Effect of Septic Tank Effluent on the Quality of Groundwater

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***Abstract*: Groundwater contamination is the main problem that is faced by various countries of the world including Pakistan. Maintaining the quality of drinking water extracted from various resources is very crucial as it directly affects public health and the surrounding environment. The main factor affecting groundwater quality is the handling of wastewater. To collect the domestic wastewater, underground septic tanks are used that serve as the onsite treatment systems. Due to the lack of maintenance of these tanks, the wastewater discharged into these tanks makes its way through the underlying layers of soil and pollutes the groundwater. The aim of this study is to analyze the effect of domestic wastewater on the quality of groundwater aquifer. In this regard, samples were collected from the handpumps and tube-wells in the vicinity of the septic tank. The selected site is Mirani Village situated at 5km east of Hyderabad, Sindh. A series of physical, chemical and biological tests were carried out for all the samples. It was observed that the quality of water is badly affected due to the intrusion of domestic wastewater in the groundwater aquifer. The obtained results show that pH, Calcium, Nitrate and Microbial contamination were beyond the permissible limit of WHO guidelines for drinking water.**

***Keywords*: septic tank, treatment, wastewater, groundwater.**

I. INTRODUCTION

In Pakistan, groundwater is a crucial source of the water supply however, it is under serious risk of pollution and water shortage. Like several developing countries, Pakistan is also facing the water scarcity problem; the main causes being lack of proper management, increasing water demands and several other factors like droughts and lack of construction of new water reservoirs. Furthermore, the evaporation rate in the country is higher than the water precipitation rate causing a continuous decrease of water in lakes and rivers as well as a reduction in groundwater (Azizullah et al., 2011)[6]. This decrease in water quantity along with the increasing water demands have worsened the situation.

Due to the population increase, industrial growth and increasing agriculture demands, water requirement has increased manifolds (Chandio and Abdullah, 1998)[1]. Consequently, the availability of per capita water has fallen from 5600m^3 to 1000m^3/annum (Water Quality status, 2003)[4]. The quality of this available water affects the health and environmental conditions of the consumers.

About 80% of people living in the main cities of the country do not have access to clean water (Zahid and Baig, 1997). Due to the consumption of low-quality water in the majority of the country, 80% of all diseases and 33% of deaths are caused (Tahir, M.A. et al., 1994). Research shows that in Pakistan, losses of Rs 25-28 billion annually are caused due to waterborne disease that makes approximately 0.6-1.44 % of the country's GDP (Tahir et al. 2010)[3].

Various pollutants infect water resources and cause contamination. Leachates from septic tanks and other municipal sewage like industrial effluents, domestic waste and poor handling of farm wastes are considered as the main cause of water contamination (Nabeela et al. 2014)[8]. Also, agricultural chemicals, landfills, hazardous waste sites, leakage of underground pipes cause groundwater pollution. The pollutants from these sources leach to the groundwater aquifer and cause its contamination. Hence this contaminated water when consumed cause severe health problems to the public and the surrounding environment.

The selected study area was a rural residential region in Mirani village, which is located at 5km east of Hyderabad city. The main sources of water supply were handpumps and tube-wells installed in the region. Samples were collected from locations around the septic tanks and analyzed for various water quality parameters like pH, Turbidity, Hardness, Total Dissolved Solids and concentration of chemicals like Chlorides, Sulfates and Microbial organisms.

II. MATERIALS & METHODS

A. Methodology:

The physical, chemical and biological parameters play a very important role in affecting the properties of water. A small deviation from the limits can cause serious health issues for the consumers. In this study, a total of 11 parameters were analyzed. The parameters analyzed were pH, Turbidity, TDS, Hardness, sulphate, nitrate, chloride, magnesium, calcium, alkalinity and Total Coliforms. The pH of the water samples were measured by using a hand held probe (ORION 3 Star, Thermo Scientific, Beverly, MA, USA).TDS and Turbidity were measured by 2540C, Standard Method (1992) and Turbidity Meter, Lamotte, Model 2008, USA, respectively. Hardness, Calcium and Magnesium were found by "EDTA titrimetric method" (APHA, 1998, part 2340, C, p. 2-36). Determination of Sulphates is being done by "Turbidimetric method" (APHA, 1998, part 4500 – SO_4^{2-} E, p. 4-178). For the estimation of Nitrates "Brucine method" is being used (Trivedi and Goel, 1984, p. 59). For the determination of Chlorides "Argentometric method" is being applied (APHA, 1998; part 4500-Cl B, p. 4-67). Total Alkalinity of the sample is being

determined by Standard Titrimetric method (APHA, 1998, part 2320 B-CO_2, D., p. 2-27). Total Coliforms were enumerated by Membrane Filtration method with EMB Agar.

