A STUDY OF PHYSICO-CHEMICAL CHARACTERISTICS OF DRINKING WATER OF BALH TEHSIL, DISTRICT MANDI, HIMACHAL PRADESH, INDIA

Sunali Mahajan[1], Anu Shree Gupta [2] & S.C. Chauhan[3]
Department of Chemistry, School of Sciences, Abhilashi University, Chailchowk Mandi, Himachal Pradesh – 175028 (INDIA)

[1] E-mail: sunaligupta_in@yahoo.com)

ABSTRACT:

Water is an important natural resource for the survival and sustenance of the living organisms. Its importance ranges from domestic, industrial to irrigation activities. Deterioration of the purity of water by the anthropogenic activities like urbanization, population growth, industrial production, climate change, agriculture is increasing also in Himachal Pradesh. Balh Tehsil, District Mandi makes up one of the developed zones of Himachal Pradesh with increased use of water for drinking and agriculture with the use of composts, fertilizers and pesticides. With the aim to study the physico-chemical characteristics of drinking water for public, water samples from ten sites were collected and analyzed for different characteristics (Colour, Odour, Temperature, pH, Turbidity, TDS, TSS, Conductivity, Total hardness and Alkalinity). Season-wise results revealed that the mean values of most of the characteristics were within the BIS/ WHO permissible standards in all the seasons.

Keywords: *IPH water supply, hand-pump water supply, drinking water quality, physico-chemical characteristics, Balh Tehsil.*

1. INTRODUCTION

Water is the most abundant compound present on this earth (Sharma and Walia ,2016., Sagar et.al, 2015., Basavaraja et al., 2011). It is indispensable element to life (Keerthika et.al ,2019., Joshua and Nazrul Islam ,2015., Shukla et.al,2013., Nabila et.al, 2014). Water of seas, oceans, lakes, rivers, springs and streams is being contaminated by the anthropogenic and natural activities due to which pure water is becoming scarcer and thus a cause of social and economic concern. Life can not survive without water on this planet (Kumar and Tripathi, 2000).

75% of the surface of earth is covered with water. But the need of people for water is a challenge because only small portion (2.5%) is fresh water out of which 68.9% exists as ice, 29.9% as ground water, 0.3% as river and lake water and 0.9% as soil moisture leaving with very small amount to be used by the people for different purposes (Water and related statistics, 2013). Due to the scarcity of water many people in the world do not get clean water. India figures at the top in the list of the number of the people not getting clean and safe water.

India is the home of one hundred thirty-three crore people and has about 4% of the world's fresh water resources at its disposal (Gangwar,2013., Suhag ,2016). These water resources are categorized as surface water and ground water. These sources are the main sources of drinking water.

India is facing the crisis of shortage of water due to the misuse and being polluted. The pollutants present in the ground water are heavy metals, chlorides, fluorides, nitrites, nitrates, sulphates and phosphates etc. The disease causing bacteria, viruses and pesticides may also be found in contamination with ground water. These contaminations are due to polluting of water with domestic waste, municipal waste, biomedical waste, landfills, septic tanks and pit latrines that deteriorate the nature of water. Detection of the cause of degradation of the nature of water is difficult as the problem is masked by the surface of earth. The contamination and pollution of the ground water being serious, efforts should be made to control these and ground water quality be monitored regularly to ensure the water is safe, usable and acceptable.

Water quality is determined by the physico-chemical and biological characteristics of the water reservoirs. This determines how well the quality of water supports the processes of the ecosystem. Water supply for drinking purpose in Balh Tehsil is (I) IPH department piped distribution system (II) Ground water system. Ground water acts as the primary source for both human consumption and plant production. Ground water contains mineral ions derived from rocks when water runs along the mineral surfaces facing the water body (Harter, 2003). The quality parameters of the water are also changed by factors like climate, slope, drainage conditions and time for which it stays at a particular locality (Pandey and Tiwari, 2009). This water is also contaminated by fertilizer and pesticides used in farming and seepage of effluent to water body.(Adekunle, 2009).

The study is, therefore, aimed to assess the physico-chemical characteristics of drinking water of Balh Tehsil, District Mandi, Himachal Pradesh. Before the determination of these parameters we must understand the location, topography, soil, climate, natural processes and anthropogenic activities of the region of study i.e Balh Tehsil, District Mandi, Himachal Pradesh.

