Health Care: Current Reviews
ISSN: 2375-4273

Khan et al. Health Care Current Reviews 2018, 6:4
DOI: 10.4172/2375-4273.1000235

Research Article Open Access

Drinking Water Quality in 13 Different Districts of Sindh, Pakistan

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Abstract

This study was intended to assess the quality of drinking water in thirteen different cities of Sindh, Pakistan. The Clean Drinking Water is a great ecological determinant of Health. Contaminated water isn't simply messy, it's destructive. About 1.8 million individuals die every year because of diarrheal infections like cholera. A huge number of others are truly sickened by a large group of water-related illnesses, a considerable lot of which are effectively preventable. An absence of appropriate sanitation administrations not just breeds diseases; it can deny individuals of their fundamental human dignity. The quality of drinking water suffers from many factors, these include excessive amounts of microbes or chemicals derived from human and animal wastes, agricultural runoff, industrial chemicals, and even natural pollutants. Drinking water samples collected from different cities of Sindh including Karachi, Hyderabad, Shikarpur, Sukkar, Badin, Ghotki, Jacobabad, Khairpur, Mirpurkhas, Mithi, Tharparkar, Sanghar and Thatta. Samples were analyzed for various water quality parameters such color, odor, taste, alkalinity, Bicarbonate, Calcium, Carbonate Turbidity, Chloride, Conductivity, Hardness as $CaCO_3$, Magnesium, pH, Potassium, Sodium, TDS(Total Dissolved Solids), Sulphate, Nitrate and microbial contamination (Total coliforms and *Escherichia coli*). Our result shows that in some cities like Badin, Ghotki, Jacobabad, Khairpur, Mirpurkhas, Mithi, Tharparkar (without RO) Sangar, Thatta, water is unfit for drinking purpose as water quality parameters exceeding the prescribed standard values. Total viable count test was performed for microbial analysis and it was found that the sample from Badin, Ghotki, Jacobabad, Sanghar and Thatta were heavily loaded by the microbial growth of faecal coliforms and *Escherichia coli*. Whereas in other cities includes Karachi, Hyderabad, Shikarpur, Sukkur; water quality parameters fall within the prescribed standard values and no faecal contamination was found.

Keywords: Water quality; Fecal contamination; Microbial analysis; Chemical analysis

Introduction

Every living thing i.e. plants; animals and human beings need water for the survival. In fact, every living thing needs water, thus human body contains about two-third of water to survive [1]. Water is essential for biochemical processes taking place in every living organism and is basic requirement for human being Water is the most widely distributed and abundant substances found in nature. The irony is that our planet is awash with water [2]. In total, there is 1400 million billion liters of water, but most of this water is not used for drinking purpose, because 97% is sea water and only 3% is fresh water, out of which 2% is lidged in the polar ice caps and glaciers, only 1% water is available for portable use; whereas more water goes for irrigation than to drinking sanitation and all other uses but unfortunately, it is largely contaminated by physical, chemical and biological impurities that may include trace elements, pesticides, and detergents For centuries, human have been disposing of waste products by burning, placing them in streams, storing them on ground or putting them in the ground. Human induced influences on surface water quality reflect not only waste discharge directly into a stream, but also include contaminated surface runoff [2,3]. The quality of ground water is most commonly affected by waste disposed and land use. One major source of contamination is the storage of waste materials in excavations, such as pits or mines [3]. The quality of water is a vital concern for mankind, since it is directly linked with human welfare Safe drinking water is essential component to humans and other living beings for survival of life on earth, as water quality has direct impact on public health The natural water analysis for physical and chemical properties including trace element contents is very important Prevalence of waterborne diseases in Pakistan is mainly due to contamination of drinking water mostly with municipal sewage and industrial waste [4,5]. According to the Pakistan National Conservation Strategy report of 1992, about 40% of communicable diseases are water borne. Major diseases mostly connected with drinking water in Pakistan are diarrhea, gastroenteritis, typhoid, cryptosporidium infections, giardiasis intestinal worms, and some strains of hepatitis [2]. water is a vector transmission of many pathogenic bacteria, viruses and protozoa and the contaminated drinking water cause many water borne diseases most typically diarrhea vomiting and gastroenteritis. Microbial safe drinking water is the basic right of human beings In Pakistan water related disease (diarrhea) is commonest illness which is come across more or less by every person at least once a year and 30-50% of hospital entrance are due to diarrhea [6]. Unequal water delivery is widespread in urban areas and outbreaks of gastroenteritis and other water born diseases has become an ordinary characteristic. Parasitic and bacterial gastrointestinal illnesses are frequent, and sometimes eruptions occur The extent of enteric diseases in different areas depends upon the extent to which certain water is exposed to contamination [4]. The incidence of typhoid fever, bacillary dysentery, infectious hepatitis and other enteric infections in many countries may transmit through water. Cholera is still a wide spread water carried disease in some developing countries [3]. Karachi is a major urban and industrialized city of Pakistan. It is one of the twenty mega cities of the world, having a population of about 22 million people and covers an area of more than 800 square kilometers. The city is faces all kinds of environmental problems, including drinking water contamination

