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Ionic Characteristics of Potable Water of Mardan District

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ABSTRACT
Water samples from different localities of Mardan were evaluated for determination of inorganic contents. It discusses the potability and quality of water, elaborates the methodology employed and presents results to attain the objectives of a survey conducted towards assessing the quality of potable water in the sample area. Potable water quality of different areas of Mardan was monitored for various physical and chemical parameters. The importance of this reference data related to the water quality of Mardan was felt after spreading of some water borne disease in the area. Ground water samples from 16 tubewells of surrounding areas of district Mardan District were collected and analyzed for pH, conductivity, total hardness, chloride contents, alkalinity, nitrites, fluorides, sulphates, TDS, TSS and inorganic contents Na and K. The value was compared with the standards of WHO and were found within the permissible limits. The toxic effects of these parameters have also been discussed. It concludes that water of all the tube well of Mardan is safe for human consumption provided the supply lines and storage tanks are prevented from being contaminated. Water resources of Mardan were almost free from any pollution.

Keywords: Heavy Metals, water, Ionic characteristics, Mardan District

1. INTRODUCTION
Water is the source of life on earth. The greater portion of all the living creatures on earth is composed of water. After air water is the second primary need of 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. The solvent properties of water are profoundly affected by its high dielectric constant due to which most of the ionic materials are dissociated in it. Furthermore the unique temperature –density relationship of water is responsible for its vertical circulation in lakes, a determining factor in their chemistry and biology[1]. Water is the most essential substance for living things and it supports the life processes. Without water it would not been possible to sustain life on this planet. The total quantity of water on earth is approximately 1.4 trillion cubic meters. Of this less than 1% water present in rivers and ground resources is available to meet our requirements[2]. These 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[3,4].

The two main sources of potable water are surface water and ground water. Rivers and streams are the important surface water and ground water sources, while springs, deep and shallow wells are the common sources of ground water. The main sources of ground water are precipitation (snow, rain, dew etc) and underground (phreatic) water.

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. 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.

Water pollution may be defined as the degradation of water quality by the introduction of chemical, physical or biological parameters into rivers, lakes, streams oceans etc[5]. Water pollution is a worldwide issue. This problem is different in numerous respects in the economically stable and unstable countries. Heat, poisonous metals, acids, sediments, animal and human wastes and synthetic organic compounds foul the waterways of developed countries. Human and animal wastes, sediments and pathogenic organisms head the list in the non-industrialized countries. In these countries, the main cause of illness and death is unsanitary water and malnutrition[6].

Potable water pollution is becoming a world-wide problem. The shallow ground water environment are being seriously polluted due to unplanned disposal of untreated domestic sewage and industrial effluents into water courses (streams/ rivers) flowing through the or in the vicinity of large population centers and industrial zones, which in turn is posing a serious threat to the contamination of the associated potable water aquifers as well as the environmental conditions of the public water supply lines and the community health (consumers). Drinking water properly treated or obtained from a relatively clean source may become contaminated in the water distribution system specially, when water supply operates on intermittent basis[7].

When water supply is turned off, contaminants from outside can sweep into leaky underground pipes and are carried through distribution system when supply is turned on again. Mixing of sewage with drinking water sources in the under developed areas is caused due to poor sanitary conditions. A large number of pathogens are transmitted to the human body through water, milk and beverages. This include bacteria, virus and protozoa[8] The large number of water pollutants may be broadly classified as organic pollutants, inorganic pollutants, sediments, radioactive materials

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and thermal pollutants. During the past two decades, the importance of determining the adverse effect of water contamination (water pollution) on public health has gained momentum. Strict water standards have been enforced in developed countries due to the increased hazardous effects on human health[9].

The complexity of water quality as a subject is reflected in many types of measurements of water and waste water quality. These measurements include pH, conductivity, total hardness, sulphates, chloride, fluoride, sodium and potassium, total alkalinity, TDS, TSS, and nitrite.

2. MATERIALS AND METHODS

2.1 *Pretreatment of samples*

Sixteen sampling points were randomly selected for sampling which included the samples collected from tube wells, open wells and hand pumps. The samples were collected in 1L properly washed plastic bottles. All precautionary measures were taken while filling the bottles with samples. Mardan was selected for on the basis of news regarding some water borne diseases in the area.

Table-1: Location Map of Mardan District

The reagent solutions were prepared in distilled water. All the apparatus was washed with detergents and sensed with distilled water before beginning and after finishing the laboratory work. The instruments used were standardized and calibrated before use.

