Proceedings of the Pakistan Academy of Sciences:
A: Physical and Computational Sciences 58(4): 35-48 (2021)

ISSN (Print): 2518-4245; ISSN (Online): 2518-4253
https://doi.org/10.53560/PPASA(58-4)626

Pakistan Academy of Sciences

Research Article

Assessment of drinking water quality of household bore well plants and WASA water supply system: A case study of Allama Iqbal Town Lahore

Mahmoona Ashraf [1*], and Ifthikhar Ahmed[1]

National College of Business Administration and Economics, Lahore, Pakistan

Abstract: The current study has been completed by collecting the 20 water samples from Allama Iqbal Town Lahore, including ten from WASA (Water And Sanitation Agency) filter plants in Iqbal Town other samples were collected from different depths from Allama Iqbal Town Lahore. After the collection of water samples, these were taken to the green lab for physiochemical analysis of samples. Water samples were subjected to Physicochemical analysis that includes temperature, pH, Total Dissolved Solids, Total Hardness, Chloride, Arsenic, Cadmium, Sodium, Nickle, Fluoride. APHA techniques were used to analysis of water samples. Comparison of samples results with values given by the World Health Organization, represented by graphs and location maps. The Filtration plant and tap water samples were odourless, tasteless, and colourless. The amount of Lead in all the parameters was below the detectable level. Correlation analysis was applied to all the parameters to check out the deep relationship among all the parameters.The correlation results showed that with the increase of pH value, all studied traits values were increased except turbidity Physiochemical parameters in all water samples of WASA (Water And Sanitation Agency) filtration plants were within the permissible limits. It revealed that water samples of filtration plants were fit for drinking purposes. Physiochemical parameters in all water samples collected from the different depths of Lahore were not within the permissible limits, and it revealed that the tap water had arsenic amount and water collected from shallow depth have not permissible limit of sulphate, Total Hardness and Total Dissolved Solids. This showed that Tap water samples were unfit for drinking.

Keywords: WASA, Physiochemical, Filtration Plants, Permissible Limits

1. INTRODUCTION

Prior to modern medicine, industrialised countries used excellent water management to minimise the number of water-related illnesses. However, epidemics of water-borne diseases keep happening in many nations, sometimes with lethal results. In developing countries, preventable water-related diseases undermine the lives of the poor. Basic human rights include access to safe drinking water and appropriate sanitation to safeguard one's health. Assuring the availability of these resources will have a major impact on development health, and productivity. It's no longer possible for me to do business as normal. We don't have time to wait for large-scale infrastructure expenditures to offer these fundamental services to everyone who requires them. There are several basic interventions that may be implemented, such as increasing the quality of water used in families and enhancing family health education. Taking some of these steps can help the impoverished take control of their fate and better their lives. They must, however, understand what works and how to use this intervention. (Gro Harlem Brundtland).

Population increase, increases demand for the world's finite fresh water supply, placing strain on developed countries. Global population predictions show that by 2015, the world's more than 6 billion people will have grown by 20% to more than 7 billion, and by 2025, the world's population will have grown by 30% to 7.8 billion. Existing systems will be severely strained, necessitating a significant increase in drinking water to satisfy the demands of an expanding population. Pollution

Received: August 2021; Accepted: December 2021
*Corresponding Author: Mahmoona Ashraf <mahmoonaashraf1@gmail.com>

levels will rise as a result of population expansion and greater demand for water and other services, while agriculture will require more water to feed and nurture big populations [1].

Lahore is Pakistan's second-largest city. The major source of drinking water for the population is groundwater. Water samples from these pipe wells are frequently analysed for numerous water quality criteria in order to preserve water quality. It was keenly observed that over the past decade, the water pressure, due to Aquifers in Lahore, Kanwar and other regions have become a threat [2]. Its groundwater must be treated before being used for household and drinking purposes, as stirring was continued inside the contaminant material [2].

In underdeveloped nations, the major reason for poverty is poor water quality. As a result, increasing the quantity, quality, and sanitation of drinking water is essential. The United Nations' Sustainable Development Goals (SDG) Programs in target 6 have prioritised reducing waterborne illnesses [3]. However, Efforts to provide people with Safe Drinking Water have faced numerous challenges. Population growth, inadequate sanitation, and water pollution are all instances of this. Waste from the home and wastewater from industry [4, 5]. That shows despite global efforts to provide safe drinking water, the spread of water-borne diseases is still a major concern.

The study of physical and chemical parameters is very important for an accurate understanding of the quality of water [6]. Various physical, chemical parameters and analysis of untreated fertiliser wastewater were studied. The results showed that parameters such as chemical oxygen demand, biological oxygen demand, electrical conductivity, total dissolved solids, total suspended solids and ammonia amount were higher than the allowable limits of CPCB (1995). The Malt Extraction Agar (MEA) medium, 15 species of fungus were isolated, showing the pollution load of wastewater.

In International Islamic University, Islamabad, a study was conducted, the objective of this study was to examine the quality of water, Rawalpindi's second major source of drinking water through physical and chemical analysis, namely the water quality of the filtration plant and the water supplied by WASA (Water And Sanitation Agency) and conduct a comparative study according to World Health Organization standards. Water quality parameters such as Total Dissolved Solids (mg/L), conductivity (μS/cm), arsenic (ppb), turbidity (NTU), chloride (mg/L), fluoride (mg/L) and sulfate (mg/L) were analysed in the lab using standard methods. It was widely examined that the pH of filtered plant samples was relatively higher than the WASA (Water And Sanitation Agency) tube wells. The taste and colour of the two WASA (Water And Sanitation Agency) tube wells and filtered plants are unobtrusive and clear. WASA tube well (T.W.29) samples were observed maximum turbidity value 1.21±0.42 NTU, but no turbidity was observed in filtered plants. The average chloride value detected from samples collected in WASA pipe Wells is higher than the chloride level detected in the filtration device. The maximum fluoride value of the sample was 1.73±0.25 mg/l, collected from WASA tube well (T.W.1), but in the RCB filter device (F.P.47) the maximum value of fluoride observed was 0.51±0.1 mg/L.

Similarly, the conductivity of pipe well water is higher than that of the filtration plant. Arsenic levels observed in WASA filtered plant samples were almost twice as high as WASA tube well samples. From WASA tube well (T.W.6) and RCB filter device (F.P.55) samples collected observed maximum sulfate value 156±25mg/l and 68±11mg / L. Majority of the drinking water samples was gathered from WASA pipe wells and filtration plants in Rawalpindi, CCB, RCB, TMA and WASA are suitable for consumption in terms of aesthetic, physical and chemical quality parameters of water [7].

