



PHYSICOCHEMICAL AND BIOLOGICAL ASSESSMENT OF POTABLE WATER OF SAHIWAL CITY

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Abstract: - Water is one of the essential necessities among all and used for various purposes from human consumption to industrial use. Over 70% above, of the Earth's surface, comprises of water, only less than 1% of which is available as freshwater. Approximately more than one billion people lack safe drinking water worldwide. This paper studies the physicochemical and biological contamination in potable water of Sahiwal, for exactness of their influence on water quality. For this purpose, the bore and municipal water samples were collected from 6 different localities of the city. They were analyzed for 11 parameters including, temperature recorded by the ordinary thermometer, taste, color and odor were detected by six senses, the value of pH and total dissolved solids (TDS) with the help of pH meter and TDS meter, turbidity by using nephelometer, total hardness, alkalinity and dissolved oxygen (DO) by the titration method. This qualitative analysis strategy adopted to undertake this research has provided valuable data and information. For all the samples, the degree of temperature and measure of color, taste and odor were unobjectionable. The amount of turbidity, alkalinity and hardness were satisfactory. The amount of pH also lies within the permissible ranges set by PS: 1932-2010, WHO and IS: (10500-2004) standards. The amount of TDS was also in between excellent to the fair ranges. However, the amount of DO in municipal water samples of Shadman Town and Sadman Town and bore water of Johar Town and Sadman Town samples was found less than the required limit set by the WHO. The research signifies that overall, the water quality of all the samples was fit for the drinking purpose and can be utilized for various domestic purposes without any reluctance or second thoughts. The results of this study can enhance the understanding of quality of safe drinking water in Sahiwal.

Keywords: - Assessment, Alkalinity, Acidity, Potable water, Dissolved Oxygen, Physicochemical, Total Dissolved Solids

1 INTRODUCTION

Approximately more than one billion people lack safe drinking water worldwide. In developing countries, approximate 50% of the water used, is obtained from boreholes and wells, and more than 1000 million people in Asia depend upon these resources. Many analytical methods are used to check the presence and concentration of harmful material in water. Most of the health issues related to water are the result of biochemical contamination present in it. In addition to the dangerous problems of water pollution in developing countries, the water caused deaths and diseases are also an important issue worldwide. Drinking water is the cause of a large number of deaths in Pakistan too. As per the conducted survey, polluted water is one of the main threats to people's fitness in Pakistan that kills about 100,000 people a year, and over 250,000 children every year. In 2015, in Pakistan, 311189 people were died because of polluted water consumption [1], and in 2018, 40% of deaths were caused by it [2].

Pakistan falls on number 80 in the list of 122 those states which consume contaminated potable water. The water quality in several cities of Pakistan is deteriorating day by day due to uncontrolled municipal and industrial wastewater



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control and excessive use of fertilizers and pesticides [3]. So, large-scale water assessment is the need of the hour to evaluate and treat drinking water in Pakistan that will help to produce water that is safe and palatable. This research is mainly based, on qualitative analysis potable of water in Sahiwal, the city of Punjab, Pakistan. This city is also one of the main cities in Punjab, Pakistan. As a district, it has a population of 2,517,560, of which 419000 are in urban areas [4], [5]. Although Sahiwal division is mainly comprised of villages, its literacy rate is relatively high compared to many other regions of Punjab, because of the importance of this city, it is essential to access and monitors the quality of its potable water, as there are no initial reports or in-depth research available related to ground and municipal water quality assessment of this city. The innovation of this research was particularly concerned about the collection of water samples, to test physicochemical and biological contamination present in the fresh potable water of Sahiwal city, for exactness of their impact on the quality of water. This qualitative analysis strategy adopted to undertake this research has provided valuable data and information. The results of this study can enhance the understanding of quality of safe drinking water in Sahiwal. For the study, time and resources were the major constraints, which limited the scope of the research within academic limits only. Moreover, the collage lab was not well equipped. So, some chemicals were brought on order, which took much of the time and cost. Some of the tests were skipped because of non-availability of required chemicals in Pakistan. The adopted methodology and the obtained results can be replicated in other cities of Pakistan and where considerable issues of potable water contamination are being rising and the availability of the resources are limited.