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Received October 25, 2018; **Accepted** December 13, 2018; **Published** December 20, 2018

Citation: Khan S, Aziz T, Noor-Ul-Ain, Ahmed K, Ahmed I, et al. (2018) Drinking Water Quality in 13 Different Districts of Sindh, Pakistan. Health Care Current Reviews 6: 235. doi: 10.4172/2375-4273.1000235

and inadequate water supply. Residential areas in Karachi are divided into planned and unplanned areas. More than 40 percent of city's population resides in squatter settlements. Unplanned areas are those where there is lack of proper shelter, water supply and other utilities essential for survival. In these areas, many people are living without access to safe drinking water and this is the most important determinant to be focused [1]. Pakistan ranked 80th in the world on availability of safe and clean drinking water to its people. It has been estimated that if no improvements are made to ensure the availability of safe drinking water, only 1000 m^3 per capita will be available from onward to 2010 in the country This aims of present study were to access the quality of drinking water in different districts of sindh, to access the level of contaminants in the drinking water samples and to compare quality of drinking water of selected districts of sindh Pakistan [2].

Material and Methods

Collection of water samples

Water samples were collected in sterile bottles as per standards with aseptic technique from running water from selected tap and from underground boring, and labeled accordingly with representative of the supply source from selected area of interest at sampling points of Karachi, Hyderabad, Badin, Larkana, Ghotki, Jacobabad, Mirpurkhas, and Thatta, (Government supply) Mithi, Sanghar, Shikarpur, Sukkur and Khairpur (Underground water supply).

Analysis of samples

All the chemicals used for analysis were of analytical grade (Merck and BDH). All the stocks solutions were prepared with double ionized distilled water. pH of water was determined by using pH meter [HI 8428, Hana]. Conductance of water was determined using conductivity meter [PC m3-Jenwary]. Total solids (TS), Total dissolved solids (TDS) and total suspended solids (TSS) were determined by using standards methods of American Public Health Association and WHO guidelines [6]. Chlorides were estimated by titration method using silver nitrate (0.043N) as standard solution and potassium chromate as indicator. Alkali metals (Na and K) were determined by using Flame Atomic Absorption Spectrophotometer Perkin-Elmer 3110. Determination of Iron (Fe), Zinc (Zn), Copper (Cu), Manganese (Mn), Lead (Pb), Chromium (Cr), Cadmium (Cd), Calcium (Ca), Magnesium (Mg), were carried out by using Flame Atomic Absorption Spectrophotometer Perkin-Elmer 400. Physical measurement and chemical analysis were carried out in triplicate for each sample and the average values were recorded.

Microbial Analysis

Pour plate method

We used this method for the detection of total viable microbial count. Mixed 1 ml of water in sterile Petri dish with 15-20 ml of Nutrient agar, mixed gently and allowed settling. Incubated at 37 degree centigrade for 24 hours. After that counts the colonies in cfu/ml with the help of counting chamber.

Final identification

Identified Colonies of *E. coli* was confirmed by sub-culture on EMB (Eosin Methylene Blue) agar and incubated at 42 degree centigrade for 24 - 48 hours and checks the growth; if green metallic sheen was produced it confirms the presence of *E. coli* in the specimen given and presence of black colonies indicated the presence of fecal *E. coli*.

