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# Determination of Water Quality Parameters of Water Supply in Different Areas of Karachi City

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**Abstract:**

*The water quality parameters of water supply in different areas of five districts of Karachi city, namely Central, South, East, West and Malir were analyzed. The various water quality parameters namely pH, Total dissolved solids (TDS), Electrical conductivity (EC), Turbidity, Total hardness (TH), Calcium ($Ca^{2+}$) Magnesium ($Mg^{2+}$), Sodium ($Na^{+}$), Potassium ($K^{+}$), Chloride ($Cl^{-}$), Sulphate ($SO_4^{2-}$), Nitrate ($NO_3^{-}$) and Nitrite ($NO_2^{-}$) were determined by using standard classical and instrumental methods of analysis. The Dissolved oxygen (DO) and Biological oxygen demand (BOD) of water samples were also measured to evaluate the biochemical characteristics of water. The results for the analysis of water quality parameters were compared with the values provided by WHO and PSQCA guidelines in order to access the quality of water. The water quality parameters for the water supply in all the selected areas of different districts of Karachi city complied with the WHO and PSQCA guidelines.*

**Key words**: TDS, Conductivity, Turbidity, Alkalinity, WHO, PSQCA

## 1. Introduction

Karachi is a metropolitan city having a moderate climate and is categorized as the economical hub of Pakistan. Water is essential for almost all the life supporting activities and the

sustainability of human life is impossible without water. It is also involved in important economical activities such as production of electricity and chemicals on industrial scale.

The lakes and rivers become highly heterogeneous water bodies due to climatic changes and discharge of effluents from domestic and industrial houses. The rivers and lakes are the main source of drinking and household water supply and hence there is a need for continuous monitoring of such water bodies. The water supply to Karachi for drinking and household use is coming from River Indus and its affiliated lakes such as Kenjhar Lake and from Hub River Canal situated in Baluchistan. The quality and chemical composition of water depends upon its source and is significantly influenced by the industrial and domestic activities (Sirajudeen and Mubashir 2013). Any imbalance in the chemical composition of water beyond the permissible limits imposes a harmful effect on the entire ecosystem. The quality of people's health is dependent upon the quality of water supplied and therefore it is essential to manage the quality of water supply by applying modern disinfection procedures such reverse osmosis and exposure to UV radiations.

The analysis of minerals such as sodium, potassium and chloride is of great importance to agricultural activities, irrigation, domestic and industrial activities (Juned and Arjun 2011). The water quality parameters of drinking water in Karachi city and different parts of country have been studied (Asadullah et al. 2013; Noor et al. 2009). The suitability of water for agricultural use is evaluated from its physico-chemical characteristics (Balamurugan and Dheenadayalan 2012). The balance of physico-chemical properties of water is very important for the ecosystem and any imbalance in the physical and chemical constituents of water can have a harmful effect on life (Agarwal 2010). The water streams are subjected to seasonal variation in their physico-chemical properties due to fluctuation in human and industrial activities and hence a

continuous monitoring of the physico-chemical characteristics of water streams is necessary to ensure the supply of good quality drinking and household water to human population (Iqbal et al. 2004).

The aim of present study is to determine the water quality parameters of water supply in different areas of Karachi. The chief chemical constituents of water samples have been determined and their values have been compared with the permissible limits as per WHO and PSQCA guidelines and their fitness for drinking purpose has been evaluated. This analysis will provide a clear picture of the quality of water being drunk by the people of Karachi and few possible measures to improve the quality of water that can be practiced domestically will also be suggested.


**Fig. 1: The Location of Karachi City in Pakistan**


**Fig. 2: The Geographical Map of Karachi showing the location of different areas of Karachi city**

## 2. Materials and Methods

### 2.1. Materials

All the glasswares of Pyrex (IsoLab-Germany) and all the chemicals of analytical reagent grade purchased from E-Merck were used. The water samples were collected in dedicated plastic containers from domestic water supply pipelines and transported to the analytical laboratory. The UV-3000 spectrophotometer was used for the analysis of sulphate, nitrate and nitrite while the alkali metal ions $Na^+$ and $K^+$ were analysed by flame photometry. All the analytical reagents were prepared in double distilled water having conductance of 6.0 x $10^{-2}$ $\mu S.cm^{-1}$.