A study conducted in Haryana in which, Water samples were taken from the 67 Locations around the monsoon season of the year 2011 received from Kanal district, Haryana and Analysis of chemical properties. Types of water in the research field, sodium-calcium is dominated during salt and magnesium bicarbonate types in pre and The post monsoon season of 2011 and Based on the water chemical phase. The chemical analysis, before and after the monsoon water samples are divided into different standards irrigation standards to study. Chemical changes due to rain and nature charging this indicates that Na-Ca-HCO3 type water

Dominant in the pre-monsoon period, dominant in the post period Mg-HCO3 Monsoon season in 2011 [8].

In Pakistan's cities like Lahore, surface and water pollution area unit caused by the byproducts of varied industries like fertilisers, pesticides, cement textile, metal, dying chemicals, engineering, power, leather food process, organic compound, construction, steel, mining energy and, sugar process, and others. Pollution deteriorates and unfolds once Drains and canals carry industrial effluents, sewage and urban wastewater area units to rivers. The rise in water pollution causes a decrease in dissolved element (DO), increased total dissolved solids (TDS), Salinity and Common Market. Thus, water becomes unsuitable for drinking, irrigation functions, and aquatic life. So there is a high need to assess drinking water quality, so people get aware of contaminated water sources. [13]

2. MATERIALS AND METHODS

2.1 Study Area

Lahore is the most powerful metropolitan city of the territory Punjab, Pakistan. Topographically it is stretched out 31°15′ to 31°45′ in north and 74°01′ to 74°39′ in east over Asian plate. The Sheikhupura region rings Lahore in the north and east, which is bordered with India [9]. River Ravi, a well-known stream channel on the northwest side, serves as an official border between Sheikhupura and Lahore. There are numerous acceptable neighbourhoods lie in Lahore, Allama Iqbal town is one of them, and Allama Iqbal Town is a business and a private area in the south-western Lahore, Pakistan. The scope for Allama Iqbal Town, Lahore, Pakistan is: 31.513981 and the longitude is: 74.28542. Its scope in DMS is 31°30'50.33"N and its longitude is 74°17'7.51"E and rise 210.45 Meters (690.44 Feet). It is one of the great neighborhoods, so there is a need of acceptable water quality. WASA (Water And Sanitation Agency) has introduced numerous filtration plants, so it's important to survey the water nature of this zone.

2.2 Selection of Sampling Sites

Samples of water were collected from that part of the area where residential and commercial activities were taking place.

Total twenty water samples from simple random sampling, including ten from WASA (Water And Sanitation Agency) filter plants and ten tap water from bore wells, were taken for this study. Samples were collected from different adjoining blocks of Allama Iqbal Town, including Gulshan block, Hunza block, Huma block, Kashmir block, Rachna block, Pak block, and Chinab block points shown in table 1.

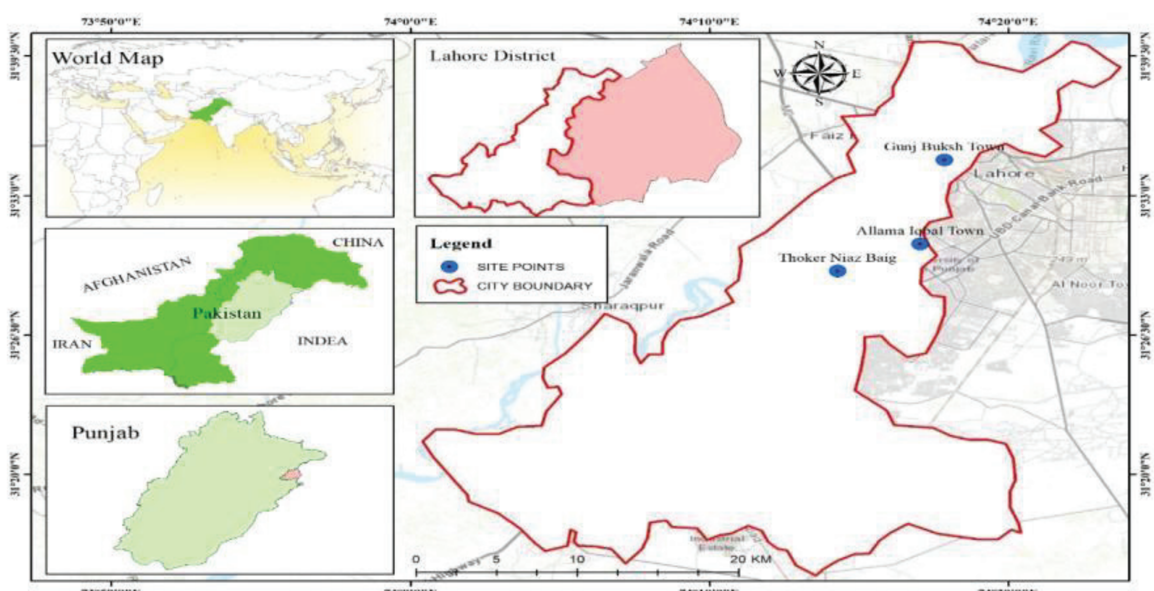

Fig. 1. Location Map of Study Area and Sampling Area

Table 1. Sample Collection Points of WASA filter Plants

Sample Numbers	Collection points
Sample No: 1	Gulshan Block
Sample No: 2	Kashmir Block (Wapda Flats)
Sample No: 3	Kashmir Block (Mosque)
Sample No: 4	Hunza Block
Sample No: 5	College Block
Sample No: 6	Pak Block
Sample No: 7	Rachna Block
Sample No: 8	Chinab Block
Sample No: 9	Huma Block
Sample No: 10	PU

After collection, samples have been brought into Pak Green lab to further analyse physiochemical parameters of samples techniques used for analysis elaborate below. The above Figure presents a map of the research area and sampling area. Health and safety measures were kept in view while samples were collected.

Random samples were collected from different depths of Allama Iqbal town, Physicochemical analysis of water samples will be done that includes temperature, pH, Total Dissolved Solids, Total Hardness, Chloride (Cl^{-1}), Arsenic, Cadmium, Sodium (Na), Nickle, Lead (Pb), Fluoride (F). APHA-4500-H+ B technique was used to analyse pH of the water sample, and APHA-2340 C technique was used to analyse the total dissolved solids of water samples.

Whereas, APHA-2340 C technique was used to analyse total hardness of water samples, APHA-4500-Cl B technique was used to analyse chloride of water samples, APHA-3111 B technique was used to analyse Arsenic of water samples. Moreover, APHA-3111 B technique was used to analyse Cadmium of water samples, and APHA-4500-SO4 C was used to analyse sulphate of water samples. Additionally, APHA-3113 B technique was used to analyse of Lead of water samples, and APHA-3111 D technique was used to analyse of Barium of water samples, and finally, APHA-4500-F-C technique was used to analyse Fluoride of water samples.