Results

Physico-chemical analysis

Results of physic-chemical parameter determined in different cities were presented in Tables 1 and 2. Objectionable Odor and taste of three were reported of three cities Jacobabad, Mithi without RO Plant and Thatta while all other cities have un-objectionable. The results showed mean pH of 7.56, total dissolve solids 1054.46 mg/L, total hardness 540.8 mg/L and alkalinity 6.51 mg/L from water samples (Figures 1 and 2). The mean concentrations of cations are in order of sodium (Na) 172.7 mg/L, Potassium 10.38 mg/L calcium (Ca) 103.53 mg/L, and

Elements	Badin	GHK	Hyd	JCD	KHI	KHP	MPK	Mithi with RO	Mithi w/o RO	SGR	SHK	SUK	Thatta
Color	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	Turbid
Odor	UO	UO	UO	O	UO	UO	UO	UO	O	UO	UO	UO	O
Taste	UO	UO	UO	O	UO	UO	UO	UO	O	UO	UO	UO	O
Alkalinity (mmol/L)	8.1	6.9	2.6	8.8	2.1	6.7	7.8	4.2	10.3	7.2	6.8	4.5	6.7
Bicarbonate (mg/L)	388	266	230	340	219	280	305	210	310	258	185	238	269
Calcium (mg/L)	198	88	56	243	41	125	92	85	235	82	110	65	254
Carbonate (mg/L)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	91	Nil	Nil	Nil	Nil
Turbidity (NTU)	4.9	Nil	5	Nil	3.5	Nil	Nil	Nil	Nil	Nil	Nil	4.5	6.5
Chloride (mg/L)	231	271	78	210	81	248	262	82	341	262	98	152	110
Conductivity(us/cm)	1845	1858	584	2544	402	1858	2030	634	4338	2150	620	648	2035
Hardness (mg/L)	350	530	170	680	123	530	430	436	2300	480	238	239	526
Magnessium (mg/L)	65	88	20	72	22	88	48	22	65	74	67	48	45
pH (30.5 C)	7.5	6.9	7.4	7.8	7.1	7.8	7.1	7.3	9.1	7.5	7.3	7.2	8.4
Potassium (mg/L)	11.6	10.5	6.8	13.8	5.7	11.8	14.1	10.8	16.2	13.5	8.6	8.7	8.6
Sodium (mg/L)	175	265	50	275	49	265	255	58	485	238	189	90	210
TDS (mg/L)	850	980	373	1650	289	1340	1292	750	2460	1192	695	487	1350
Sulphate (mg/L)	234	255	44	310	51	320	236	225	358	236	53	108	210
Nitrate (mg/L)	1.4	3.1	1	1.2	1.5	2.5	1.2	1.1	1.3	1.1	1.0	1.3	1.1

CL=clear
UO= un-objectionable
O= Objectionable
Hyd: Hyderabad, JCD: Jacobabad, MPK: Mirpurkhas, SHK: Shikarpur

Table 1: Physical and chemical characteristics of different elements in drinking water.

Microbial Analysis of Drinking Water												
Organism	**Badin**	**Ghotki**	**Hyd**	**JCD**	**Karachi**	**MPK**	**Mithi1**	**Mithi 2**	**Sanghar**	**SHK**	**Sukkur**	**Thatta**
Coliform	Present	Present	Not Present	Present	Not Present	Not Present	Not Present	Not Present	Present	Not Present	Not Present	Present
E. coli	Present	Present	Not Present	Present	Not Present	Not Present	Not Present	Not Present	Present	Not Present	Not Present	Present

Hyd: Hyderabad, JCD: Jacobabad, MPK: Mirpurkhas, SHK: Shikarpur.

Table 2: Microbial Analysis of Drinking Water.

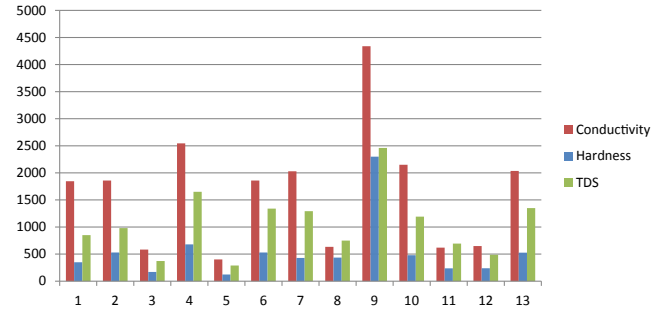

Figure 1: Showing conductivity, hardness and TDS of 13 different cities.

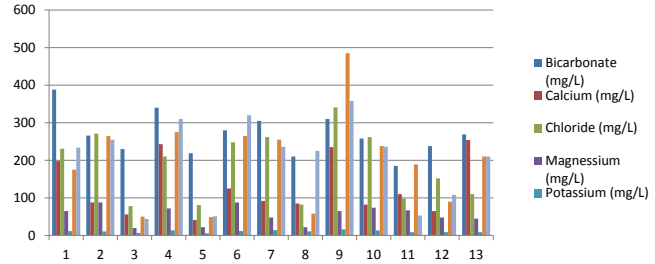

Figure 2: Showing different elements of 13 different cities.

magnesium (Mg) 55.6 mg/L, while anions are in order of bicarbonates (HCO_3^-) 269.4 mg/L, sulphates (SO_4^{-2}) 203.07 mg/L chlorides (Cl^-) 185.84 mg/L, and nitrates (NO_3^-) 1.43 mg/L.