### 2.2. Sampling

The water samples from different sampling location inside the Karachi city were collected in plastic containers. The volume of each sample was 2.0 litres as measured by measuring cylinder. The temperature of the water samples was determined at the sampling site and samples were kept in refrigerator at $4^oC$ in order to avoid bacterial growth and possible change in the water quality parameters. A total of twenty areas were selected for sampling and tap water/domestic water supply pipeline samples were collected by allowing the water to drain for 2 minutes before the collection of sample. The location of Karachi inside the country and the geographical map of Karachi showing the location of different areas of Karachi are given in Fig. 1 and 2. The sampling plan was prepared in such a way to select a nearly equal number of samples from each district of Karachi city. The sampling locations inside Karachi city for assessment of water quality parameters of water supply are given in Table 1.

**Table 1. The Sampling Plan for the Collection of water Supply Samples from different areas of Karachi**

| Sample No. | Sampling Location | District | Town |
|---|---|---|---|
| S1 | Gulshan-e-Hadeed | Malir | Bin Qasim Town |
| S2 | Quaidabad | Malir | Bin Qasim Town |
| S3 | Malir | Malir | Malir Town |
| S4 | New Karachi | Central | New Karachi Town |
| S5 | Buffer Zone | Central | North Nazimabad Town |
| S6 | North Nazimabad | Central | North Nazimabad Town |
| S7 | Gulberg | Central | Gulberg Town |
| S8 | Liaquatabad | Central | Liaquatabad Town |
| S9 | Gulistan-e-Jauhar | East | Gulshan Iqbal Town |
| S10 | Gulshan-e-Iqbal | East | Gulshan Iqbal Town |
| S11 | Korangi | East | Korangi Town |
| S12 | Landhi | East | Landhi Town |
| S13 | Orangi | West | Orangi Town |
| S14 | Naval Colony | West | Baldia Town |
| S15 | S.I.T.E. | West | S.I.T.E. Town |
| S16 | New Town | South | Jamshed Town |
| S17 | Saddar | South | Saddar Town |
| S18 | Lyari | South | Lyari Town |
| S19 | DHA | South | Cantonment Area |
| S20 | Manzoor Colony | South | Jamshed Town |

## 2.3. Methods

The water samples were analysed in triplicate for various water quality parameters such as pH, Total dissolved solids (TDS), Electrical conductivity (EC), Turbidity, Total hardness (TH), Calcium ($Ca^{2+}$) Magnesium ($Mg^{2+}$), Sodium ($Na^{+}$), Potassium ($K^{+}$), Chloride ($Cl^{-}$), Sulfate ($SO_4^{2-}$), Total alkalinity/Total Acidity (TA), Nitrate ($NO^{3-}$), Nitrite ($NO^{2-}$), Dissolved oxygen (DO) and Biological oxygen demand using standard classical and instrumental methods of analysis. The commercial testing kits were used for the determination of nitrate ($NO_3^{-}$) and nitrite ($NO_2^{-}$).

## 3. Results and Discussion

The water quality parameters of all the water supply samples are tabulated in Table 2. Each water quality parameter is discussed individually and the values are compared with the WHO and PSQCA guidelines for drinking water. The variation in the water quality parameters is elucidated by bar graphical distribution and the factors which are responsible for the variation in water supply parameters of Karachi water supply have also been discussed to present a clear picture of water supply system of Karachi City.

