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Study on Chemical Investigations of Drinking Water Eminence of Diverse Textile Industries in Korangi Industrial Area Karachi, Sindh, Pakistan

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Abstract. Workers and employees in the textile business frequently need access to potable water, which could lead to an extreme burden of water related diseases. The present study is meant to describe the drinking water quality in the textile industries of Korangi, Karachi, Pakistan. Forty-four samples of potable water were collected for analysis from S-1 to S-4 sources available in textile industries. The analysis was carried out for Total Hardness (TH), Total Dissolved Solids (TDS), bicarbonates, chlorides, nitrates, calcium, and magnesium. Results showed that the calcium concentration in water samples from S-1, S-2 and S-3 were lower than the WHO range, whereas all other parameters are well within WHO limits. All parameters for water samples from S-4 are higher than WHO maximum limits.

Keywords: water quality, chemical investigations, textile industry, industry staff

Introduction

Safe potable water is of utmost importance for human health and well being. The quality of water is affected by impurities which eventually affect human well being. According to the World Health Organization (WHO), access to safe drinking water might result in perceptible health benefits (Organization, 2022). The potable water quality is for the users if water levels cross above the standards set by World Health Organization (WHO) and Pakistan Environmental Protection Agency (EPA) which ultimately affects human health (Ahmed *et al*., 2020).

Only 3% of the water on earth is fresh water and only a small fraction of this freshwater (0.01%) is available for human consumption (Arya, 2021). Due to the rapid population growth, urbanization, climatic change, use of natural resources and need for food, even this small amount of fresh water is under immense strain. With modernization comes an increase in the need for freshwater for industrial and agricultural uses, which could lead to a serious water crisis in the years to come (Kong *et al*., 2021).

Only a small number of heavy metals, such as copper, selenium and zinc, in low concentrations, are necessary to maintain human health and these elements can have detrimental health effects on humans when exceeding their limits (Maleki and Jari, 2021). The number of diseases that are intensely impacted by the higher concentrations of water impurities (Krupiñska, 2020).

The water impurities can enter the environment through anthropogenic activities and natural processes (Abbasi *et al*., 2021). Industrial processes like electroplating, metal smelting and industrial waste are also sources of heavy metals in groundwater and surface water (Mukherjee and Singh, 2021). An important source of potable water that needs little to no daily treatment is ground or bore water. Despite of this, illnesses brought on by drinking contaminated groundwater or bore water has been reported in different countries. Most countries do not properly treat or recycle domestic, agricultural and industrial wastewater, consequently, it is the source of too much water pollution (Tortajada, 2020).

Accordance to a source (Ahmed *et al*., 2020) only 20% of the population in Pakistan has access to clean potable water. Old sewage infrastructure and the local government's failure to separate sewage lines from potable water sources in Pakistan, especially in the Karachi metropolis, provide an extreme risk of water related pollutants spreading to the community (Ahmad *et al*., 2021). Textile industries are important to carry out

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research on potable water as workers and employees spend a significant amount of time in working places and consume their daily drinking water from industrial water sources. However, there is a lack of knowledge on the quality of potable water in the textile sectors. Therefore, the goal of this study is to carefully assess the quality of drinking water in the textile industries of Korangi Karachi, Pakistan.

Material and Methods

Study area. The study area is located in Karachi, Pakistan's Korangi district. One of the major industrial zones of Karachi city, Korangi Industrial Area (KIA) is home to nearly 4500 businesses, including textile, pharmaceutical, chemical, steel and automobile companies (Rahman, 2021). An estimated 1.5 million individuals are employed by the more than 5000 industrial, commercial and service businesses. In this area, 372 textile mills are in operation.

The area is close to the Arabian sea, that's why groundwater/bore water is extremely salty because of seawater intrusion and without treatment cannot be used for the potable purpose. Therefore, the public water system is the primary source of drinking water.

Sampling procedure. Forty-four potable water samples were collected from four different sources of origin. The source of potable water was:

- S - 1: KW&SB (Karachi Water and Sewerage Board) as direct supply
- S - 2: KW&SB water stored in Textile industry tanks
- S - 3: KW&SB water stored in coolers
- S - 4: Ground water/bore water, approx. 250 feet deep.