Many studies have been, presented at the research level on the qualitative assessment of water, which will make public the consequence of this purposed research. In 2020 the research was conducted to check the physical (pH, EC, TDS, total hardness, turbidity) and chemical (Ca, NO₃, K, Fe, Zn, SO₄, Na, Mg, HCO₃, Cl) parameters of bore water samples collected at the depth of 100 and 150ft from the Sindh Industrial and Trading Estate (SITE) zone of Karachi and it was observed that all the parameters other than the pH of the samples were above the requirements of WHO and Pakistani standards of water quality [6].

In 2013, in district Mardan Khyber Pakhtunkhwa, Pakistan, various physicochemical parameters odor, taste, temperature, color, alkalinity, total hardness pH, TDS, EC, HCO₃, Mg, Ca and turbidity, were investigated for 39 potable water samples gathered from groundwater source of 13 union councils. The results showed that the taste of 23%, TDS of 15% samples, EC of 38% samples and the hardness of 20% of samples, were out of the ranges set by the Pakistani Standards of water and WHO, [7]. In India, the drinking water quality of many lakes were evaluated, for physicochemical and biological parameters, i.e. Total Hardness, TDS, DO, Specific Conductance, COD, pH, DO, temperature, TS, and Total Alkalinity by the standard methods. The results for many lakes in Nagpur city, Gorewada lake and various other lakes revealed that the majority of the parameters were significantly dominant, in the summer as compared to the winter [8], [9],[10].

Farzaneh [11], in 2019, checked the microbial and physical quality of potable water of Maku city (Iran) and, also determined the spatial distribution of chemical quality parameters of potable water through GIS during summer and winter. The research conducted for two years showed, all the parameters under consideration for 136 samples from 36 distribution networks during summer and winter were, within the standard ranges of WHO and Iranian National Standard, and overall, water was good and safe for drinking. In Bahr Dar city (Ethiopia) microbiological study, i.e. total coliform and faecal coliform by membrane filtration technique and physicochemical study, i.e. turbidity, EC, nitrate, TDS, pH, sulphate, temperature, free residual chlorine, phosphate, iron and manganese by thermometer, EC meter, pH meter, TDS meter, turbidity meter and by standard methods of APHA was conducted to check the water quality. It was found that TC and FC bacteria were detected in all the tap water samples [12].

Various biochemical and physical parameters were analyzed for one year, before and after the monsoon season, for different potable water samples of city Bhopal, India. From the results, it was observed that most of the parameters, including pH, electrical conductivity, Cl⁻, alkalinity, total hardness, calcium hardness, magnesium hardness, dissolved oxygen, chemical oxygen demand were, within the prescribed range, of IS: 10500 while others such as free carbon dioxide, biochemical oxygen demand were out of the range of ISI and WHO [13].

The physiochemical study conducted in different commercial and residential areas of Perak state Malaysia revealed that the overall water was safe for potable water supply with the values of all the parameters within the required limits of NDWQS and WHO [14]. The research was aimed to analyze the different water quality parameters in Manchar Lake Sindh, Pakistan during 2005-2007, (Ni, Zn, Cr, Pb, Se, Mg, Mn, Fe, total alkalinity, K⁺, Ca⁺², EC, Cd, Cu, pH, Cl⁻, PO₄⁻³, SO₄⁻², Co and As) and it was observed that other than, carbon monoxide, chromium, copper and manganese, all other elements were more than required limits, compared with WHO standards [15].