**Table 2. Water Quality Parameters of Water Supply in Different Areas of Karachi City**

| Sample No. | Physico-chemical | | | | | Cations | | | | Anions | | | | Biochemical | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | pH | EC | TDS | TH | TA | $Ca^{2+}$ | $Mg^{2+}$ | $Na^{+}$ | $K^{+}$ | $Cl^{-}$ | $SO_4^{2-}$ | $NO_2^{-}$ | $NO_3^{-}$ | DO | BOD |
| S1 | 7.35 | 840 | 477 | 215 | 61 | 49 | 23 | 40 | 5.9 | 130 | 63 | 0.022 | 2.6 | 4.9 | 1.2 |
| S2 | 7.02 | 856 | 486 | 216 | 54 | 56 | 29 | 85 | 5.9 | 134 | 33 | 0.015 | 1.5 | 6.4 | 2.0 |
| S3 | 7.20 | 895 | 505 | 230 | 80 | 60 | 20 | 85 | 5.3 | 174 | 39 | 0.023 | 1.3 | 6 | 0.8 |
| S4 | 7.30 | 964 | 540 | 235 | 65 | 64 | 18 | 95 | 5.9 | 174 | 75 | 0.004 | 0.7 | 5.2 | 1.4 |
| S5 | 7.80 | 855 | 490 | 210 | 55 | 53 | 19 | 65 | 5.9 | 145 | 78 | 0.006 | 0.9 | 3.4 | 0.6 |
| S6 | 7.20 | 883 | 491 | 213 | 55 | 64 | 13 | 85 | 5.9 | 136 | 41 | 0.007 | 0.45 | 5.6 | 1.0 |
| S7 | 7.8 | 1035 | 514 | 213 | 60 | 58 | 12 | 54 | 5.7 | 130 | 55 | 0.02 | 1.2 | 5.0 | 1.2 |
| S8 | 7.10 | 855 | 485 | 215 | 54 | 44 | 19 | 80 | 6.4 | 130 | 97 | 0.007 | 0.9 | 7.2 | 1.6 |
| S9 | 7.00 | 654 | 357 | 178 | 58 | 44 | 17 | 55 | 3.2 | 105 | 35 | 0.01 | 1.7 | 5.4 | 1.2 |
| S10 | 6.75 | 973 | 475 | 225 | 60 | 60 | 13 | 50 | 5.5 | 126 | 50 | 0.025 | 1.3 | 4.6 | 1.2 |
| S11 | 6.70 | 874 | 486 | 225 | 56 | 56 | 21 | 85 | 5.3 | 153 | 51 | 0.012 | 1.0 | 4.2 | 2.0 |
| S12 | 7.02 | 907 | 515 | 245 | 56 | 55 | 16 | 85 | 8 | 158 | 82 | 0.016 | 1.6 | 4.2 | 1.8 |
| S13 | 7.50 | 683 | 379 | 180 | 55 | 49 | 14 | 70 | 4.8 | 103 | 100 | 0.012 | 1.1 | 5.6 | 0.5 |
| S14 | 6.70 | 663 | 370 | 174 | 52 | 42 | 17 | 65 | 7.0 | 93 | 95 | 0.015 | 1.0 | 5.0 | 1.3 |
| S15 | 6.90 | 863 | 470 | 224 | 63 | 62 | 26 | 75 | 6.4 | 150 | 92 | 0.015 | 1.0 | 5.3 | 1.1 |
| S16 | 6.90 | 1015 | 490 | 260 | 55 | 64 | 24 | 95 | 8.5 | 173 | 57 | 0.005 | 1.8 | 4.4 | 2.0 |
| S17 | 6.85 | 814 | 562 | 213 | 55 | 60 | 15 | 85 | 6.4 | 133 | 75 | 0.003 | 0.5 | 4.3 | 2.2 |
| S18 | 7.05 | 1174 | 570 | 220 | 57 | 56 | 15 | 80 | 6.2 | 133 | 75 | 0.007 | 0.7 | 5.4 | 1.4 |
| S19 | 6.90 | 845 | 481 | 215 | 58 | 53 | 20 | 75 | 6.4 | 130 | 62 | 0.012 | 1.3 | 4.6 | 1.0 |
| S20 | 7.45 | 861 | 483 | 216 | 54 | 56 | 19 | 90 | 6.9 | 139 | 45 | 0.009 | 0.9 | 4.8 | 1 |
| **WHO** | 6.5–8.5 | 1400 | 1000 | 500 | 120 | 100 | 150 | 200 | - | 250 | 250 | 1.0 | 5.0 | - | - |
| **PSQCA** | 6.5–8.5 | - | 500 | - | - | 100 | 50 | 50 | 10 | 250 | 250 | 1.0 | - | - | - |
| **STD** | 0.32 | 121 | 54.5 | 20.2 | 5.97 | 6.59 | 4.40 | 15.2 | 1.08 | 21.7 | 24.3 | 0.006 | 0.49 | 0.83 | 0.47 |

***All the concentrations are measured in units of $mg.L^{-1}$.**

## Temperature (°C)

The importance of temperature in biological activities inside water streams is very well understood. The temperature of water samples was in the range of 25 to 28 °C. The temperature of water can be affected by the presence of certain industrial effluents and the variation of temperature has an effect on the density of water streams (Gopalkrushna 2011).

## Turbidity

The turbidity is caused by fine and colloidal suspended solids in water. The turbidity of water samples from Karachi was in the range of 0 to 0.5 NTU which is in accordance with WHO and PSQCA guidelines. The turbidity of water samples fluctuates from area to area due to leakages in the water supply pipelines and mixing of turbid waste water with drinking water.