1.1 Location: Mandi, Himachal Pradesh, India.

District Mandi is centrally located in Himachal Pradesh in the Shivalik Hills of Himalayas. Balh Tehsil is centrally located in District Mandi with its location co-ordinates as 31.5968^0 N and 76.9256^0 E. It is surrounded by Sundernagar, Karsog, Chachyot, Sadar Mandi, Rewalsiar and Baldwara Tehsils of District Mandi. The Tehsil is the medley of hills and valley with altitudes varying from 900 meters to 1189 meters above mean sea level. The Tehsil receives the rainfall throughout the year, 80% of the total annual rainfall in the months of July, August and September. The maximum temperature is reported as about 42^0C.

2. MATERIALS AND METHODS

Samples of drinking water were collected from ten locations of Balh Tehsil (Table 1) during the day time. Samples were collected from the public tap water and hand-pump water (ground water), in the months of June, August and November 2019. The samples were taken in clean polythene bottles of one litre capacity without any air bubbles. The well stoppered bottles were first prewashed with detergent and then rinsed with 10% HNO_3 acid, distilled water and sampling water respectively. Water was collected in the bottles after allowing it to run for about 10 minutes from the tap and hand-pump at each sampling station. The bottles were tightly stoppered and labelled. They were then brought to the laboratory and stored at 4^0C till were subjected to analysis. Standard methods (APHA-2012) were followed for the handling and analysis of samples in the laboratory. The samples were tested for various physico-chemical characteristics (Table 2).

Table 1: Detail of samples of drinking water obtained from different sampling locations.

Sr. No	Sample No.	Sampling station	Sampling location	Water Supply
1	S-1	Nerchowk	Abhilashi Campus	IPH
2	S-2	Nerchowk	Abhilashi Campus	Hand-pump
3	S-3	Bhangrotu	Near Govt.Sr.Sec. School	IPH
4	S-4	Bhangrotu	Near Govt.Sr.Sec. School	Hand-pump
5	S-5	Kanaid	Near Govt.Sr.Sec. School	IPH
6	S-6	Kanaid	Near Govt.Sr.Sec. School	Hand-pump
7	S-7	Lohara	Near Bus Stop	IPH
8	S-8	Lohara	Near Bus Stop	Hand-pump
9	S-9	Rati	Near Govt. Hospital	IPH
10	S-10	Rati	Near Govt. Hospital	Hand-pump

Table 2: Physico-chemical characteristics, their measuring units and methods of analysis.

S.No	Physico-chemical characteristics	Unit	Method
1	Colour	Hazen	Spectrophotometric Method
2	Odour	TON	Threshold odour number Method
3	Temperature	^{0}C	Thermometry
4	pH	-	Electronic meter
5	Turbidity	NTU	Nephelometric Method
6	Conductivity	µS/cm	Conductimetric Method
7	TDS	mg/l	Gravimetric Method
8	TSS	mg/l	Filtration Method
9	Total hardness	mg/l	EDTA Method
10	Alkalinity	mg/l	Titrimetric Method

3. RESULTS AND DISCUSSION

Color : The colour of the samples was determined from the original water samples without filtration. It was noted by direct observation for all the water samples. They were found colourless and clear.

Odour: Odour is due to the presence of chemicals in the water. These chemicals originate from the decomposition of vegetable matter , municipal and industrial waste discharges by microbial activity .A direct inspection of the water samples for odour was carried out and found the samples odourless.

Temperature: It is very important parameter and decides the ecology of the area, solubility of salts and gases in the water. It was recorded in degree Celsius with the help of mercury thermometer. The mean temperatures of pre-monsoon ,monsoon, post -monsoon period of IPH water supply were 24.3^0C, 32.16^0C, 15.3^0C whereas those for hand-pump water supply 22.3^0C, 30.3^0C, 20.7^0C. The higher temperatures recorded in pre-monsoon and monsoon seasons were due to the prolonged sunshine and weather condition of the area whereas the lower temperature recorded during post monsoon season might be due to the cold weather leading to lower atmospheric temperature. The higher temperature of the hand-pump water supply than that of IPH water supply during post monsoon season might be due to the lower atmospheric temperature than that of down the earth.