Devendra [16], measured the various biological and physicochemical parameters, to assess the bore water quality of various wards of Indore city India and the parameters analyzed from November to February and March to May include (1)Total alkalinity, (2)Temperature, (3)pH, (4)Total hardness, (5) TDS, (6)Chloride, (7)Turbidity and(8) COD. After comparing the obtained result with the Indian Standard of Drinking Water Standards, (IS 10500-2012) it was observed, that during the wet season, the majority of the parameters of water quality were higher up to some extent than in the dry time of year. The research was conducted, in University of Punjab at Lahore (Pakistan) to determine the chemical, physical and biological contamination present in water samples.

The studies showed that the amount of all the under-consideration parameters was above the WHO standards. The overall, water quality was not good [17]. The study was, conducted in Nekemte Oromia (Ethiopia) to check the bacteriological, chemical and physical quality of untreated, primary distribution sources and residential tap water in the dry season for the one year. The outcomes revealed that for most of the samples, all the parameters were as per within the World Health Organization and Ethiopian Drinking Water Standards, but some of them were more than the range. It was concluded that bacteriological contamination was present in both sources of drinking water [18]. In 2013, at Sargodha city, (Pakistan) for one-month June-July, the groundwater quality assessment was done, to check the physicochemical parameters including; pH, EC and TDS. It was, concluded that the amount of the parameters was more than the WHO prescribed limits. Hence the water was substandard and not safe from a drinking point of view [19]. The drinking water quality near and surrounding the municipal solid waste dumping areas in Jhang city, Pakistan was assessed in 2018, for the various physicochemical parameters. It was noticed that TDS was high (75%), CE (90%), Cl⁻ (35%), Hardness (60%), Alkalinity (25%) and calcium (30%) respectively. The water condition in controlled area was much stable and 90% of samples results were in limits as per WHO purposed values of parameters [20]. The chemical, biological and physical water quality tests performed on the water samples of Islamabad showed that alkalinity, hardness, and TDS in all the samples were within the range set by the Pakistan Standard and Quality Control Authority (PSQCA). However, coliform and E. coli bacteria were found in all samples. The water was suggested not fit for drinking purposes as per WHO recommendations. A large amount of calcium, limestone, and magnesium carbonate in potable water caused a critical degree of hardness in I-9 and G-10 parts, in Islamabad [21],[22].

2 METHODOLOGY

Water pollution is a severe worldwide issue which demands unending analysis and modification of water resource policy at all levels. In Pakistan, city Sahiwal (30.6682° N, 73.1114° E) is the administrative center of District and Division Sahiwal in Punjab, with a population of 1,843,194 people. For the water quality assessment bore and municipal samples were collected from 6 different sites that were Farid Town (30.6722°N, 73.0789° E), Sadman Town (30.6654°N, 73.1088°E), Canal Colony (30.6706°N, 73.0981°E), Staff Colony (30.66663°N, 73.0946°E), Shadman Town(30.6878°N, 73.1010°E), and Johar Town (30.6586°N, 73.128°E) Sahiwal.

