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Evaluation of Drinking Water Contamination in Vehari Region (Pakistan)

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ABSTRACT: *Present studies were conducted to evaluate the quality of ground drinking water in Vehari city of Punjab, Pakistan. Water samples were subjected to physicochemical characterization for pH, electrical conductivity (EC), total suspended solids (TSS), total dissolved solids (TDS), phosphatic compounds, oils and fats. The observed ranges of pH (7.3-7.7), phosphatic compounds (0.001-0.006 mg/L), oils and fats (<1) were found within the WHO limits. The values of electrical conductivity(896-1875µS), total dissolved solids (400-8000 mg/L), and total suspended solid (1200-2800mg/L) were exceeded by WHO limits in Muslim Town, TBZ Colony, Vehari Zoo, D- block, Stadium Road, 9-11 WB, Sharqi Colony, and Danewal areas of Vehari. The investigated groundwater of Tehsil Vehari was found to be unfit for human consumption, and a dire need was felt for removing pollutants from this water before its consumption for drinking purposes in Tehsil Vehari.*

Keyword: Vehari, Drinking water, Contamination, Human being

INTRODUCTION

Access to high-quality drinking water is the basic right of each human being (Hannan et al., 2008) so regular monitoring of water quality and its treatment is necessary for the safety of local residents (Ambreen et al., 2019;

Mohsin et al., 2013). Water is polluted by several contaminants (Shakoor and Nasar, 2016)e.g., pathogens e.g., viruses, bacteria, protozoa's *etc.* (Abbas et al., 2014), inorganic pollutants, e.g., metals, acids, salts (Chaudhari et al., 2019; Haq, 2005; Rehman et al., 2019; Ullah et al., 2019), numerous anions and cations e.g., Ca^{+2}, Mg^{+2}, F^{-}, nitrates, phosphate, sulphates, *etc*. (Ali et al., 1996; Ullah et al., 2009), dyes (Hussain et al., 2023), pure organic compounds e.g., pesticides, oils and many water-based radioactive materials (Ambreen et al., 2019; Rasool et al., 2016). Groundwater is mostly contaminated due to several human activities (Hammer, 1986) as many million tons of sewage and other soluble or insoluble effluents are released into the water on a regular basis by human beings (Memon et al., 2016). The quality of water can be affected by temperature (Marcus et al., 1990), pH, electrical conductivity, alkalinity, hardness (Mohsin et al., 2013), total suspended solids (TSS), total dissolved solids (TDS) (Zhang et al., 2013), surfactants (Önder et al., 2007) and oils and fats (Farmaki et al., 2007) *etc*.

Currently, water pollution has become an important issue in Pakistan due to industrial growth and rapid rise in population (Jabeen et al., 2015). Poor management and monitoring of drinking water quality has had a terrible impact on public health. Pakistan ranks at number 80 among 122 nations regarding drinking water quality; there is a common violation of various drinking water quality parameters set by WHO (Azizullah et al., 2011). Drinking water sources (groundwater and surface water)are mainly contaminated with pesticides, toxic metals, and chemical and microbial pollutants throughout the country. Furthermore, improper disposal of industrial, municipal and agricultural waste by humans results in deterioration of water quality (Azizullah et al., 2011; Hussain et al., 2021). Several studies demonstrate the alarming situation of drinking water quality in some cities of Pakistan (Ghani et al., 2019; Iqbal et al., 2019; Waseem et al., 2014). For example, it was reported that poor water quality in Bahawalpur is responsible for severe waterborne diseases such as cholera, diarrhea, *etc.* (Mohsin et al., 2013). Drinking water from some Vehari regions were found to be unfit for human consumption due to its hardness (Ghani et al., 2019). Freshwater resources in Mardan have been reported to be severely affected by a many marble industries (Noreen et al., 2019). Microbial contamination has also been reported in the drinking water of

numerous Pakistani regions (Nabeela et al., 2014) e.g., Saggiyan-Lahore (Javed et al., 2021), Karachi (Amin et al., 2019), Vehari (Khalid et al., 2018), Kohat (Muhammad et al., 2017), Peshawar (Ali et al., 2012)and various regions of Northern Pakistan (Muhammad et al., 2012). Drinking water contamination accounts for 20-40 % of all diseases in Pakistan and is a cause of national income losses of approximately Rs 25–58 billion annually (Nabeela et al., 2014).Water is free in Pakistan, so the public does not pay attention to conserve it. In this regard, awareness is needed through electronic and print media. Also, a realistic water pricing mechanism can be implemented to discourage its enormous waste at the commercial and household level. The Pakistani government should pay serious and urgent attention to conserve water and minimize water pollution (Nabi et al., 2019).