Table3 (A):- IPH Water Supply Results of analysis of water samples for quality parameter (Temperature values)

S. No.	Season (2019)	Month	Sample No.					Min.	Max.	Mean	Std Dev.	BIS Standards	WHO Standards
			S-1	S-3	S-5	S-7	S-9						
1	Pre Monsoon	Jun.	24.1	24.4	24.3	24.4	24.1	24.1	24.4	24.26	0.152	No std.	30o C
2	Monsoon	Aug.	32.2	32.1	32.3	32.2	32	32	32.3	32.16	0.114		
3	Post Monsoon	Nov.	15	15.5	15.1	16	15	15	16	15.32	0.432		

Table 3(B):- Hand-Pump Water Supply Results of analysis of water samples for quality parameter (Temperature values)

S. No.	Season (2019)	Month	Sample No.					Min.	Max.	Mean	Std Dev.	BIS Standards	WHO Standards
			S-2	S-4	S-6	S-8	S-10						
1	Pre Monsoon	Jun.	22.6	22.3	22.3	22.3	22.2	22.2	22.6	22.34	0.152	No std.	30^0C
2	Monsoon	Aug.	30.3	30.2	30.3	30.4	30.1	30.1	30.4	30.26	0.114		
3	Post Monsoon	Nov.	22	20	20	20	21.5	20	22	20.7	0.975		

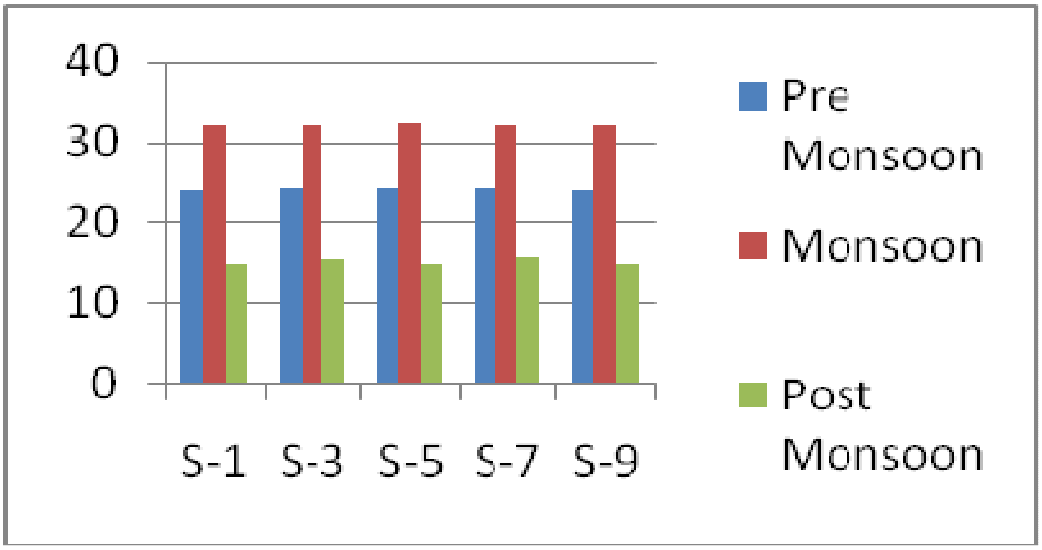

Figure 1(A) Variation In Temperature Levels Of IPH Water Supply Across The Sampling Sites.

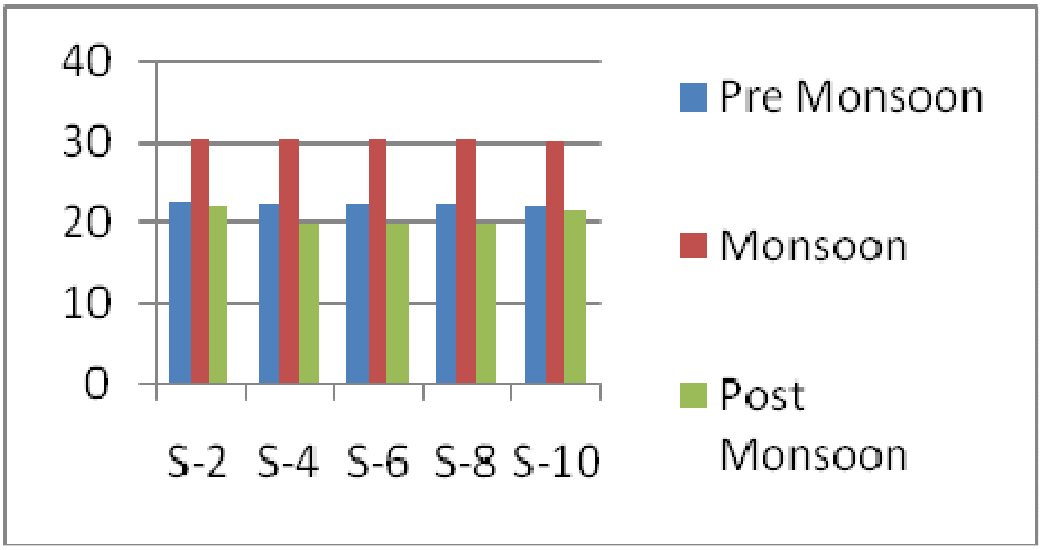

Figure 1(B) Variation In Temperature Levels Of Hand-Pump Water Supply Across The Sampling Sites.