3. RESULTS

3.1 Physiochemical Characteristics of WASA (Water And Sanitation Agency) filter plants samples

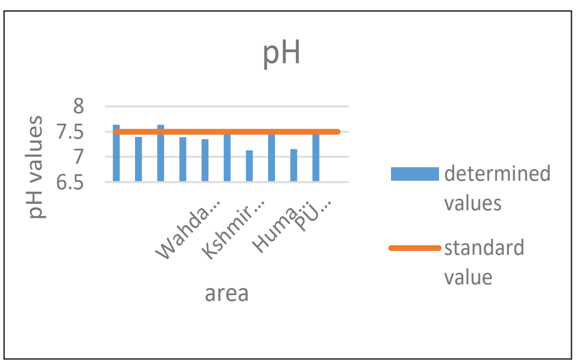

Fig. 2. Effect of pH on drinking water sample

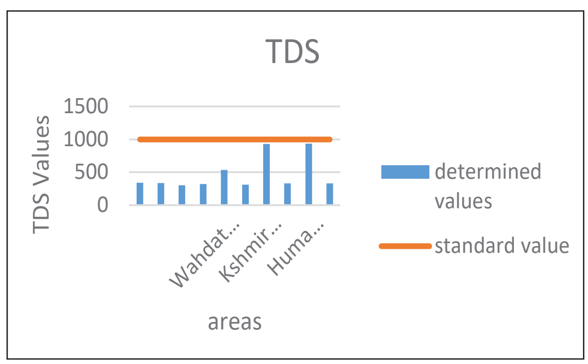

Fig. 3. Effect of TDS on drinking water samples

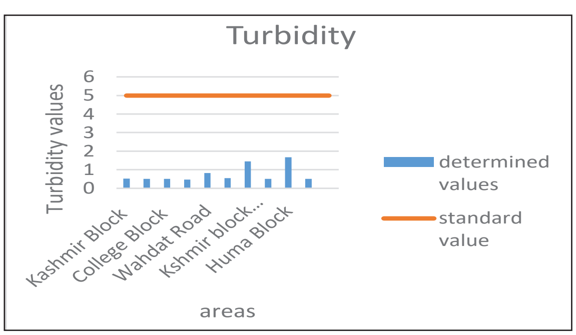

Fig. 4. Effect of turbidity on drinking water samples

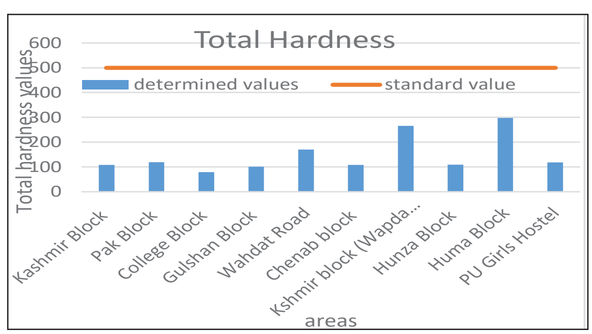

Fig. 5. Effect of TH on drinking water samples

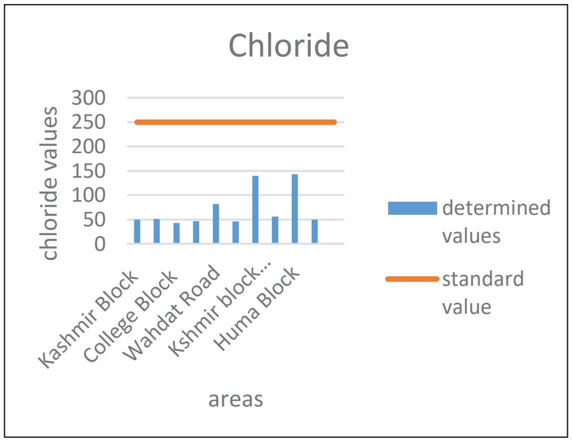

Fig. 6. Effect of chloride on drinking water samples

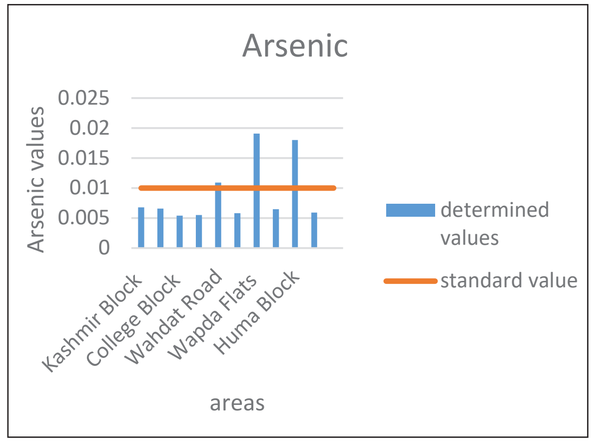

Fig. 7. Effect of Arsenic on drinking water samples

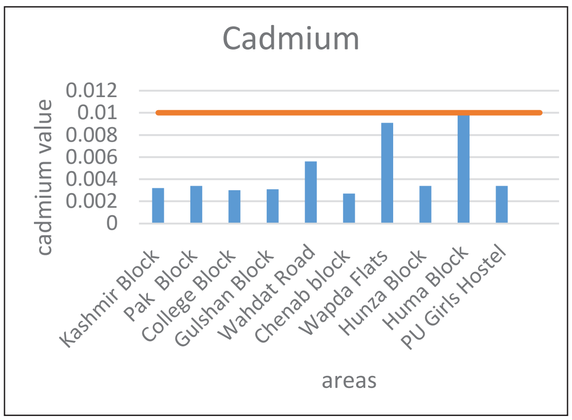

Fig. 8. Effect of cadmium on drinking water samples

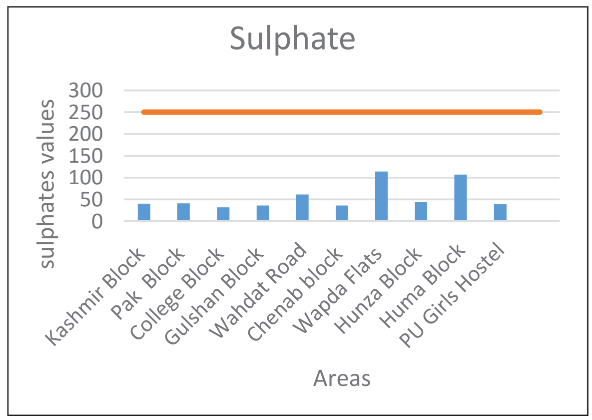

Fig. 9. Effect of sulphate on drinking water samples

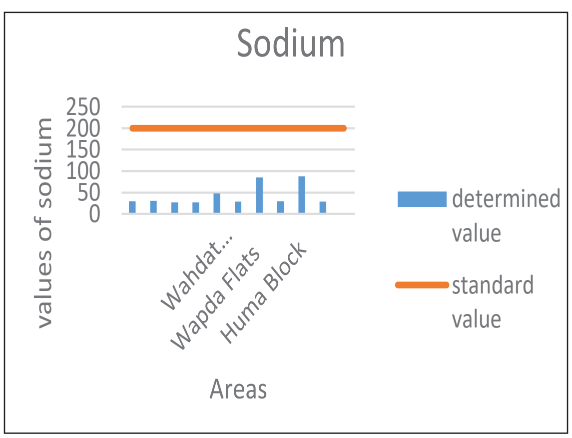

Fig. 10. Effect of sodium on drinking water samples

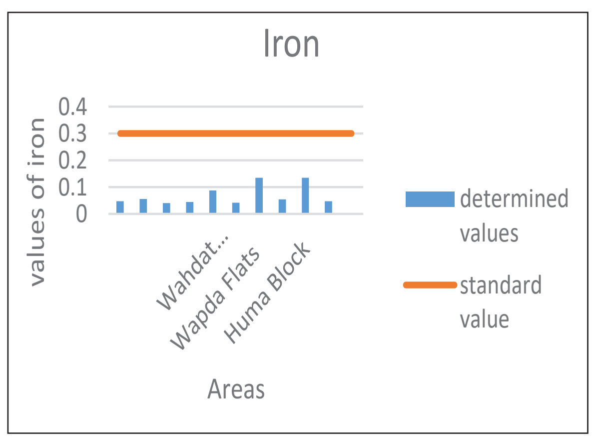

Fig. 11. Effect of Iron on drinking water samples

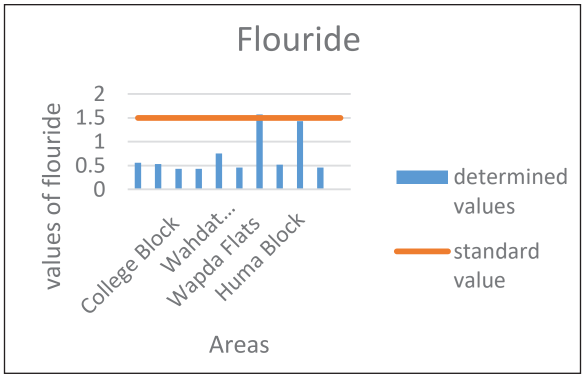

Fig. 12. Effect of Fluoride on drinking water samples

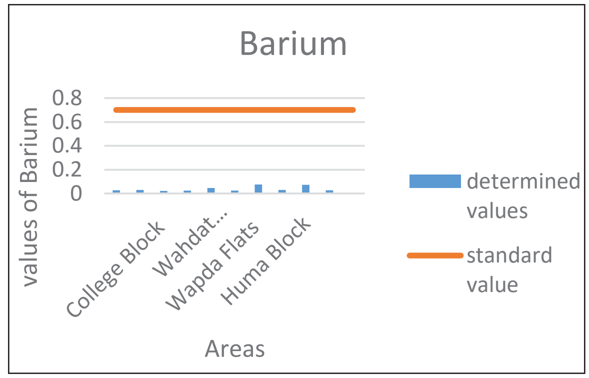

Fig. 13. Effect of Barium on drinking water sample

3.2 pH

The typical scope of the pH of the water is between 6.5-8.5. On the off chance that the pH of the water prior to apportioning water in the line isn't kept up, it can Causes lines and erosion Contamination and reasons for drinking water Bad taste, smell and color [10]. As seen in Figure 2, it is noticed that pH estimation of all sample of water tests is inside the suggested range (6.5-8.5). Advocacy by the World Health Organization rules standard for drinking water.

3.3 Turbidity

Turbidity is a characteristic of water that causes natural, suspended, and colloidal components to disperse and maintain light qualities of the water sample. As appeared in Figure 4, it is seen that all turbidity esteems Drinking water tests are underneath the Recommended range upheld by the world World Health Organization rules Drinking water principles. As the standard estimation of turbidity is 5NTU.

3.4 Total Hardness