B. Sampling methodology

Four locations were selected within the study area, two of which were having handpump sources (HP-1 & HP-2) and two tube-well sources (TB-1 & TB-2). All four sources were under domestic use and were near the individual septic tank. The depth of the handpumps was about 25-35 ft whereas tube-wells had the depth of 60-65 ft. The sampling was done twice in the month of August, 2019. First sampling was done in dry weather and second was done a week after the rainy season. Samples were collected according to the standard procedure.

III. RESULTS & DISCUSSION

All the samples were analyzed for the above mentioned parameters. Fig 1 shows the comparison of obtained results of pH with WHO Standards. The results indicate that the maximum and minimum pH values in the groundwater from all the sampling sites lie above the limit specified by WHO.

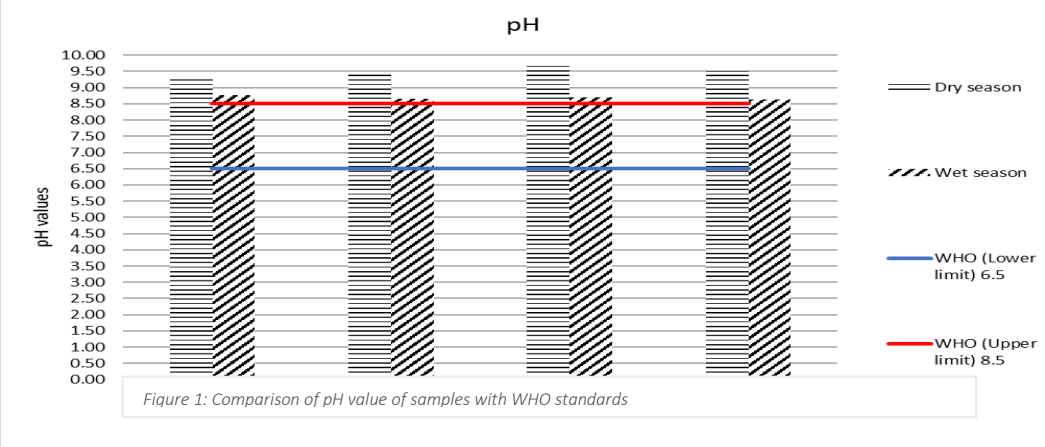

Fig. 1

The range of the pH results was 8.6 4 to 9.68. This indicates that all the samples are alkaline in nature. The lowest value was observed in TB- 2 whereas TB-1 was having the highest value. Moreover, pH values were observed to be very high during the dry season but during the wet season, it decreased considerably.