Considering the importance of water quality, current studies were performed to evaluate water contamination in various regions of Vehari, Pakistan.

MATERIALS AND METHODS

Pyrex-origin glassware and analytical grade chemicals were used in all of the experiments. The glassware includes test tubes, glass beakers (50ml, 100ml, 250ml, 500ml, 1000ml), measuring cylinders (25ml, 100ml, 250ml), volumetric flasks (25ml, 50ml, 100ml, 250ml), pipettes (2ml, 10ml), micro pipettes (up to 300ul), round bottom flask (50ml, 100ml, 250ml), petri dishes, watch glass and funnels. China dishes, silica crucible, glass rods, magnetic stirrer, burner, tripod stand, wire gauze, spatula, Whatman's filter paper #2 and ashless, sucker were purchased from Crystal Instruments, Laboratory Equipment Supplier, Pakistan.

Spectro-analytical instrument (GmbH) (Labtech International), Incubator (DH3600II) (Labtech International), Analytical balance (EJ-300) (Labtech International), Drying Oven (WHL-25) (Labtech International), Ultra sonic mixer (GS-D120) (Labtech International), Magnetic & heating plate (78-1) (Lab Chem international), pH meter (Bante, PHS-25CW) (Lab Chem international) and TDS Meter (Lab Chem international) were used in the experimental work.

Study Area and Collection of Water Samples

Vehari district(area = 4364 km^2) is located between 30.22 º′ and29.36º′ N, 72.53 º′ and 71.44 º′ Eand it is comprised of three Tehsils, namely

Mailsi, Burewala and Vehari (Khalid et al., 2018). Samples of ground drinking water were collected from electric pumps (normally used for consumption purposes in Vehari) located in ten different areas (Muslim Town, Danewal Town, D-Block, Peoples Colony, Vehari Zoo and Wildlife, 9/11, Stadium Road, Seed Farm Road, Tariq-bin-Ziyad Colony and Sharqi Colony) of Vehari city (Table 1), within an area of 11 Km^2. The collected water samples were stored carefully in plastic bottles according to a reported procedure (Khan et al., 2013). All bottles were carefully filled with water (without any splashing), appropriately sealed, tagged and instantly delivered to the laboratory for the physicochemical testing. They were finally analyzed for pH, electrical conductivity (EC), total suspended solids (TSS), total dissolved solids (TDS), phosphatic compounds, oils and fats. The EC and pH were measured on the spot by anEC/pH meter, while the physical appearance of water samples was determined visually.

Detection of Total Suspended Solids (TSS)

All water samples, one by one, were passed through preweighed filter papers. The solid residue (TSS) left on the filter paper was dried in an oven (103º to 105° C) for 10 minutes until all the water vapors evaporated and the weight of the filter paper was no longer changed. The filter paper was again weighed; the gradual increase in the weight of the filter paper(after filtration and drying) represents the total suspended solids (TSS) present in a water sample.

Detection of Oil and Fats

The sealed water samples were passed through a preweighed membrane filter paper. The residue (oil and fats) obtained on the filter paper was dried using a distillation pump (to evaporate water) until the weight of the filter was no longer changed. The filter paper was again weighed; the gradual increase in the weight of a filter paper(after filtration and drying)represents the total amount of oil and fat in a water sample.

Detection of Phosphatic Compound

Spectro-analytical instrument (GmbH) was used to analyze phosphate in water samples. It is a smart analyzer vision 6.01.0948 with 1 dilution factor. The testing range of the instrument was 0.001-60.000 ppm.