## pH

The pH value is an indicator of relative acidity or alkalinity of a solution. The pH of the water samples was in the range of 6.65 to 7.80 which is very much acceptable for drinking. Most of the samples were alkaline while samples S8, S11, S13, S14, S15, S17 and S19 had pH less than 7. The alkalinity is due to the presence of carbonates and bicarbonates. The pH of all the samples was found to be within the WHO and PSQCA guidelines (6.50-8.50). The lower limit of pH for drinking water is determined by the corrosive effects of water at pH below 6.50 while the upper limit is due to a bitter taste and scaling effect of water above pH 8.50. The variation in pH of water supply in different areas of Karachi city is shown in Fig. 3.

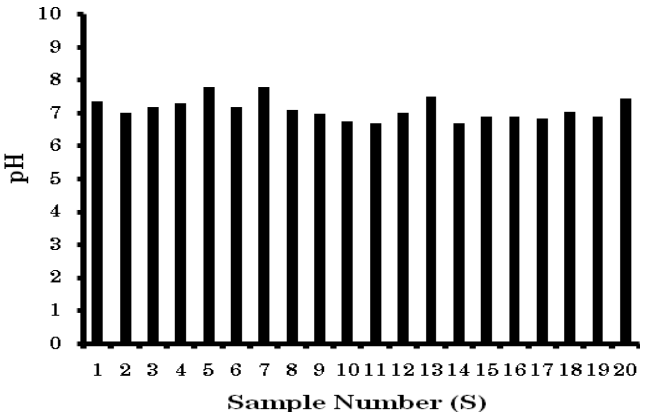


**Fig. 3. The pH variation of water samples from different areas of Karachi city**

## Total Dissolved Solids (TDS)

The TDS consists of constituent ions of inorganic salts which determine the saline behaviour of the water stream and also a small amount of organic matter that may be dissolved in water (Heydari and Bidgoli 2012). A higher TDS causes adverse change in the taste of water and is also not good for metallic pipelines used for transportation of water inside homes (Ramesh and Seetha 2013). The TDS of water supply in different towns in Karachi City was in the range of 350 to 600 $mg.L^{-1}$. The WHO guidelines say that TDS higher than 500 $mg.L^{-1}$ makes the water somewhat undesirable for drinking although under certain conditions water up to 1500 $mg.L^{-1}$ TDS content can be used for drinking. PSQCA recommends that water with TDS greater than 500 $mg.L^{-1}$ should not be used for drinking. A few samples namely S3, S4, S7, S12, S17 and S18 have TDS values in the range of 500 to 600 $mg.L^{-1}$ which may be due to addition of some ions during the transportation of water in water pipelines or may be due to seepage of industrial effluents as these areas either have industrial zones or located very near to industrial areas. The variation in TDS of water supply in different areas of Karachi city is shown in Fig. 4.

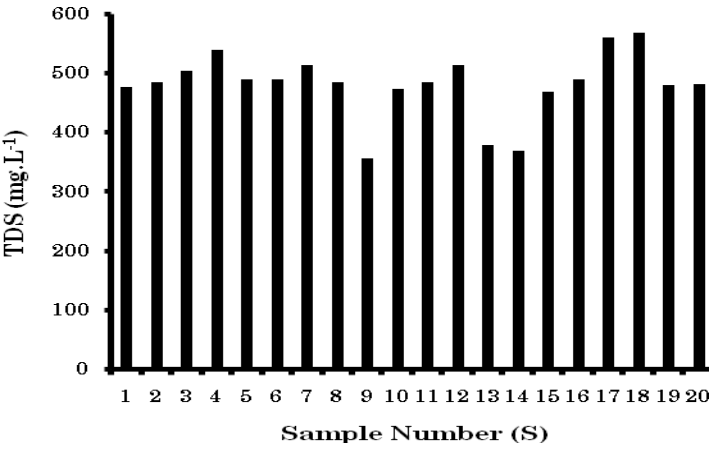


**Fig. 4. The TDS variation of water samples from different areas of Karachi city**

## Electrical Conductivity

The capacity of water to conduct electric current is termed as electrical conductivity (EC). It is used indirectly to determine the total dissolved solids in a water sample. The conductivity of water samples was in the range of 650 to 1200 $\mu S.cm^{-1}$, which is very acceptable as per WHO limits. The conductance of a water sample is directly proportional to the inorganic dissolved solids capable of dissociation into ions. The value of electrical conductivity is often used as an index of total dissolved materials in a water sample and is related to the TDS of water sample by a mathematical factor that depends upon the concentration and type of ions present in the water sample. The variation in electrical conductivity of water supply in different areas of Karachi city is shown in Fig. 5.