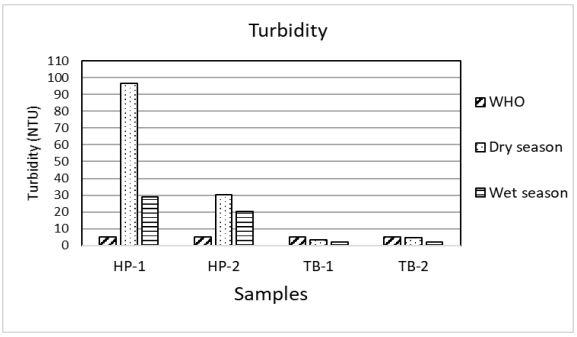

Figure 2: Comparison of Turbidity values of samples with WHO standard

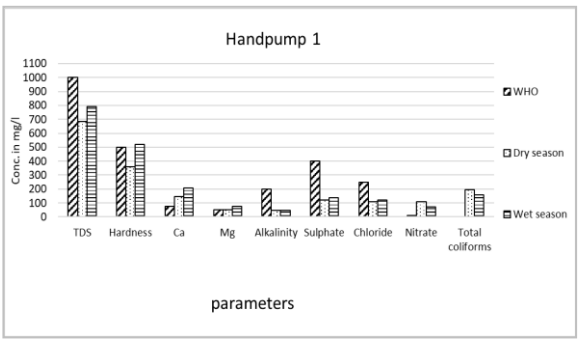

Figure 3: Comparison of different parameters of HP- 1 with WHO standards

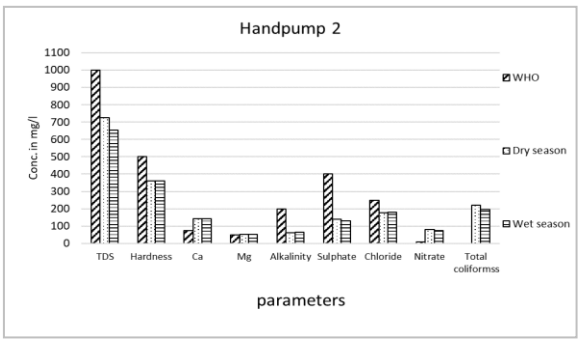

Figure 4: Comparison of different parameters of HP- 2 with WHO standards

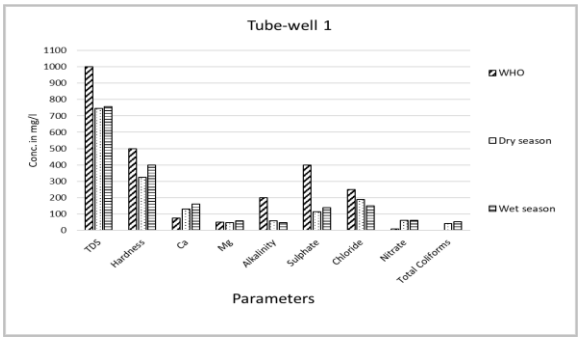

Figure 5: Comparison of different parameters of TB-1 with WHO Standards

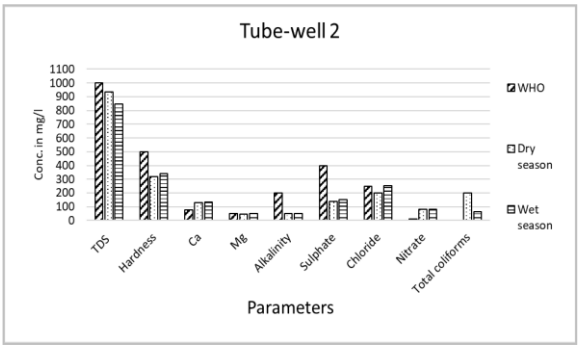

Figure 6: Comparison of different parameters of TB- 2 with WHO Standards

Figure 3 shows the comparison of different parameters of the HP-1 sample with WHO limits. These results show that TDS, Chloride, Sulfate, and Alkalinity of the sample were lying within the safe limit, however, the Hardness of the sample was

slightly higher than the permissible limit in the wet season. Also, Calcium and Magnesium were found to be above the safe limit; their range being higher during the wet season. The Coliform Count was very high in both the trials, so the water is contaminated. Turbidity results of all samples are given in fig 2. Turbidity and Nitrate content of HP-1 is above the safe limit. A comparison of different parameters of the HP-2 sample with WHO Standards is shown in figure 4. The results indicate that the sample contains high Coliform Count hence the water is highly contaminated. Furthermore, the Turbidity of the sample was also above the safe limit. However, Calcium, and Nitrate were above the allowable range. Other parameters like TDS, Hardness, Alkalinity, Chloride, and Sulfate were within the WHO limits, however Magnesium was slightly above the allowable range.
Fig 5 shows the comparison of parameters of TB-1 with WHO limits. Results indicate that the Turbidity of this sample was low and under the permissible limit. The Coliform Count was higher than the permissible limit but lower than the above two samples. There was not much variation in the results of Calcium and Magnesium with respect to handpump water. Nitrate was also slightly above the permissible limit.

Figure 6 shows a comparison of parameters of TB-2 sample with WHO standards. The obtained results show that the sample contains very low turbidity. The coliform count was high, especially in the dry season. Nitrate content was high in both dry and wet seasons and calcium were also beyond the safe limit. Magnesium was found to be within the allowable range.

From the above results, it is clear that Turbidity was high in handpump water. Also, Coliforms were detected in all four samples in every trial. The presence of Coliform bacteria in water indicates that water is contaminated with the fecal contamination of humans or animals. Nitrate content was also high in all the samples. General sources of Nitrate in groundwater maybe fertilizers, decayed vegetables, septic systems, animal feedlots, and food processing waste. The reason for high Nitrate value in samples may be because the sample sources were near the septic tanks and animal waste and fertilizers were also disposed of in the wastewater system. Moreover, the pH of all the samples is also very high and beyond the permissible limit which indicates that the groundwater is alkaline. The alkalinity in groundwater may be due to the mineral composition of soil layers and wastewater composition being discharged from domestic life.

IV. CONCLUSIONS

The above study shows that various physical, chemical and biological parameters of the groundwater are exceeding the WHO limits. The Coliforms were found in all the samples and the Nitrate level of the sample is also very high. This indicates that water maybe contaminated with domestic wastewater. Other parameters like pH and Calcium were also coming above the allowable limits. The Turbidity was higher in handpump water whereas the tube-well water had the Turbidity under the allowable limit. The concentration of pH, Turbidity, and Coliforms was higher in dry weather. Furthermore, the contamination level was found to be higher in handpump water than the tube-well. This difference of contamination level maybe due to the difference of depth of the source of water.

V. RECOMMENDATIONS

Based on the above study, the following recommendations are made:

- The drinking water may be used after boiling.
- If boiling is not practicable, proper filters may be used for purification of water. Maintenance of these filters should be done properly.
- For fetching water, deep wells may be availed.
- For the storage and primary treatment of wastewater, engineered septic tanks should be provided.
- Septic tanks should be cleaned and maintained properly. Sludge should be removed every six to twelve months; this period should not exceed three years.
- Soak-wells should be provided for the safe disposal of treated wastewater from the septic tanks.

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