RESULTS AND DISCUSSION

Physical data from the investigated water samples are summarized in Table 1. Table 2 displays the data obtained on conductivity, total dissolved solids

(TDS), total suspended solids (TSS), phosphatic compounds, oils and fats.

Table 1: Physical data of various sampling areas

Sample No	Area	Depth of source	Color	pH	Temp
S-1	Muslim Town	100 ft	Transparent	7.5	32 ºC
S-2	Danewal Town	150 ft	Transparent	7.7	29 ºC
S-3	D-Block	90 ft	Slightly Yellow	7.3	29 ºC
S-4	Peoples Colony	90 ft	Transparent	7.5	28 ºC
S-5	Vehari Zoo and Wildlife	100 ft	Transparent	7.3	27 ºC
S-6	9/11	90 ft	Transparent	7.4	30 ºC
S-7	Stadium Road	100 ft	Slightly Yellow	7.3	28 ºC
S-8	Seed Farm Road	120 ft	Transparent but changes after some time.	7.3	32 ºC
S-9	Tariq-bin-Ziyad Colony	150 ft	Transparent	7.5	29 ºC
S-10	Sharqi Colony	180 ft	Transparent but changes after some time.	7.4	30 ºC

Table 2: A pH, EC, TDS and TSS values of water (each sample 25 ml) from different Vehari site

Sample No	Sample vol. in ml	Conductivity (µS)	TDS (mg/L)	TSS in mg/L	Phosphatic compound (mg/L)	Oil and fats
S-1	25 ml	1432	2000	1600	0.006	<1
S-2	25 ml	1012	8000	2000	< 0.006	<1

S-3	25 ml	1584	1600	1200	< 0.005	<1
S-4	25 ml	1203	400	2400	< 0.002	<1
S-5	25 ml	1548	2000	2400	< 0.001	<1
S-6	25 ml	1875	2400	2000	< 0.006	<1
S-7	25 ml	1415	1600	2000	< 0.001	<1
S-8	25 ml	902	8000	2400	< 0.001	<1
S-9	25 ml	1770	1600	2800	< 0.001	<1
S-10	25 ml	896	8000	2000	< 0.002	<1

pH

The pH value of water has been considered one of the major parameters of water quality in an aquatic system. A high pH range is liable for the bitter taste of the ground drinking water (Rasool et al., 2016). In Tehsil Vehari, the pH of the investigated water samples (S1-S10) was found to be7.3-7.7as shown in Figure 1; the obtained data thus demonstrates a slightly alkaline nature of drinking water in the city of Vehari. The alkaline pH of water was owed to the presence of bicarbonates and a weathering creation of carbonaceous rocks in the study area (Lopez-Pazos et al., 2009). The observed value (7.3-7.7) lies within the pH range (6.5-8.5) recommended by the World Health Organization in its ″Guidelines for Drinking-Water Quality″(WHO, 2004, 2011) and the Pakistan Environmental Protection Agency(Pak-EPA, 2008)for the ground drinking water used for drinking purposes. Thus, the observed pH values of all Vehari water samples collected were found within the safe limits of WHO and Pak-EPA. Safe pH values were also previously reported in another Tehsil Mailsi (other Tehsil) of Vehari City (Pakistan) when similar investigations were carried out on drinking water quality (Abbas et al., 2014).

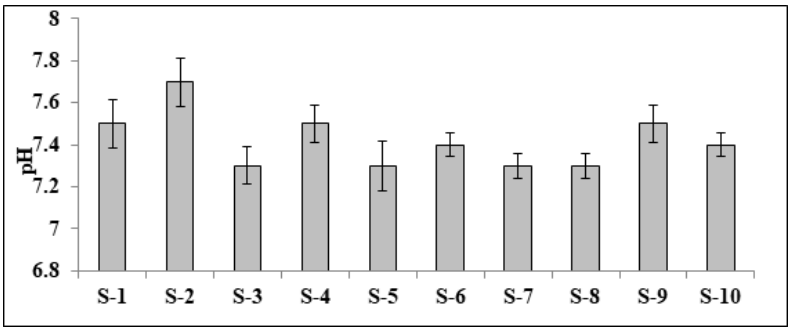

Fig. 1. pH values of underground drinking water samples (S1-S10) of Vehari

Electrical Conductivity (EC)