1.5-litre polyethylene bottles were washed and rinsed with distilled water and groundwater then collected samples. Samplings were done carefully to avoid any deterioration in water quality.

Lab analysis. The water sample was chemically analyzed using the APHA-recommended methods for determining total dissolved solids (TDS), total hardness, bicarbonates, chlorides, nitrates, magnesium and calcium (Federation and Association, 2005).

Statistical analysis. For initial data recording, graphical presentation and statistical analysis, MS Excel (Office 365 Pro Plus) and Minitab version 16 were used.

Results and Discussion

The statistics of the results are shown in Table 1. The table shows the chemical analyses of four different drinking water sources that are available in textile industries in Korangi Karachi. The study found that source water S-4 had significantly higher overall averages for total hardness, TDS, Cl^{-1}, HCO_3^{-1}, NO_3^{-1}, Ca^{+2} and Mg^{+2} than any other source. The contents of these components varied slightly between S-1, S-2 and S-3.

The average concentration of the total hardness (TH) was 786.97 mg/L in S-4. According to the WHO/Pakistan EPA's range limits of TH is between 10 mg/L to 500 mg/L. The water samples from different sources were within the permissible levels, except S-4 (Fig. 1). Water hardness specifically groundwater hardness is a result of weathering phenomena of limestone, sedimentary rock and calcium-bearing minerals. However, hardness in groundwater can also result from industrial effluent.

The taste, odour and softness of water are associated with the Total Dissolved Solids (TDS) concentration

Table 1. Showing the concentrations [(mean (min-max)] values of testing parameters in potable water samples in the study area

Source of water number of samples (mg/L)	S-1	S-2	S-3	S-4
	12		10	
TH	321.46 (251-396)	350.81 (260-470)	298.21 (178-349)	786.97 (660-880)
TDS	486.22 (389-596)	574.86 (349-570)	430.29 (370-520)	3214.6 (1400-4000)
Cl	59.21 (43.56-64.48)	64.21 (40.12-72.11)	58.61 (43.11-60.22)	786.21 (510-1011)
HCO_3	191.69 (130-220)	210.12 (150-250)	160.24 (140-200)	704.2 (500-840)
NO_3	0.81 (0.04-0.98)	0.88 (0.06-0.90)	0.61 (0.04-0.62)	5.26 (1.6-6.2)
Ca	60.91 (40-92.8)	64.26 (28.9-76.0)	58.11 (41.0-69.2)	105.21 (44.81-140.1)
Mg	40.91 (20.0-60.0)	44.28 (19.1-65.0)	38.72 (17.0-52.2)	258.33 (50.1-140.3)

and the maximum limit set by WHO/Pakistan EPA is 1200 mg/L. It was observed that the average concentrations of TDS for S-1 and S-3 were 486.22 mg/L and 430.29 mg/L (Fig. 2), respectively. However, the concentration of TDS for S-4 was 3214.60 mg/L greater than permissible limits. A high-level TDS in S-4 samples is due to the possible seeping of domestic wastewater and leaching of salts from the soil (Abdalla and Omer, 2009).

Figure 3 shows the results of chloride concentration in different sources of potable water samples. The average amount of chloride in S-3 was the lowest at 58.61 mg/L of all the sources. Nevertheless, there was a slight change between the amount of chloride in S-3 and S-1. The amount of chloride was higher in S-4 *i.e.* 786.21 mg/L. Conferring to WHO/Pakistan EPA safe limits.

The permissible level of chloride in drinking water is up to 250 mg/L. All the water samples excluding S-4 exhibited within the safe limits. Chloride in groundwater can come from a variety of sources, including weathering, the leaching of sedimentary rocks and soils, saltwater intrusion, municipal and industrial water, etc. (Sarath *et al*., 2012).