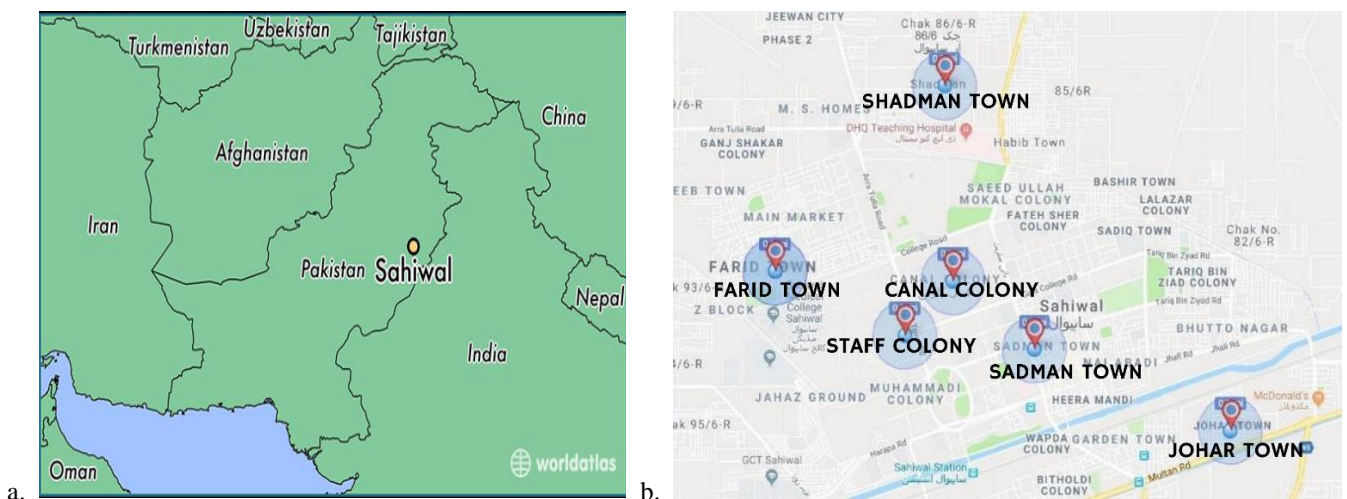


Figure 1: a, Location, Sahiwal city, and b, selected sites of a city

The framework of methodology adopted during the research work is as follows;