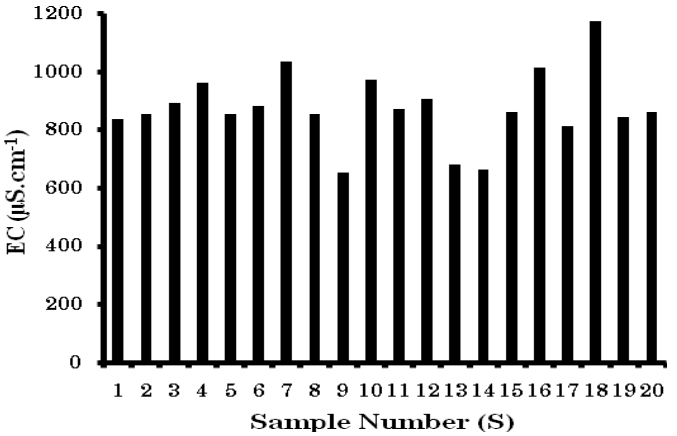


**Fig. 5. The EC variation of water samples from different areas of Karachi city**

## Total Hardness

The term "Hardness" in water chemistry explains a property of water which prevents the formation of lather when soap is mixed with water and also increases the boiling point of water due to attractive forces between water molecules and ions. The hardness is due to the presence of salts of calcium and magnesium. The hardness of water samples from different areas fluctuates depending upon the concentration of $Ca^{2+}$ and $Mg^{2+}$ ions in the total dissolved solids. The use of water with high hardness causes choking of water supply pipelines, calcification of arteries, kidney and stomach disorders. The hardness of all the water samples was within the prescribed WHO limits ($TH \leq 500$ mg.$L^{-1}$).

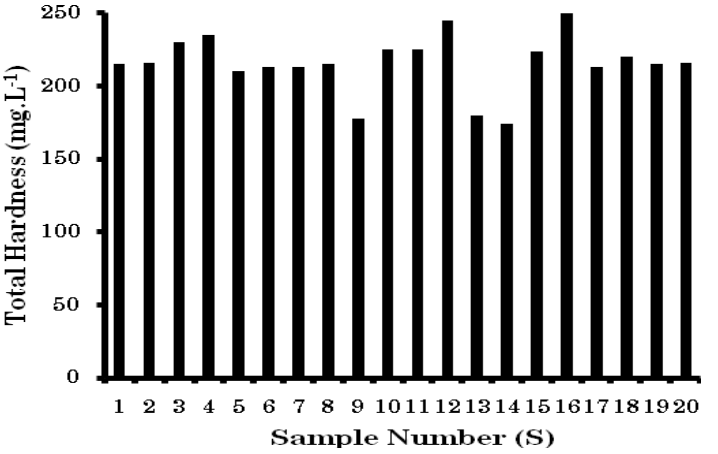


**Fig. 6. The TH variation of water samples from different areas of Karachi city**

## Total Alkalinity

Alkalinity of water is its capacity to neutralize a strong acid and it is normally due to the presence of carbonate, bicarbonate, and hydroxide compounds of sodium, potassium and calcium. It is very important to determine the alkalinity of a drinking water stream as these water streams are often affected by acidic inputs from rainfall and wastewater. The alkalinity of water streams is also subjected to seasonal changes. The alkalinity of water samples was in the range of 50 to 80 $mg.L^{-1}$. The recommended limiting value by WHO is 120 $mg.L^{-1}$. A water having acidity is vulnerable to significant changes in pH upon receiving effluents from industrial and domestic activities while slightly alkaline water is resistant to change in pH and also has a pleasant taste. The variation in alkalinity of water samples from different areas of Karachi is due to industrial activities and discharge of untreated industrial waste in water streams which significantly effects the chemical composition of water.