2.2 *Reagents Used*

All the chemicals were of analytical grade (Merck & BDH) and were used without further purification. Chemical evaluation of each sample was carried out following the standard method [10] 14 physicochemical parameters are discussed below briefly:

The pH of the samples was calculated using pH meter (mettler delta). The temperature of the laboratory was noted. The pH meter was first washed with freshly prepared solutions of standard pH tablets. Then the pH of the samples was noted directly from the pH meter screen. Conductivity meter (Jenway, model 4060) was used to measure the conductance of water samples. The instrument was first calibrated with freshly prepared standard KCl solution. The reading for each sample was noted directly from the digital screen of the instrument after putting the electrode in the separated portion of the sample. The readings were in micro-Siemens (µs) $\pm$1% accuracy. To measure the hardness of samples, 25ml sample was taken in a cleaned titration flask, 2ml NH_3/NH_4Cl buffer solution of pH = 10 was added to it. After shaking very small quantity of solid Eriochrome Black T was added as indicator for color change and titrated against standard EDTA (Ethylene diamine tetra acetic acid) solution in burette. The volume used was noted and hardness was reported as $CaCO_3$, mg/L. For the determination of Calcium contents in water samples, 2mL of buffer solution (having pH = 12.5) was added to the water sample (25ml) and a small amount of mureoxide indicator was added, and titrated against standard EDTA solution taken in burette. The volume used was noted and result was reported as $CaCO_3$/L.As hardness is usually caused by Ca (Calcium) and Mg (Magnesium) with negligible contribution from other cations that is why the formula (Magnesium = total hardness ─ Calcium) gives satisfactory results for the magnesium concentration in the sample. The results were reported without further modifications. For measuring total alkalinity, 25ml water sample was titrated with pre-standardized H2SO4 solution using methyl orange as indicator. Nitrite contents in water were measured by qualitative method. The appearance of pink color was an indication of the presence of nitrite. As the color was appeared only in some samples and was very light pink,

quantitative analysis was not performed. Argentometric titration was performed for the determination of chloride contents in water samples. 0.02 N H_2SO_4 solution (equivalent to the alkalinity of the sample) was added to 25mL sample followed by the addition of 3-4 drops of the indicator ($K_2Cr_2O_7$ solution) and titrated against standard 0.01 N $AgNO_3$ solution (0.01Normal). 10ppm of fluoride solution was prepared from NAF and 5 standards (1, 2, 4, 6,8ppm) were prepared. Then 20mL of solution from 1ppm standard solution was taken in a flask and 2mL of fluoride adjusting solution was added to it followed by stirring on hot plate. Reading was noted by dipping electrode of ion meter in the solution. Procedure was followed for all solutions.

Whattman filter papers (Quality No. 1) were put in oven at 105ºC for ½ hour followed by cooling in desiccator for another ½ hour time. Then every one of these was weighed separately. Then 50mL water from each sample was filtered through one by one. These filter papers were put in oven for half an hour at 105 ºC followed by their weighing on cooling. Finally the filter papers were weighed and from the weight difference the amount of TSS was determined. For determining TDS in a sample the simple principle of subtracting the TSS of that sample from its TS was followed as given in formula: TDS in mg/L = TS in mg/L ─ TSS in mg/L. Sodium and potassium content were measured using flame photometer. The concentration of sodium and potassium were determined in mg/L.

3. RESULTS AND DISCUSSIONS

Physical and chemical analysis of water samples is presented in Table-2 and Table-3 present a comparison among some analytes of present studies with the reported results[11]. pH is one of the parameters which determine the acidic or alkaline nature of water. Table-2 Shows the pH of drinking water, which is in the range of 6.5-7.8.