Because of its remarkable solubilising characteristic, groundwater will be tougher than fresh water in general, especially for stones containing gypsum, calcite, and dolomite, which are responsible for water hardness. Contamination of groundwater by sewage and run-off from soils, particularly those with a limestone origin, can also produce hardness [11]. It is seen that all hardness esteems Drinking water tests are beneath the recommended range upheld by the World Health Organization rules Drinking water norms. As the standard estimation of turbidity is <500 mg/L.

3.5 Chloride

Chloride is available in drinking water. The most clear pungent impact is high Chloride wastewater and modern wastewater, Contains deicing salts and Saline intrusion is from common sources Chlorine in drinking water. As appeared in Figure 6, it is seen that Chloride esteems for samples of drinking water tests are inside the suggested range. Backing by the World Health Organization rules for drinking water and the mean estimation of chloride is 70.8000, and results shows that the chloride level of the relative multitude of tests are protected from extreme degree of chloride

3.6 Arsenic

Arsenic is a normally happening component, yet long haul openness can cause malignant growth in individuals the standard estimation of arsenic given by World Health Organization is 0.010 mg/L. As appeared in the figure 6 all the samples having controlled values of arsenic, and safe for drinking purpose.

3.7 Cadmium

Cadmium happens normally in zinc, in Lead and copper metals, in coal and other petroleum products, in shale's and is delivered during volcanic activity. As appeared in Figure 8, it is seen that Cadmium esteems for all drinking water tests are inside the suggested range. Suggested by the World Health Organization (WHO) rules for drinking which 0.01

mg/L Water, and results shows that the cadmium level of the multitude of tests are protected from unreasonable degree of cadmium.

3.8 Sulphate

As appeared in Figure 9, it is seen that sulfate esteems for all drinking water tests are inside the suggested range. Promotion by the World Health Organization (WHO) rules for drinking 250 mg/L Water. Results show that the sulfate level of the relative multitude of tests are protected from the unreasonable degree of sulfate and the water is alright for drinking reason. Sulpahte levels over 250 mg/L may make the water taste severe or like medication. Significant level of sulfate can likewise consume plumbing, especially copper funneling. In regions where the sulfate level is high, plumbing materials more impervious to consumption, for example, plastic line, are generally utilised.