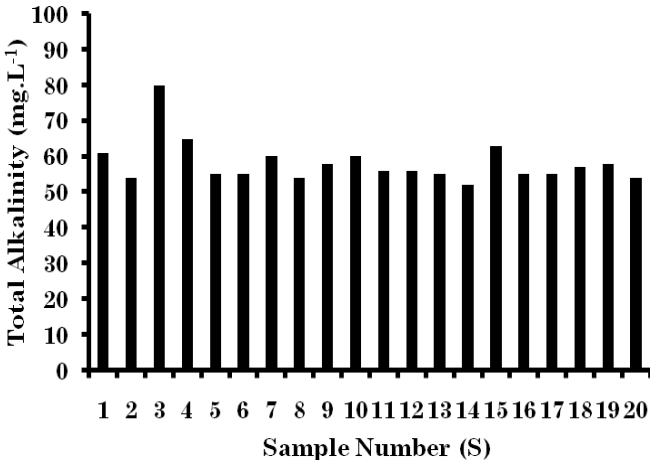


**Fig. 7. The TA variation of water samples from different areas of Karachi city**

## Calcium

The calcium ions are a major constituent of igneous rocks. The calcium ions have the ability to impart a pleasant sweetening taste to water but an increase in concentration above the recommended limit can cause stomach disorders and on domestic scale may also form a calcified deposit inside water supply pipelines and hinder the flow of water. The natural water streams have a definite concentration of calcium ions depending upon the solubility of calcium salts but it can also enter into water supply system through the construction material of concrete pipelines and leakages (Pradhan and Pirasteh 2011). The concentration of calcium in water is directly related to its hardness. The concentration of calcium in the samples was in the range of 40 to 65 $mg.L^{-1}$ which is very suitable as per WHO and PSQCA guidelines ($Ca^{2+} \leq 100$ $mg.L^{-1}$).

## Magnesium

The magnesium is a chief constituent of water hardness. It is essential for the growth of phytoplankton's and is essential role in photosynthesis makes it a very important chemical constituent of water (Jadhav, Patil and Raut 2013). The magnesium ions serve as cofactors for the function of several enzymes involved in the regulation of biochemical activities inside the human body. The concentration of magnesium in the samples was in the range of 12 to 30 $mg.L^{-1}$ which is very suitable as per WHO and PSQCA guidelines.

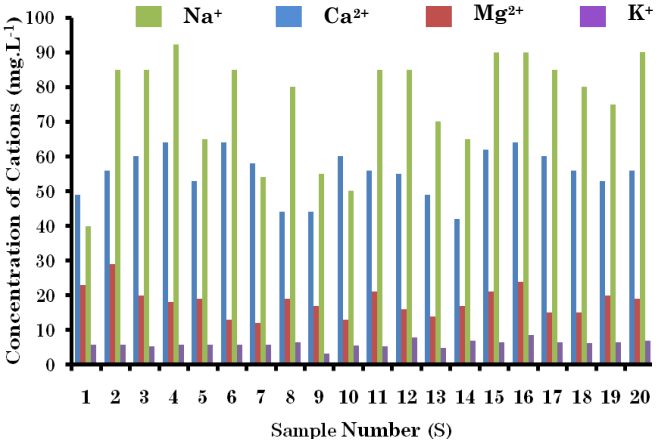


**Fig. 8. The concentration of different captions in water supply of different areas of Karachi city**

## Sodium

The sodium is essentially introduced into the water during the water softening process. Although there is no apparent adverse effect of sodium on human health, the people with hypertension and heart diseases are recommended to drink water having ≤ 20 $mg.L^{-1}$ sodium. The prescribed WHO limit for concentration of sodium in drinking water is 200 $mg.L^{-1}$ while that from PSQCA is 50 $mg.L^{-1}$. The concentration of sodium in our

analysis was in the range of 40 to 100 $mg.L^{-1.}$ Although this concentration of sodium is very acceptable for drinking purpose, a few samples contain higher concentration of sodium than prescribed PSQCA limits.

**Potassium**

The potassium is also added to water during the water softening process by potassium based softeners. The potassium also has the ability to cause laxative effects. In our analysis of Karachi water supply, the concentration of potassium was in the range of 3.20 to 8.50 $mg.L^{-1}$ which is in compliance with PSQCA standards for drinking water. The WHO does not provide any specific guidelines for the concentration of potassium in drinking water.

**Chloride**

The chief source of chloride in water streams are the chloride salts including sodium chloride. The chloride in drinking water may cause laxative effects if present in excess concentration. The chloride plays an important role in determining the salinity of a water stream. In our analysis, the chloride concentration was in the range of 100 to 160 $mg.L^{-1}$, which is very much suitable in light of WHO and PSQCA guidelines ($Cl^- \leq 250$ $mg.L^{-1}$). The variation in chloride concentration varies in different water streams.