Like pH, the electrical conductivity (EC) of water is also considered an important parameter for determining the quality of water of different aquifers (Company, 1990).The EC data of the investigated groundwater samples (S1-S10) of Tehsil Vehari are compared in Figure 2. the EC values were found to be 896-1875µS/cm. The observed value should not exceed 400µS/cm, according to the WHO and Pak-EPA standards. So, it can be concluded that the electrical conductivity of the drinking water of the Vehari region does not lie within the standard limits of WHO and Pak-EPA. The higher EC value of drinking water was owed to the presence of many dissolved mineral contents, which are found in drinking water in the form of several soluble or in soluble ions (Ahdullah et al., 1999).

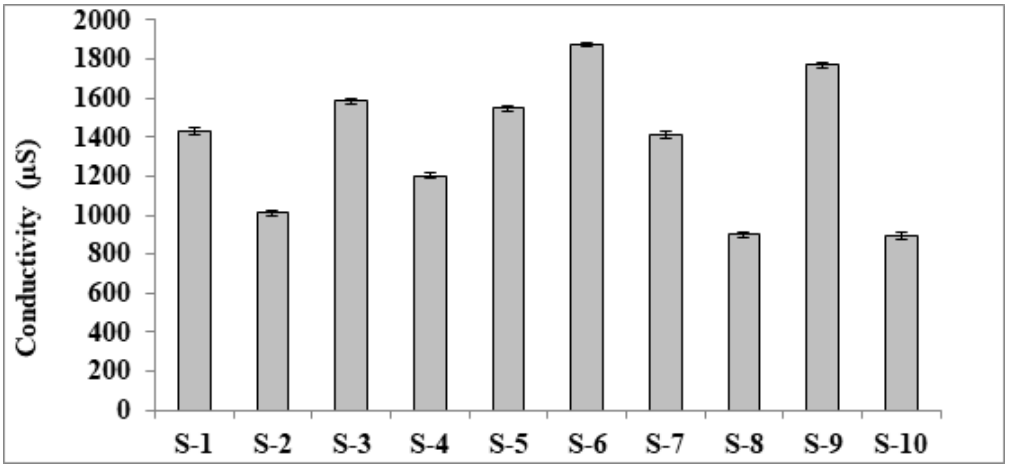

Fig. 2.Electrical conductivity of underground drinking water samples from different areas of Vehari city

Total Dissolved Solids (TDS)

TDS evaluates the full amount of the cations and anions in the water. TDS of

the investigated water samples (S1-S10) was found to be 400-8000 mg/L. The amount of TDS in drinking groundwater should not be greater than 1000 mg/L. TDS values of all the investigated water samples (S1-S10) were found to be higher as compared to Pak-EPA and WHO standards. The higher amount of TDS in these areas can be attributed to the mineralization and dissolution of the inorganic and the organic reserves in the groundwater as has been described by Mohsin et al. (Mohsin et al., 2013). It is considered that the values of TD solids are frequently higher in those regions where the HCO^{-3}, Ca^{+2}, NO^{-3} and SO_4^{-2}were in higher concentration. The data obtained are graphically presented in Figure 3.