Table-2: Physical and Chemical parameters of potable water samples

Sample ID	Na^+ ppm	K^+ ppm	Ca^{2+} Mg/L	Mg^{2+} (mg/L)	pH	Conductivity (µS/cm)	T.Hardness as $CaCO_3$(mg/L) and $MgCO_3$	T.alkalinity as $CaCO_3$(mg/L)	TSS (mg)	TDS (mg)	Nitrite as NO_2	Sulphate	Flouride (ppm)
1	140	4.8	62.4	158.4	7.0	888	220.8	144	89	296	0.04	103.86	0.67
2	97	3.5	38.4	115.2	7.5	750	153.6	140	2	242	0.06	74.18	0.81
3	49	3.9	57.6	182.39	6.9	572	240	152	5	176	0.08	19.78	0.56
4	70.5	4.9	91.2	148.8	7.2	695	240	168	69	230	0.05	44.51	0.85
5	68.5	5.9	187.2	144	6.5	805	331.2	160	71	254	0.05	59.35	0.62
6	64.5	3.8	67.2	144	7.1	650	211.2	148	68	185	0.07	39.56	0.67
7	66.5	4.3	86.4	206.4	7.1	703	292.8	168	68	217	0.04	49.45	1.33
8	24.5	5.8	110.4	211.2	7.0	690	321.6	156	49	202	0.03	54.40	0.53
9	42	5.1	105.6	244.8	7.1	708	350.4	152	62	196	0.06	39.56	0.46
10	53.2	5.2	134.4	292.8	6.7	865	427.2	180	57	235	0.05	98.91	0.67
11	36	4.8	144	283.2	7.2	875	427.2	180	53	288	0.07	89.02	0.46
12	43.6	4.6	134.4	220.8	7.0	722	355.2	152	41	222	0.09	74.12	0.45
13	46.4	4.5	115.2	211.2	7.8	683	326.4	144	66	221	0.08	54.40	0.61
14	54.8	4.5	91.2	244.8	7.8	768	336	136	56	226	0.04	84.08	0.82
15	60.4	4.7	100.8	211.2	7.6	758	312	156	29	240	0.05	39.56	1.2
16	63.6	4.7	86.4	196.8	7.8	718	283.6	128	38	248.1	0.03	74.18	0.62

The maximum limit of pH for domestic water supply is 5-9.Most of the samples analyzed have pH within the limit; however some of the samples (13, 15) are slightly alkaline. The conductivity values for water samples are given in Table-2. For all the samples, the values of conductivity lie in the range of 572-888µS/cm. All the samples bear conductivity value above the maximum permissible level presence of high concentration of dissolved salts in these samples. Calcium carbonate is the one of the most abundantly found mineral in water. Values of total hardness ($CaCO_3$ and $MgCO_3$) are given in Table-2.

The WHO maximum Permissible limit for hardness is 500mg/L. The table shows that the hardness of the samples ranges from 153.6-427.2 mg/L all below permissible level for hardness but still they are parameters of potable water considerably higher than the WHO desirable level of 100ppm. The values of calcium concentrations are given in the table-2.The table shows that the Calcium concentration of water samples ranges from 38.4-187.2mg/L, which is below the WHO permissible level of 250mg/L. The concentration values of Magnesium in the samples are given in table-1.These values are ranging from 115.2-292.6mg/L, indicating high concentrations of Mg in most of the samples. Some areas have Magnesium concentration within the permissible limits. Majority of the samples have dangerously high level of Magnesium. Alkalinity is mainly caused by OH^-, $CO_3^{-2}$and HCO_3^{-2} salts, although other salts are also responsible. The determined data for total alkalinity is shown in Table-2 indicating the m-alkalinity range of 136-180mg/L for the samples, lying below the WHO permissible level of 500mg/L but substantially higher than the desirable level of 30mg/L. The nitrite values are shown in Table-2. The positive result for qualitative test and negative result for quantitative test clearly indicate the presence of nitrite that can rightly be called as

trace amount in these samples. This concentration is taken as lower than the WHO standard of 0.1mg/L for nitrites.

Total dissolved solids indicate the presence of salts that are in soluble form and may cause hardness. Dissolved Solids in excess are objectionable in drinking water because of the possible physiological effect, unpalatable mineral taste and corrosion. The TDS values are presented in table-2 ranging from176-96mg/L, all below the WHO limit of 500mg/L.

4. CONCLUSION

On the basis of ionic characterization of these water samples, it is evident that the presence of all parameters within Permissible limits according to WHO chart (table 3) make the water safe forHuman consumption provided the Lines are safe from any foreign contamination. The study clearly showed that water is safe for drinking purpose.

Table-3: WHO Permissible limits for drinking water

Analytes	**Standards**	**Analytes**	**Standards**
Electrical Conductivity	400 µ mhos/cm	Magnesium as $MgCO_3$	150 mg/L
pH	6.5-9.2	Sulphates as SO_4^-	250 mg/L
Total Dissolved Solids	500mg/L	Sodium a Na+	250 mg/L
Total Suspended Solids	5mg/L	Potassium as K+	12 mg/L
Chloride as Cl-	250mg/L	Total Alkalinity	30-500 mg/L
Nitrite as No3-	0.1mg/L	Fluoride	0.5-1.5 mg/L
Total Hardness as $CaCo_3$ and $MgCO_3$	500 mg/L	Phenolphthalein Alkalinity	300 mg/L
Calcium as $CaCO_3$	250 mg/L		

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