**Sulphate**

Sulphate is a constituent of gypsum and other minerals and is discharged into water streams due to leaching from these mineral deposits and from industrial wastes. The concentration of sulphate was in the range of 30 to100 $mg.L^{-1}$. This variation is most probably due to the discharge of sulphate ions into

water streams by leakage into the water supply pipelines from industrial wastes and domestic activities. The concentration of sulphate in all the water samples is in compliance with WHO and PSQCA limits.

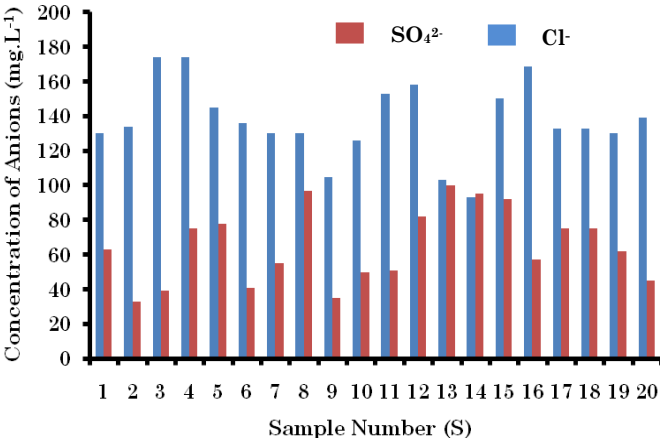


**Fig. 9. The concentration of different anions in water supply of different areas of Karachi city**

It can be observed from the above results that there is significant variation in the concentration of different cations and anions in water samples collected from different areas of Karachi city. Since there are two major sources of water supply to Karachi, namely River Indus and its associated lake such as Keenjhar lake in Sindh and the Hub river canal in Baluchistan, the variation in water quality parameters is most probably due to influxes of domestic waste water, industrial waste water and sewerage water from the waste water disposal pipelines due to incompact nature of these water supply and disposal channels. The concrete pipes are composed of calcium salts and are a source of addition of calcium and sulphate to water. The fluctuation in sodium, potassium and chloride is most probably due to waste from soap and leather industries. Therefore, there is a need to improve the water supply and water disposal infrastructure.

## Nitrite and Nitrate

Nitrate and nitrite ions are present in water streams in trace amounts but an excess amount of nitrate and nitrite ions is a possible indication of contamination from bio-sewage. An elevated level on nitrite and nitrate in drinking water causes a serious threat for pregnant women and newly born infants of less than 3 months age because of possible occurrence of Methaemoglobinaemia or "Blue Baby Syndrome" in which the blood loses its ability to carry sufficient oxygen. The removal of nitrites and nitrates can be accomplished by reverse osmosis and distillation although the most preferable precautionary measure is to eliminate the contamination source. The nitrite value was in the range of 0.003 to 0.025 $mg.L^{-1}$ while that of nitrate was 0.45 to 2.6 $mg.L^{-1}$. The oxidation of nitrite produces nitrate ions. The WHO and PSQCA recommended limit is 1.0 $mg.L^{-1}$ for nitrite ions. The WHO limit for nitrate ions in drinking water is 5.0 $mg.L^{-1}$.

## Dissolved Oxygen

Dissolved oxygen (DO) is a very important biochemical parameter for water quality assessment and it gives vital information about the biological activity going on in water. In our analysis, the dissolved oxygen was in the range of 3.4 to 7.2 $mg.L^{-1}$, which is very acceptable. The samples S6 and S13 have DO content less than 4 $mg.L^{-1}$, which is little less than recommended value of DO in drinking water. In general, water containing 5.0 $mg.L^{-1}$ of DO is considered as optimum for drinking use. The DO value of all the water samples is very much acceptable and suitable for drinking purpose. The WHO and PSQCA does not provide any guidelines for the concentration of dissolved oxygen in drinking water but most environmental scientists are of the opinion that the

concentration of dissolved oxygen in healthy drinking water should be at least 4 $mg.L^{-1}$ or greater.