3.9 Sodium

As appeared in Figure 10, it is seen that sodium esteems for all drinking water tests are within the suggested range. Advocacy by the World Health Organization (WHO) rules for drinking 200 mg/L Water, and results show that the cadmium level of the relative multitude of tests is protected from over the top degree of sodium, and the water is alright for drinking reason.

3.10 Lead (Pb)

Concentration of Lead in all the water samples are below detectable level.

3.11 IRON (Fe)

Fe is regularly present in fresh water as salts comprising Fe(III) when the pH is over 7. As appeared in Figure 11, it is seen that iron qualities for all drinking water tests are within the suggested range. Advocacy by the World Health Organization rules for drinking which 0.3 mg/L Water.

3.12 Barium (Ba)

As appeared in Figure 13, it is seen that Barium esteems for all drinking water tests are inside the suggested range. Support by the World Health Organization (WHO) rules for drinking which 0.7 mg/L Water. Results show that the barium level of the multitude of tests is protected from extreme degree of barium, and the water is alright for drinking reason.

3.13 Flouride (F)

Fluoride itself might be hazardous at elevated levels. Inordinate fluoride produces flourosis alterations in tooth lacquer that vary from scarcely observable white spots to stain and pitting. So there should not be high measure of fluoride present in drinking water. As appeared in Figure 12, it is seen that Fluoride esteems for all drinking water tests are inside the suggested range, suggested by the World Health Organization (WHO) rules for drinking which 1.5 mg/L.