Microbial analysis

The results of microbial analysis were presented in Table 2. Coliforms, *E. coli* and fecal coliforms were seen on samples of five cities (Badin, Ghotki, Jacobabad, Sanghar and Thatta).

Discussion

The current water supply in Pakistan is inadequate and poor for drinking purpose which has a great health risk to the public. Drinking water should be free from color, turbidity, odor, and microbes. Our results showed that 75-85% of collected water was contaminated in Sindh. In most of the areas and cities of Pakistan the rudimentary source of provision is ground water supply, which contains various pathogens like viral, bacterial, and protozoan agents causing 2.5 million deaths from endemic diarrheal disease each year. According to WHO only 36% of the Pakistani population on average, including 41% in urban areas and 32% rural areas, has access to safe drinking water in the country. We have evaluated the quality of drinking water from different areas of Sindh including urban (Karachi and Hyderabad) and rural settings and have found a distressing situation of drinking water quality. For the testing of water quality along with toxic chemicals and trace elements we have used different parameters which include some sensory evaluation like taste, color and odor and for the assessment of water pH, hardness, alkalinity we followed the American Public Health Association (APHA) reference methods which surveyed the permissible limits as per WHO guidelines. The average pH of drinking water samples was found to be 7.43 which are in range as per WHO recommended limits (6.5 – 8.5). The permissible range for the water hardness [presence of $CaCO_3$(mg/L)] was lies within the range of 500 as per APHA except Mithi and Tharparker. Estimated water hardness value 2300 which is very high as per reference range of APHA, Jacobabad water hardness value is 680 and Thatta with 526 water hardness values.

The utilization of poor quality water causes waterborne diseases and their spread. Water and sanitation department has been focusing on water quantity due to increasing requirements rather than water quality. In Pakistan, about 50 % of diseases and 40 % of deaths occur due to poor drinking water quality reported in community health studies. The greatest threats posed to water resources arise from contamination by bacteria, nitrates, metals, trace quantities of toxic materials, and salts. Seepage overflow into drinking water sources can cause disease from the ingestion of microorganisms such as *E. coli*, Giardia, Cryptosporidium, Hepatitis A, and Helminthes. Sewage is entering the water source; there are usually coliform bacteria, specifically *E. coli* bacteria, in the water. Our results revealed the presence of Coliforms, *E. coli* and fecal coliforms in water samples of five cities includes: Badin having 100-60 CFU/ml of Coliforms and *E. coli*, Ghotki 50-40 CFU/ml of Coliforms and *E. coli*, Jacobabad, Sanghar and Thatta >500 CFU/ml of Coliforms and *E. coli*. Our results showed that Thatta district has the most polluted drinking water and unfit for drinking as per water quality parameters showing exceeding prescribed standard values along with fecal contamination.

The release of toxic chemicals from urban communities and industries without any treatment into water bodies deteriorates water quality and also causes adverse effects to human beings. Biochemical analysis of drinking water showed that sodium, potassium, TDS, Sulphate and nitrate all have exceeding values with reference to recommended values as per APHA (American Public Health Association). All this is due to the lack of awareness, treatment technology, equipment, trained personnel, and quality monitoring.

Conclusion

Drinking water samples collected from different cities of Sindh including Karachi, Hyderabad, Shikarpur, Sukkar, Badin, Ghotki, Jacobabad, Khairpur, Mirpurkhas, Mithi, Tharparkar, Sanghar and Thatta. Samples were analyzed for various water quality parameters such color, odor, taste, alkalinity, Bicarbonate, Calcium, Carbonate Turbidity, Chloride, Conductivity, Hardness as $CaCO_3$, Magnesium, pH, Potassium, Sodium, TDS (total dissolved solids), Sulphate, Nitrate and microbial contamination (total coliforms and *Escherichia coli*). It was found that in some cities like Badin, Ghotki, Jacobabad, Khairpur, Mirpurkhas, Mithi, Tharparkar (without RO), Sangar, Thatta, water is unfit for drinking purpose as water quality parameters exceeding the prescribed standard values. Total viable count test performed for

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