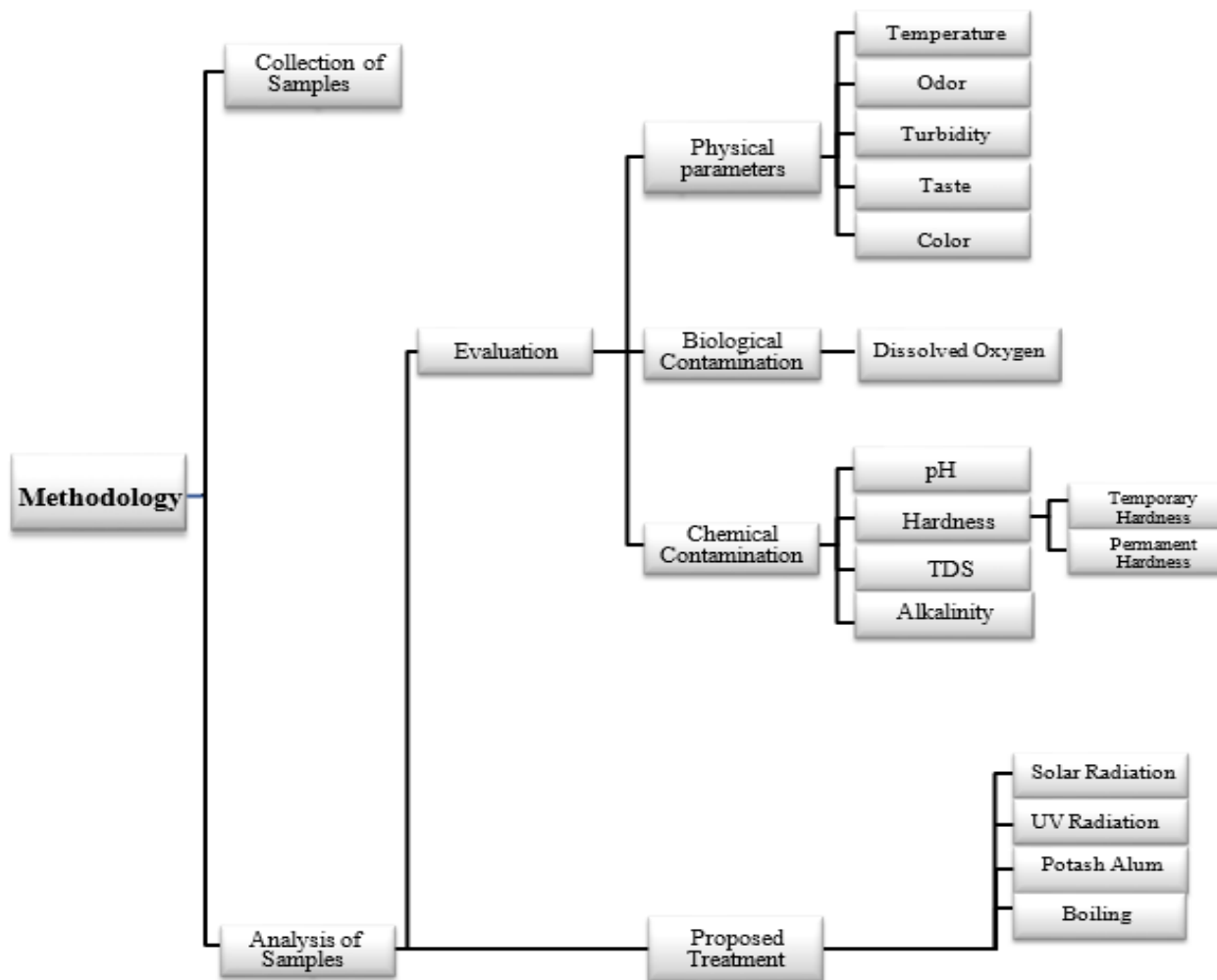


Figure 2: Framework of Methodology

Total of eleven parameters was considered such as temperature, taste, odour, colour, turbidity, pH, alkalinity, TDS, total hardness and DO for analysis of water samples. The apparatus used were a thermometer, nephelometer, burette, flask, measuring cylinder, stirrer, pipette, pH and TDS meter. The procedure adopted was as follows, the temperature of the water samples was recorded by the ordinary thermometer. The odour, colour and taste were tested by smelling, visualizing and by drinking the water samples respectively. The pH value was noted by placing the pH meter into the specimens. The turbidity of the samples was checked by nephelometer with a nephelometric tube inside, filled with the water sample. The amount of scattering of light gives the measure of turbidity present in a sample. The amount of Total Hardness, Alkalinity and Dissolved Oxygen (DO) were investigated in water samples by the titration method. The difference between the initial and the final reading of the burette filled with the standard solutions gives the amount of that particular parameter present in water samples. In the case of Total Hardness, the titrant used was sodium salt of EDTA with the blue colour representing the endpoint of the titration. For alkalinity test, the standard solution was sulphuric acid and the endpoint light orange colour. For checking, the DO of the water samples, sodium thiosulphate was used as a titrant, and the endpoint was yellow. The number of TDS present in water was counted simply by dipping the TDS meter into the water sample. The beneficial and reliable methods for the elimination of water contaminations (if present, in any season), were also suggested that can be adapted efficiently by the people at the domestic level. The purposed methods for the treatment of the water samples include boiling, UV radiations, solar radiations and by using potash alum.

3 ANALYSIS AND RESULTS

The integral role of water depends on the quality of the water. According to the research, carried out with the analysis of the Sahiwal areas, the results were monitored for water quality assessment. A total of twelve samples were collected from six distinct areas. A brief overview of the state of water quality in these areas is discussed below. The required and permissible limits of different water quality parameters set by PS:1932-2010, WHO and IS (10500-2004), standards are discussed in the table1 given below.