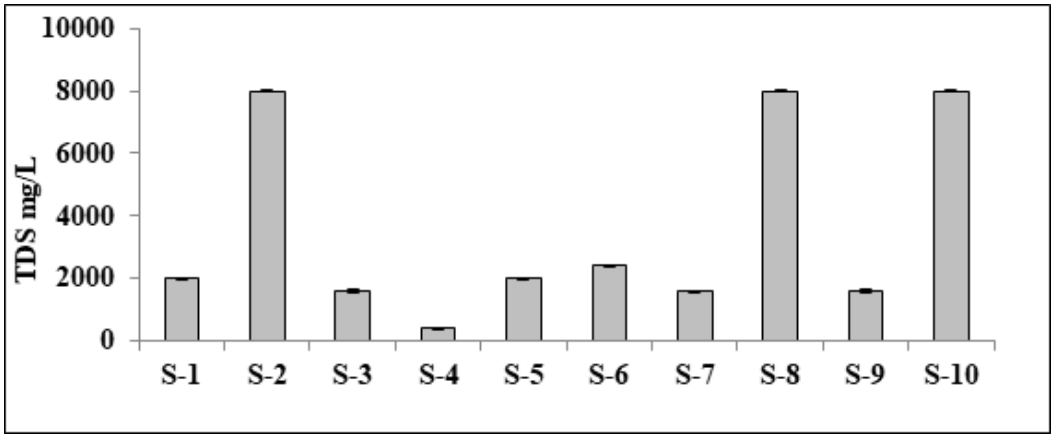

Fig. 3. Total Dissolved Solid (TDS) of underground drinking water samples from different areas of Vehari

Total Suspended Solids (TSS)

Total suspended solids can be well defined as all the particles in water that will not cross through a glass fibre filter without an organic binder. As the concentrations of TSS increase, the overall water quality of the water also decreases because higher concentrations of suspended particles will reduce the clarity of the water (Zhang et al., 2013). The observed mean value for TSS for the entire drinking water sample was 2080 mg/L with minimum and maximum values of 2800 mg/L for Site-9 and 1200 mg/L for Site-3. The observed TSS values of all groundwater samples (S1-S10)of the Vehari region are presented in Figure 4.

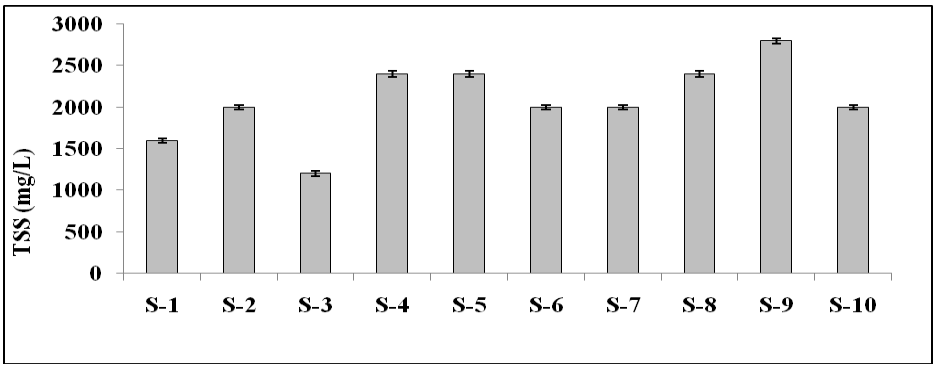

Fig. 4. TSS of ground drinking water samples collected from areas of Vehari

Phosphatic Compounds

The concentration of phosphate should be 0.1-5 mg/Lin drinking water according to WHO recommendations (WHO, 2004). It was found to be 0.001-0.006mg/L in the water samples investigated (S1-S10); this quantity is almost negligible and could not contaminate the water samples. Thus, the total concentration of phosphates in the ground drinking water of the Vehari region was found within secure limits, which are not dangerous for human consumption.

The mean values of the phosphatic compounds present in the ground watersamples collected from the ten Vehari sites are presented in Fig. 5.