The mean value for bicarbonate was lowest in S-3 *i.e.* 160.24 mg/L. The bicarbonate mean concentrations in S-1 and S-2 were 191.69 mg/L and 210.12mg/L, respectively. The mean value of bicarbonate concentration in S-4 was considerably greater than the other sources 704.20 mg/L (Fig. 4). Water samples from S-1, S-2 and S-3 sources were within the permissible levels, however, S-4 samples exceeded the max limit. The elevated concentration of HCO_3 in S-4 samples indicates mineral dissolution processes (Rezaei *et al*., 2021).

The lowest nitrate concentration was found in S-3 samples, while samples S-1 and S-2 had similar and

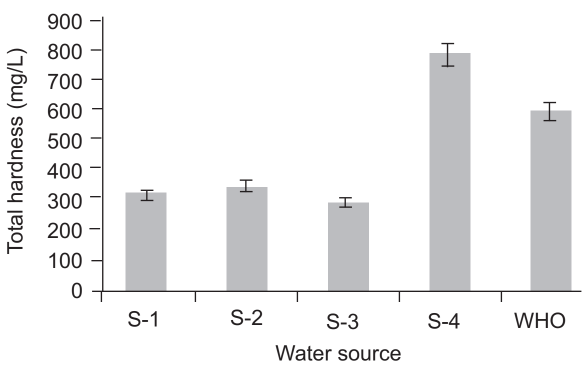

Fig. 1. Concentration of total hardness in potable waters of the study area.

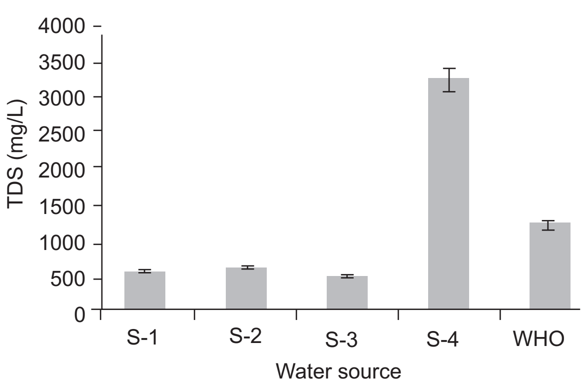

Fig. 2. Concentration of total dissolved solids in potable waters of the study area.

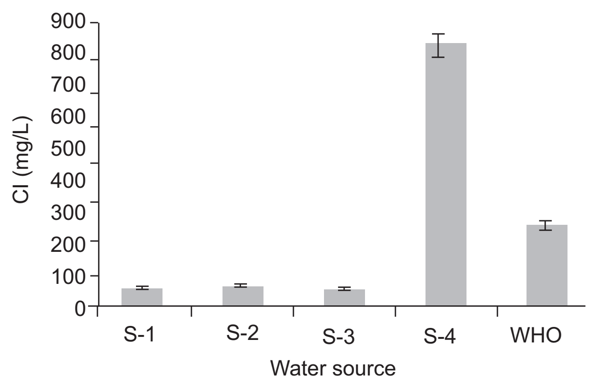

Fig. 3. Concentration of chloride in potable waters of the study area.

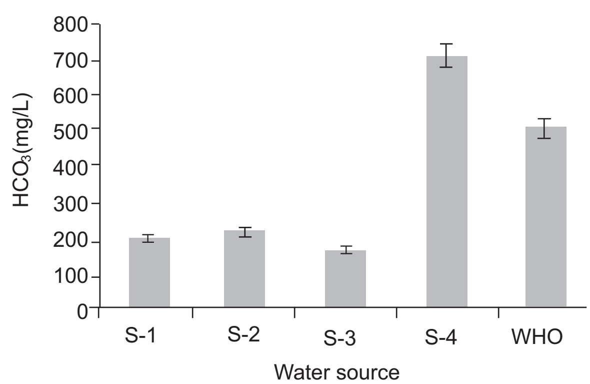

Fig. 4. Concentration of bicarbonate in potable waters of the study area.

somewhat higher nitrate contents S-3 (Fig. 5). Low concentrations of nitrate in drinking water typically less than 3 mg/L can be brought on by natural processes. Nitrate concentrations greater than 10 mg/L raise health concerns. Runoff or leakage from fertilized soil, wastewater, landfills, animal feedlots, septic systems, or urban drainage can all contribute to high levels of nitrate in water (Akhtar *et al*., 2021).