3.14 Physiochemical Characteristics of samples collected from household bore wells

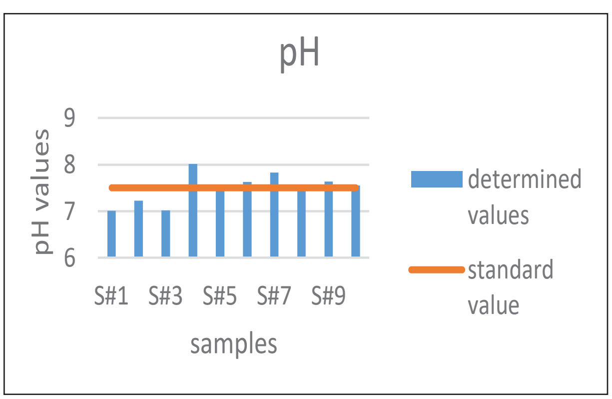

Fig. 14. Effect of pH on drinking water sample

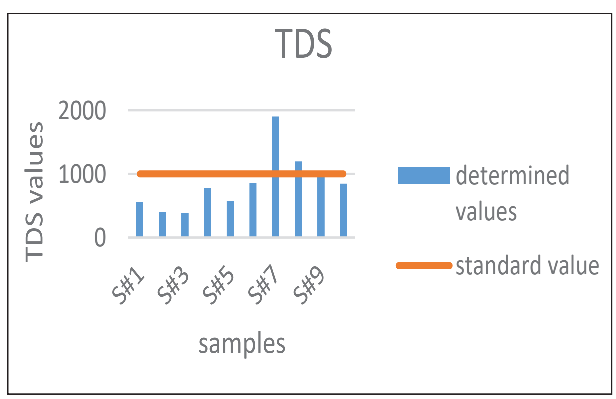

Fig.15. Effect of TDS on drinking water sample

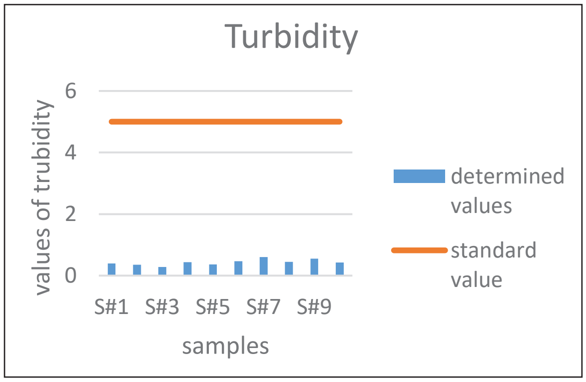

Fig. 16. Effect of Turbidity on drinking water sample

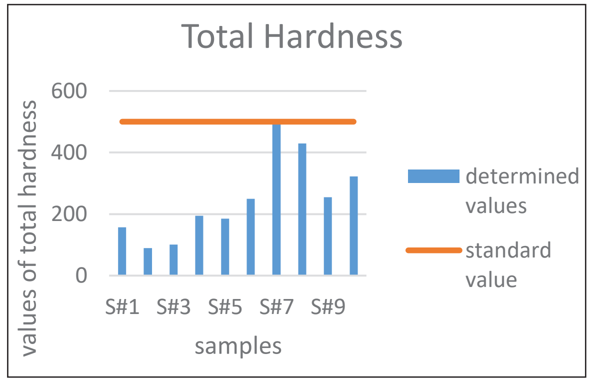

Fig. 17. Effect of TH on drinking water sample

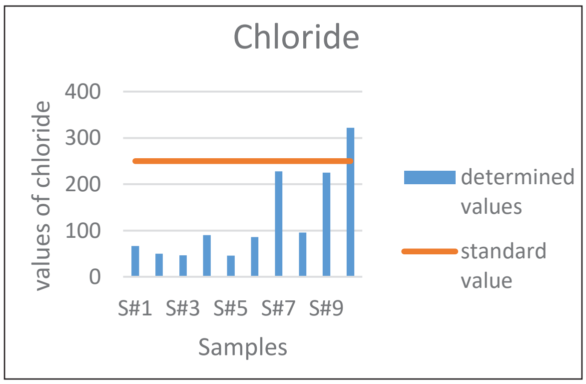

Fig. 18. Effect of Chloride on drinking water sample

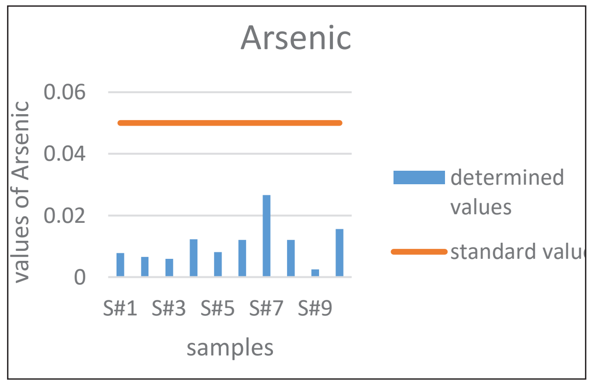

Fig. 19. Effect of Arsenic on drinking water sample

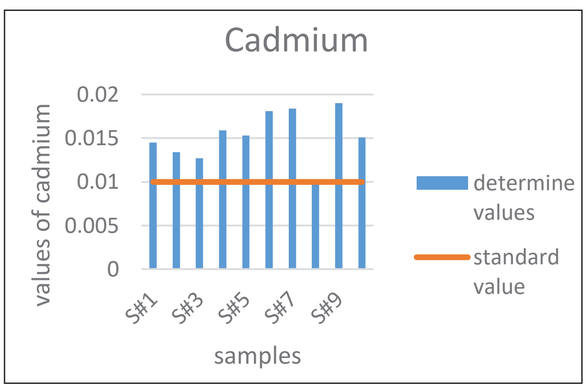

Fig. 20. Effect of Cadmium on drinking water sample

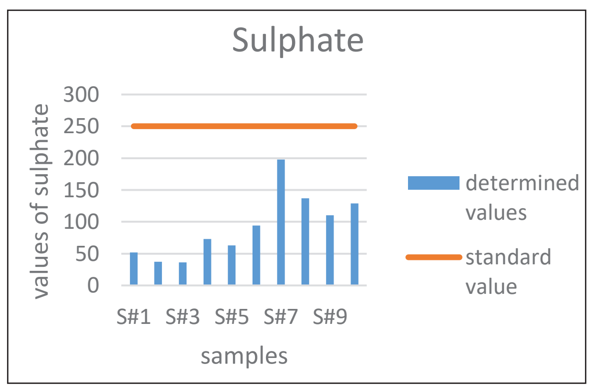

Fig. 21. Effect of Sulphate on drinking water sample

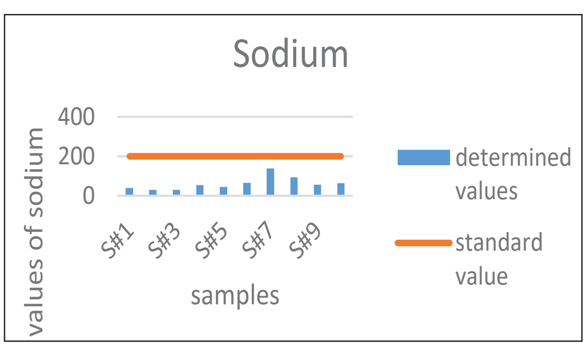

Fig. 22. Effect of Sodium on drinking water sample

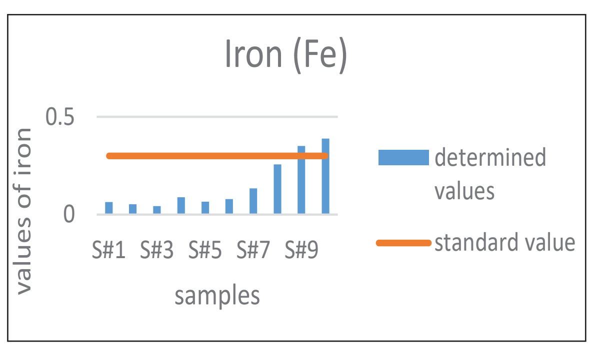

Fig. 22. Effect of Iron on drinking water sample

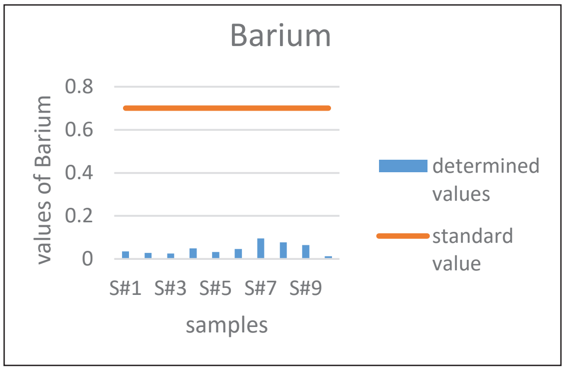

Fig. 24. Effect of Barium on drinking water sample

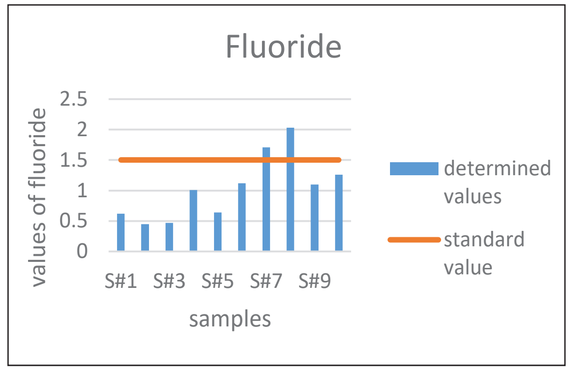

Fig. 25. Effect of Flouride on drinking water sample

3.15 pH

As shown in Figure 14, samples collected from different depths in Allama Iqbal Town it is observed the pH value of all samples of drinking water is not within the recommended limit (6.5-8.5) only one sample have pH value of 7 and all other samples having more pH than 7.

3.16 TDS

As demonstrated in Figure 15, all TDS levels in samples collected are within the WHO's recommended range. Except for the values of sample # 7 and sample # 8, the TDS range of the samples collected from different depths in Allama Iqbal Town is good.

3.17 Turbidity

As shown in Figure 16, it is observed that all turbidity values of Drinking water samples collected from Allama Iqbal Town are below the Recommended range advocated by the world World Health Organization guidelines Drinking water standards. As the standard value of turbidity is 5NTU. As we go deep down the turbidity of the sample decreases and water gets clean. So the water of Allama Iqbal town is collected from different depths having no turbidity.

3.18 Total Hardness

As shown in Figure 17, it is observed that all hardness values Drinking water samples collected from Allama Iqbal Town Lahore are below the Recommended range advocated by the world World Health Organization guidelines Drinking water standards. As the standard value of turbidity is <500 mg/L.As we go deep down water has a lower level of hardness, so the water of this area has a normal range of total hardness.

3.19 Chloride

As shown in Figure 18, it is detected that Chloride values for collected water samples collected from Allama Iqbal Town are within the recommended range except for the water sample (sample# 10) collected from the shallow depth have the high value of chloride, Advocacy by the World Health Organization guidelines for drinking water and results shows that the chloride level of all the samples is safe from an excessive level of chloride.

3.20 Arsenic

As shown in Figure 19 all the samples collected from Allama Iqbal Town have the same value as recommended value. So all the samples have controlled values of arsenic, and are safe for drinking purposes.

3.21 Cadmium

As shown in Figure 20, it is examined that Cadmium values for all collected samples of water from Allama Iqbal Town are not within the recommended range. Advocacy by the World Health Organization guidelines for drinking which 0.01 mg/L Water and results show that the cadmium level of all the samples is not safe from an excessive level of cadmium, and not safe for drinking purposes.

