples was 19.78-103.86mg/l lying below the WHO standard recommended value of 250mg/l . The high concentration of sulfates in the water might be due to leaching of sulfate fertilizers to the water table.

Fluorides: The fluorides in water come from fluoride bearing rocks or from the water treatment processes (fluoridation). The data for fluoride concentration were given in Table-2 (column-5), which ranged from 0.45-1.33ppm indicating that only samples No. 9, 11 and 12 which were from Azizullah khan house, Thopo chowk and Gaju khan had the low fluoride concentration, while the remaining samples had higher levels of fluoride concentration. The highest concentration was found in the case of sample No.7 that was 1.33ppm.

This study has shown an alarming situation regarding the high values (89 mg/l) of TSS and conductivity (888 μS) for the collected samples. The relevant civic authorities should take urgent and effective steps to provide safe and healthy water to the large population of the district. The District Government should make consistent efforts to maintain the quality of drinking in the area as per the recommended standards of WHO.

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