The amount of calcium in S-1, S-2 and S-3 were 60.91 mg/L, 64.26 mg/L and 58.11 mg/L, respectively (Fig. 6). The amount of calcium was the highest in (S-4) *i.e.* 105.21 mg/L. According to WHO and Pakistan EPA guidelines the permissible limit of calcium in potable water is 75 mg/L to 200 mg/L. The water samples S-1 to S-3 contained an amount of calcium that was below the WHO/Pakistan EPA limits, but the amount of calcium in S-4 was within the permissible limits. The lower and the higher Ca^{2+} concentration

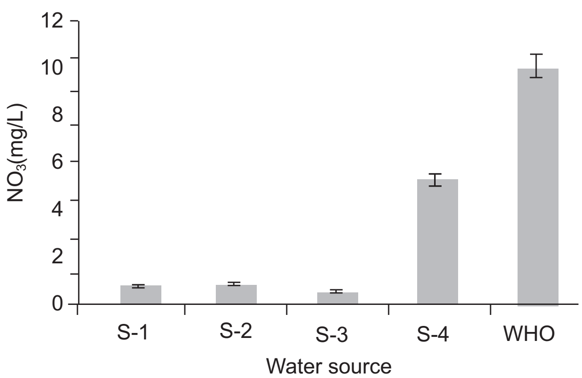

Fig. 5. Concentration of nitrate in potable waters of the study area.

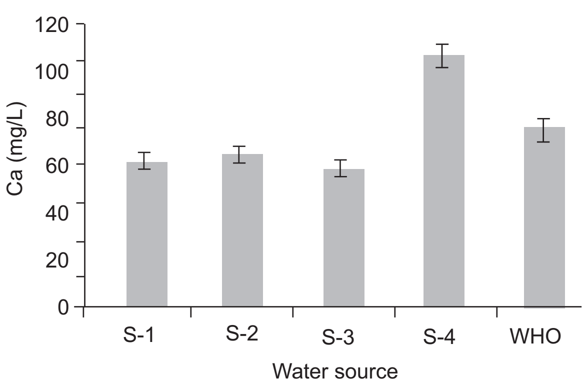

Fig. 6. Concentration of calcium in potable waters of the study area.

intake can affect human health, as high concentration can cause abdominal discomfort (Fischer *et al*., 2018).

The concentrations of magnesium in water samples from the study area are shown in Fig. 7. The average Mg concentration is varying between 40.91 to 258.33 mg/L. The permissible limit is between 30 mg/L to 100 mg/L. The water samples from all the sources except S-4 were found within the acceptable limits.

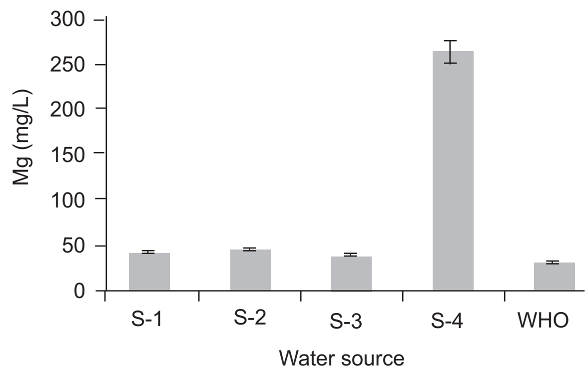

Fig. 7. Concentration of magnesium in potable waters of the study area.

Conclusion

More than 1.2 million people die every year as a result of contaminated water. Whether water is utilized for drinking, domestic use, food production, or recreational activities, it is important for the public's health to have access to safe, readily available water. Concerning chemical quality, the water samples from S-1, S-2 and S-3 sources were suitable for drinking purposes except for calcium, which was lower than that WHO limits. The waters from S-4 sources was unhealthy and unsafe for drinking purpose. To prevent the health risk associated with drinking water in the study area, especially from S-4 sources, it is necessary to implement practices and protocol designs for safe water supply.

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Conflict of Interest. The authors declare they have no conflict of interest.

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