Table 2. Correlation among all studied Variables

		pH	TDS (mg/L)	Turbidity (mg/L)	Total Hardness (mg/L)	Chloride (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Sulphate (SO4-2) (mg/L)	Sodium (Na) (mg/L)	Iron (Fe) (mg/L)	Barium (Ba) (mg/L)	Fluoride (F) (mg/L)
pH	Pearson Correlation	1	.306	-.301	.269	.229	.009	.451*	.289	.220	.197	.146	.187
	Sig. (2-tailed)		.189	.197	.252	.330	.971	.046	.217	.351	.404	.540	.429
	N	20	20	20	20	20	20	20	20	20	20	20	20
TDS (mg/L)	Pearson Correlation	.306	1	.276	.961**	.695**	.617**	.856**	.974**	.972**	.540*	.848**	.892**
	Sig. (2-tailed)	.189		.239	.000	.001	.004	.000	.000	.000	.014	.000	.000
	N	20	20	20	20	20	20	20	20	20	20	20	20
Turbidity (mg/L)	Pearson Correlation	-.301	.276	1	.289	.231	.452*	-.135	.318	.445*	.095	.507*	.443
	Sig. (2-tailed)	.197	.239		.216	.326	.045	.571	.172	.049	.690	.022	.051
	N	20	20	20	20	20	20	20	20	20	20	20	20
Total Hardness(mg/L)	Pearson Correlation	.269	.961**	.289	1	.723**	.604**	.833**	.982**	.957**	.648**	.780**	.948**
	Sig. (2-tailed)	.252	.000	.216		.000	.005	.000	.000	.000	.002	.000	.000
	N	20	20	20	20	20	20	20	20	20	20	20	20
Chloride (mg/L)	Pearson Correlation	.229	.695**	.231	.723**	1	.491*	.569**	.800**	.641**	.861**	.395	.647**
	Sig. (2-tailed)	.330	.001	.326	.000		.028	.009	.000	.002	.000	.085	.002
	N	20	20	20	20	20	20	20	20	20	20	20	20
Arsenic (mg/L)	Pearson Correlation	.009	.617**	.452*	.604**	.491*	1	.359	.639**	.717**	.106	.408	.530*
	Sig. (2-tailed)	.971	.004	.045	.005	.028		.120	.002	.000	.656	.074	.016
	N	20	20	20	20	20	20	20	20	20	20	20	20

		pH	TDS (mg/L)	Turbidity (mg/L)	Total Hardness (mg/L)	Chloride (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Sulphate (SO4-2) (mg/L)	Sodium (Na) (mg/L)	Iron (Fe) (mg/L)	Barium (Ba) (mg/L)	Fluoride (F) (mg/L)
Cadmium (mg/L)	Pearson Correlation	.451*	.856**	-.135	.833**	.569**	.359	1	.832**	.764**	.510*	.631**	.677**
	Sig. (2-tailed)	.046	.000	.571	.000	.009	.120		.000	.000	.022	.003	.001
	N	20	20	20	20	20	20	20	20	20	20	20	20
Sulphate (SO4-2) (mg/L)	Pearson Correlation	.289	.974**	.318	.982**	.800**	.639**	.832**	1	.960**	.670**	.786**	.924**
	Sig. (2-tailed)	.217	.000	.172	.000	.000	.002	.000		.000	.001	.000	.000
	N	20	20	20	20	20	20	20	20	20	20	20	20
Sodium (Na) (mg/L)	Pearson Correlation	.220	.972**	.445*	.957**	.641**	.717**	.764**	.960**	1	.467*	.868**	.923**
	Sig. (2-tailed)	.351	.000	.049	.000	.002	.000	.000	.000		.038	.000	.000
	N	20	20	20	20	20	20	20	20	20	20	20	20
Iron (Fe) (mg/L)	Pearson Correlation	.197	.540*	.095	.648**	.861**	.106	.510*	.670**	.467*	1	.325	.644**
	Sig. (2-tailed)	.404	.014	.690	.002	.000	.656	.022	.001	.038		.162	.002
	N	20	20	20	20	20	20	20	20	20	20	20	20
Barium (Ba) (mg/L)	Pearson Correlation	.146	.848**	.507*	.780**	.395	.408	.631**	.786**	.868**	.325	1	.824**
	Sig. (2-tailed)	.540	.000	.022	.000	.085	.074	.003	.000	.000	.162		.000
	N	20	20	20	20	20	20	20	20	20	20	20	20
Fluoride (F) (mg/L)	Pearson Correlation	.187	.892**	.443	.948**	.647**	.530*	.677**	.924**	.923**	.644**	.824**	1
	Sig. (2-tailed)	.429	.000	.051	.000	.002	.016	.001	.000	.000	.002	.000	
	N	20	20	20	20	20	20	20	20	20	20	20	20

3.22 Sulphate

As shown in Figure 21, it is examined that sulphate values for all collected samples from Allama Iqbal Town Lahore are within the recommended range. Advocacy by the World Health Organization guidelines for drinking water which 250 mg/L, and results shows that the sulphate level of all the samples are safe from an excessive level of sulphate, and the water is safe from an excessive amount of sulphate.

3.23 Sodium

As shown in Figure 22, it is observed that sodium values for all drinking water samples collected from Allama Iqbal Town Lahore are within the recommended range. Advocacy by the World Health Organization (WHO) guidelines for drinking water which is 200 mg/L, and results show that the sodium level of all the samples are safe from an excessive level of sodium, and the water is safe for drinking purposes.

3.24 Lead (Pb)

Concentration of Lead in all the water samples are below the detectable level.

3.25 Iron

As shown in Figure 23, it is observed that iron values for all drinking water samples collected from Allama Iqbal Town Lahore are within the recommended range. Advocacy by the World Health Organization guidelines for drinking water which 0.3 mg/L and results show that the iron level of all the samples are safe from an excessive level of iron, and the water is safe for drinking purposes.

3.26 Barium

As shown in Figure 24, it is observed that Barium values for all drinking water samples collected from Allama Iqbal Town Lahore are within the recommended range. Advocacy by the World Health Organization guidelines for drinking water which is 0.7 mg/L, and results show that the barium level of all the samples is safe from excessive barium level, and the water is safe for drinking purposes.

3.27 Fluoride

As shown in Figure 25, it is observed that fluoride values for all drinking water samples collected from Allama Iqbal Town Lahore are not within the recommended range. Advocacy by the World Health Organization guidelines for drinking water which 1.5 mg/L. Fluoride value depends upon the depth of the sample as samples collected from the deep depth value of fluoride is less and samples taken from shallow depth value of fluoride is more. Results show that the fluoride level of all the samples are not safe from an excessive level of Fluoride, and the water is safe for drinking purpose, samples that were taken from shallow depth have high fluoride amount as compared to the samples taken from a deep depth.