Table 1-Permissible limits/ranges/standard set by PS: 1932-2010(R), WHO and IS: (10500-2004) For Water Quality

Parameters	Required to Permissible Limit		
	PS: 1932-2010	WHO	IS:10500-2004
Temperature (°C)	-	7-50	-
Taste	Acceptable	Agreeable	Agreeable
Odor	Unobjectionable	Agreeable	Agreeable
Color mg/l (cobalt scale)	5-25	15	5-25
Turbidity (NTU)	5-10	5	5-10
Dissolved Oxygen (mg/l)	-	3-9	-
Total Dissolved Solids (mg/l)	1000-1500	>600-1000	500-2000
Total Hardness(mg/L)	200-500	150-500	300-600
Alkalinity(mg/l)	400-500	500	200-600
pH	6.5-8.5	6.5-8.5	6.5-8.5

After performing the entire tests, the results were evaluated and summarized in the Table-2 given below;

Table 2-Results of Water Analysis

Site: Sahiwal City											
Longitude: 30.6682° N, Latitude: 73.1114° E											
Date of Collection of Samples: March 02, 2019											
Location	Coordinates	Type Of Sample	Temperature (°C)	Color, Odor & Taste	Turbidity (NTU)	pH	TDS (ppm)	Total Hardness (mg/l)	Alkalinity (mg/l)	DO (mg/l)	Remarks
Canal Colony	30.6706° N 73.0981° E	Municipal Bore	22	Unobjectionable	Agreeable	8	266.5	Agreeable	Agreeable	3.73	Satisfactory
			26		Agreeable	7.5	287.25	Agreeable	Agreeable	6.16	Satisfactory
Shadman Town	30.6878° N 73.1010° E	Municipal Bore	24	Unobjectionable	Agreeable	7.55	527.75	Agreeable	Agreeable	2.15	Satisfactory
			27		Agreeable	7.5	695.5	Agreeable	Agreeable	3.88	Satisfactory
Farid Town	30.6722° N 73.0789° E	Municipal Bore	25	Unobjectionable	Agreeable	8	716.25	Agreeable	Agreeable	3.73	Satisfactory
			25		Agreeable	7	155.25	Agreeable	Agreeable	3.13	Satisfactory
Sadman Town	30.6654° N 73.1088° E	Municipal Bore	24	Unobjectionable	Agreeable	6.55	227.5	Agreeable	Agreeable	2.42	Satisfactory
			22		Agreeable	7.28	818.25	Agreeable	Agreeable	2.82	Satisfactory
Staff Colony	30.6663° N 73.0946° E	Municipal Bore	23	Unobjectionable	Agreeable	8	269	Agreeable	Agreeable	3.12	Satisfactory
			23		Agreeable	8.5	288.25	Agreeable	Agreeable	4.44	Satisfactory
Johar Town	30.6586° N 73.1283° E	Municipal Bore	26	Unobjectionable	Agreeable	8	567	Agreeable	Agreeable	4.34	Satisfactory
			24		Agreeable	7.4	576	Agreeable	Agreeable	2.46	Satisfactory

4 CONCLUSION

Following conclusion can be drawn from the conducted study:

- The overall water quality of the city is satisfactory and, as such, there is no need for treatment at the initial domestic level. For all the samples, the temperature, color, taste and odor were unobjectionable. The turbidity, alkalinity and total hardness in the water was also within an acceptable value.



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- The amounts of DO for some samples were somehow less than then WHO limits. The amount of pH also remained within the permissible ranges set by different standards PS: 1932-2010, WHO and IS: (10500-2004) standards. The number of TDS present in water was also lying within the excellent to the fair ranges.
- For the study, time and resources were the major constraints, which limited the scope of the research within academic limits only. Moreover, the collage lab was not well equipped. So, some chemicals were brought on order, which took much of the time and cost. Some of the tests were skipped because of non-availability of required chemicals in Pakistan.
- From, the results of the whole testing, it is concluded that there are no significant issues of any type of contamination, i.e. physical, biological and chemical present in the water of Sahiwal city and is considered as safe for drinking. The methodology adopted may also be, replicated in different cities of the country at small scale economically.
- The beneficial and reliable methods for the elimination of water contaminations (if present, in any season), were also suggested that can be adapted efficiently by the people at the domestic level. The purposed methods for the treatment of the water samples include boiling, UV radiations, solar radiations and by using potash alum.

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