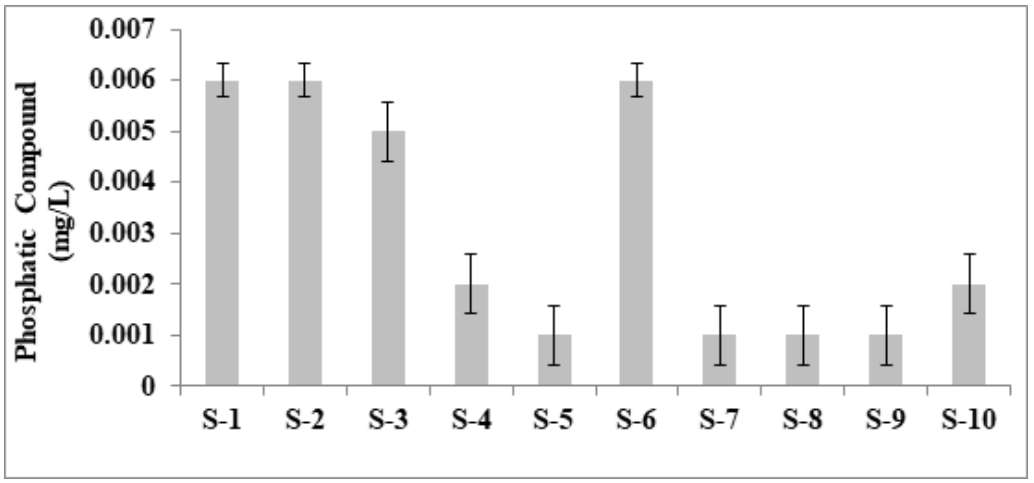

Fig. 5. Phosphatic compound of underground drinking water samples from different areas of Vehari

Oil and Fats

Oil and fats include a broad family of chemical compounds, such as greasy substances of hydrocarbon and biogenic origin. These types of compounds, when discharged into surface or groundwater, can cause ecological contamination and

numerous public health risks. The concentration of oils and fats in the investigated water samples (S1-S10) was found to be in a range of 0.6-1 mg/L; the observed values are smaller than 1 mg/L which is considered a negligible amount in drinking water because it could not affect the purity/quality of water.

The mean value of fats and oils in ground drinking water collected from ten different sites of Vehari has been presented in Fig. 6.

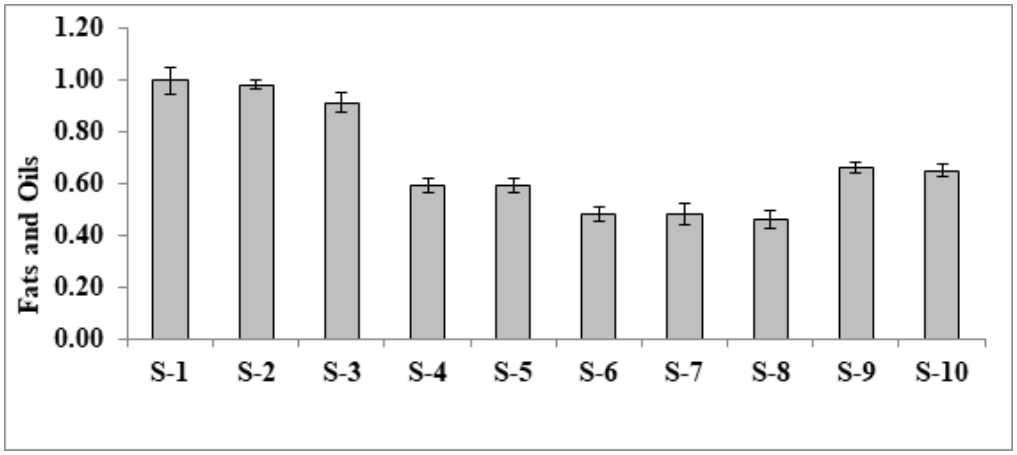

Fig. 6. Oils and fats of underground drinking water samples collected from different areas of Vehari

CONCLUSION

Water contamination is a serious threat to human health. The observed ranges of pH (7.3-7.7), phosphatic compounds (0.001-0.006 mg/L), oils and fats (<1) were found within the safe limits of WHO. However, due to the high values of electrical conductivity (896-1875µS), total dissolved solids (400-8000 mg/L) and total suspended solid (1200-2800 mg/L) compared to those recommended by WHO, the underground water of certain areas (Muslim Town, TBZ Colony, Vehari Zoo, D-block, Stadium Road, 9-11 WB, Sharqi Colony and Danewal areas of Vehari) of Tehsil Vehari is not suitable for drinking purposes. It is recommended that special management and monitoring procedures are essential in Vehari city to lower the adverse health effects of drinking water. Suitable treatment strategies should be adopted for the removal of water hardness in water-contaminated areas. More and more plantations should be done to improve underground water. It is very important to adopt sustainable, effective, and hygienic measures for the water bodies of Vehari City.

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