3.28 Correlation Analysis

The pH was positively correlated with TDS, Total Hardness, Chlorides, Arsenic, Cadmium, sulphate, sodium, Iron and Floride while the negative correlation with Turbidity (mg/L). TDS was positively correlated with turbidity, total hardness, chloride, arsenic, cadmium, sulphate, sodium, iron, barium, and fluoride. The turbidity was positively associated with Total hardness, chlorides, arsenic, sulphate, sodium, iron, and Barium while a negative association was found with cadmium. The hardness was positively correlated with Chlorides, arsenic, cadmium, sulphates, sodium, iron, barium, and fluorides. Chlorides were positively associated with Arsenic, cadmium, sulphate, sodium, iron, barium, and fluoride. Arsenic was positively correlated with Cadmium, sulphate, sodium, iron, barium, and fluorides. The correlation results showed that with the increase of pH value all studied traits values were increased except turbidity as shown in Table 1.

4. CONCLUSION AND RECOMMENDATIONS

Analysis of Physicochemical parameters that includes pH, Total Dissolved Solids, Total Hardness, Chloride Content, Cadmium, Arsenic, fluoride, Barium, Iron, Sodium, Sulphate and Lead. Analysis of 20 different water samples has been collected 10 from WASA(Water And Sanitation Agency) filter plants and 10 from Allama Iqbal

Town,. It is concluded that:

- o All the tap water samples and Filtration plant samples were tasteless, odourless, and colourless and the amount of Lead in all the parameters were below the detectable level.
- o Physiochemical parameters in all water samples of WASA filtration plants were within the permissible limits and this showed that the water samples of filtration plants were fit for drinking purposes and working efficiently.
- o Physiochemical parameters in all water samples collected from the different depths of Lahore were not within the permissible limits and this showed that the tap water has arsenic amount and water collected from shallow depth have not permissible limit of sulphate, total hardness and Total Dissolved Solids. This showed that Tap water samples were unfit for drinking.
- o Hence it is suggested that, to control water defilement and to adequately actualise quality norms for drinking water preventive estimates should be taken at all water treatment plants and water conveyance frameworks.
- o For observing of water quality financially savvy system ought to be expected. To improve existing water conveyance foundation, broad assets ought to be submitted. For the upkeep of drinking water quality principles, public mindfulness ought to be set up.
- o The World Health Organization and national drinking water authorities should add 5 ppm of the florid element to the drinking water quality standard since it is required for proper tooth growth.
- o Drinking water quality standards for pathogenic microorganisms and their toxins should be included in World Health Organization and Pakistan drinking water recommendations.
- o Toxins limitations that should be included in World Health Organization World Health Organization and Pakistani drinking water quality standards, and these standards must be enforced globally, including in Pakistan.
- o The general cleanliness and hygiene of water at main stage reservoirs must be maintained on a regular basis, and district and federal governments must set guidelines.
- o For the preservation of the general public's health, the local municipality should include appropriate professional disciplines, particularly environmentalists, doctors, and town planners, while making water-use choices.
- o Further study could be hung on the evaluation of E-coli microbes and organic boundaries for the WASA channel plants and family unit bore wells.

5. ACKNOWLEDGEMENT

I owe my acknowledgement to Dr. Rizwan for his valuable contribution to my study.

6. REFERENCES

1. World Health Organization. Poverty and health: Geneva, WHO, (1999)., (Document EB105/5).
2. S. Kanwal . Lahore's groundwater depletion-A review of the aquifer susceptibility to degradation and its consequences, Technical Journal, University of Engineering and Technology (UET) Taxila., Vol: 20(1) Pp: 26-38 (2015).
3. UN, Transforming Our World: the 2030 Agenda for Sustainable Development, UN, New York, NY, USA, 2015. Retrieved from: https://sustainabledevelopment.un.org/post2015/transformingourworld.
4. N. D. Troyer . Water quality assessment of streams and wetlands in a fast growing East African city, Water., Vol: 8(4)., Pp: 123 (2016).
5. Z. A. Alemu, K. T. Teklu, and T. A. Alemayehu . Physicochemical quality of drinking water sources in Ethiopia and its health impact: a retrospective study., Environmental *Systems Research.,* Vol: 4(1). Retrieved from: https://environmentalsystemsresearch.springeropen.com/articles/10.1186/s40068-015-0049-7 (2015).
6. B. A. Begum, S. K. Biswas, E. Kim, P. K. Hopke, and M. Khaliquzzaman . Investigation of Sources of Atmospheric Aerosol at a Hot Spot Area in Dhaka, Bangladesh. J. Air Waste Manage. Assoc. 55: 227–240 (2005).
7. M. Islamuddin, A. Farooque, B. S. Dwarakanath, D. Sahal, and F. Afrin . Extracts of Artemisia annua leaves and seeds mediate programmed cell death in Leishmania donovani. *Journal of medical microbiology*, 61(12), 1709-1718 (2012).
8. G. B. Tomar, R. K. Srivastava, N. Gupta, A. P. Barhanpurkar, S. T. Pote, H. M. Jhaveri, and M. R. Wani . Human gingiva-derived mesenchymal stem cells are superior to bone marrow-derived mesenchymal stem cells for cell therapy in

regenerative medicine. *Biochemical and biophysical research communications*, 393(3), 377-383 (2010).

9. A. M. Muhammad, and T. Zhonghua . Municipal solid waste and its relation with groundwater contamination in Lahore, Pakistan., *Research Journal of Applied Sciences, Engineering and Technology.,* Vol:7(8) Pp: 1551-1560 (2014).
10. D. G. Haleem . Exaggerated feedback control decreases brain serotonin concentration and elicits hyperactivity in a rat model of diet-restriction-induced anorexia nervosa. *Appetite,* 52(1), 44-50 (2009).
11. L. Olumuyiwa, A. Fred, and M. Ochieng . Characteristics, qualities, pollutions and treatments of water in Durban, South Africa., *International Journal of Water Resources and Environmental Engineering,* Vol: 4(6), Pp: 162-170 (2012).
12. M. S. Akhtar, J. Panwar, and Y. S. Yun . Biogenic synthesis of metallic nanoparticles by plant extracts. *ACS Sustainable Chemistry & Engineering,* 1(6), 591-602 (2013).
13. EPA, (1996). U.S. Environmental Protection Agency, American Society of Civil Engineers, and American Water Works Association. Technology Transfer Handbook: Management of Water Treatment Plan Residuals. EPA/625/R-95/008. Washington DC.