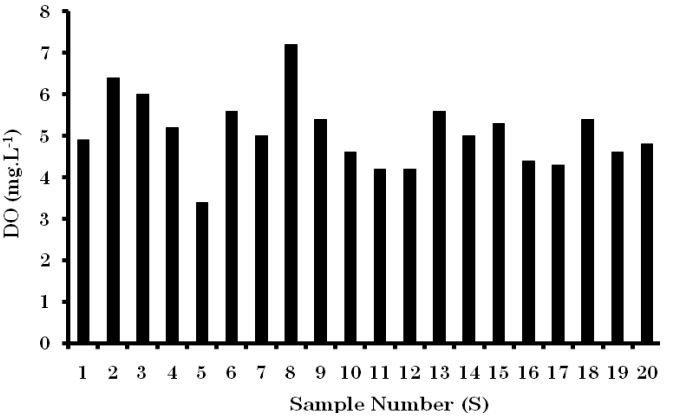


**Fig. 10. The concentration of DO in water supply of different areas of Karachi city**

## Biological Oxygen Demand

The BOD is a measure of bacterial contamination in water, which is an indirect indicator of water contamination by human/animal waste. In our analysis, the BOD of water samples is in the range of 0.50 to 2.60 $mg.L^{-1}$. The acceptable value of BOD is $\leq 1$ $mg.L^{-1}$ and if a drinking water supply had BOD greater than 1 $mg.L^{-1}$ it is susceptible to produce water borne infections and/or diseases. The samples S2, S8, S11, S12, S16, S17 and S18 have a higher BOD value than acceptable indicating bacterial contamination which can be due to pathogens giving rise to bacterial infections.

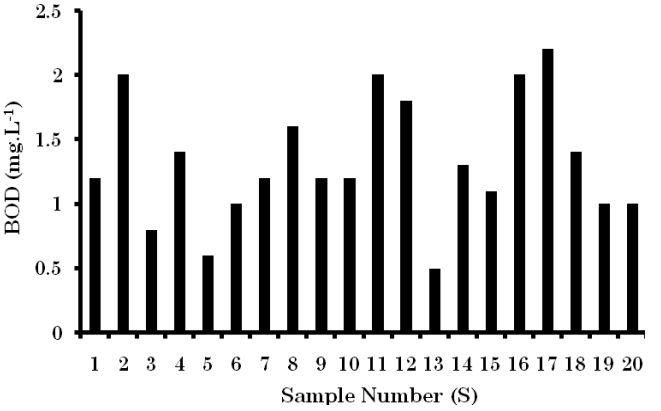


**Fig. 11. The BOD in water supply of different areas of Karachi city**

## Conclusion

The experimental values of different water quality parameters of all the water supply samples (S1 To S20) from Karachi city are tabulated in Table 2 and a comparison with WHO and PSQCA guidelines has been made. The standard deviation of the experimental results is also given to indicate the spread of the experimental data. All the water quality parameters of water samples selected from Karachi water supply were within WHO and PSQCA limits except that the concentration of sodium in a few samples exceeds the PSQCA limit. It must be emphasized that the PSQCA guidelines are those which are set for highly purified and chemically balanced bottled drinking water and are therefore much strict as compared to WHO guidelines. Therefore, if a chemical component of water exceeds the PSQCA limits, it does not render the water unfit for drinking and the value must also be compared with the WHO limits. The comparison of experimental values with the WHO and PSQCA guidelines leads us to the conclusion that the water supplied to Karachi is suitable for drinking in terms of its chemical composition. However, samples S2, S8, S11, S12, S16, S17 and S18 had unacceptably high biological oxygen demand

indicative of bacterial contamination and hence, must be processed through disinfection techniques (e.g. exposure to UV light) before its use as drinking water. In Karachi water supply, the most probable source of bacterial contamination is the sewerage discharge, which is usually flowing in pipelines parallel to that of drinking and household water and breakages in pipelines lead to contamination of water supply with the sewerage water.

As concluded from our results, the major water quality problem in Karachi is the microbiological contamination of water which can give rise to severe water borne diseases. In order to improve the microbiological quality of drinking water, the following measures can be taken on domestic and government scale.

## Suggestions for the Improvement of Water Quality on Domestic Scale

The following measures can be taken by the people on domestic level.

1. The water must either be boiled before drinking or disinfected through UV radiations.
2. To remove suspended impurities, the water must be passed through specific polypropylene cartridge filters that retain suspended particles of micrometer dimensions.

## Suggestions for the Improvement of Water Quality on Government Scale

The following measures can be taken by the government on district and/or city level.

1. The water supply and sewerage pipelines should be maintained in a good condition to avoid leakages and possible contamination of domestic water supply.
2. On a large scale, the water must be treated by UV radiations

at the water filter treatment plants installed by the government in different districts and towns of Karachi city.

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