pH

pH is a quality parameter which decides the acidity and alkalinity of water, lower value gives acidity while higher the alkalinity. pH value with 7 is considered neutral and best for drinking purpose. pH values for the water samples (IPH and hand-pump) were determined and found in the range of 6.97 to 7.03 which is well within the BIS and WHO standards.

Table 4 (A):- IPH Water Supply Results of analysis of water samples for quality parameter (pH values)

S.No	Season (2019)	Month	Sample No.					Min.	Max.	Mean	Std Dev.	BIS Standards	WHO Standards
			S-1	S-3	S-5	S-7	S-9						
1	Pre Monsoon	Jun.	6.96	7.05	6.98	6.98	6.96	6.96	7.05	6.986	0.037	6.5-8.5	6.5-8.5
2	Monsoon	Aug.	7.00	7.03	7.04	7.03	7.03	7.00	7.04	7.026	0.015		
3	Post Monsoon	Nov.	6.98	7.00	7.00	7.00	6.99	6.98	7.00	6.994	0.009		

Table 4 (B):- Hand-pump Water Supply Results of analysis of water samples for quality parameter (pH values)

S.No.	Season (2019)	Month	Sample No.					Min.	Max.	Mean	Std Dev.	BIS Standards	WHO Standard
			S-2	S-4	S-6	S-8	S-10						
1	Pre Monsoon	Jun.	6.96	7.02	6.97	6.95	6.95	6.95	7.02	6.97	0.055	6.5-8.5	6.5-8.5
2	Monsoon	Aug.	7.03	7.03	7.02	7.01	7.05	7.01	7.05	7.028	0.015		
3	Post Monsoon	Nov.	6.99	7.00	7.00	7.00	7.00	6.99	7.00	6.998	0.004		

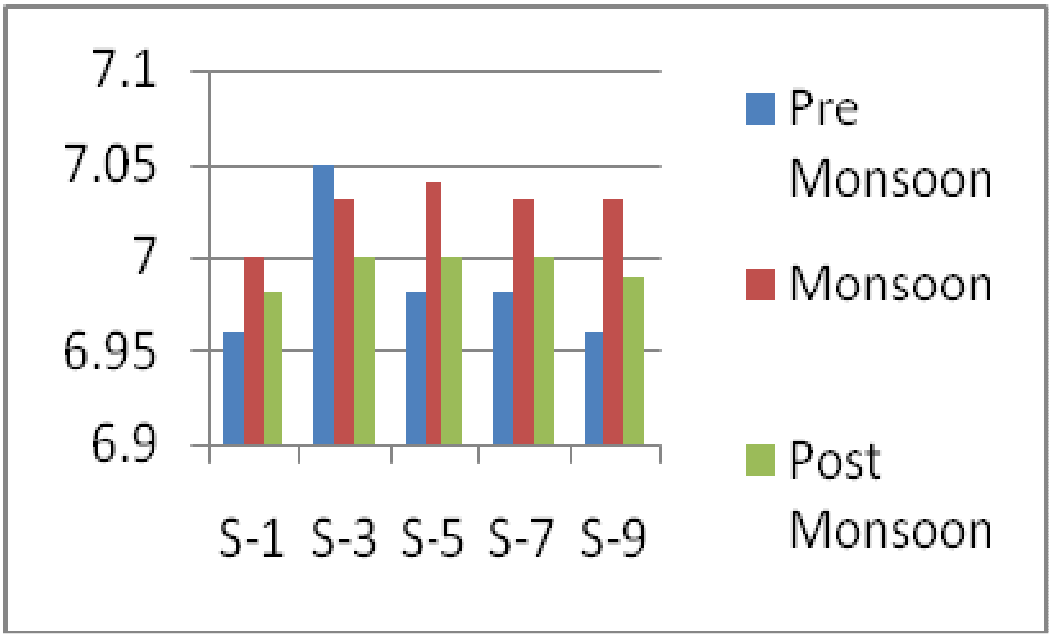

Figure 2(A) Variation In pH Levels Of IPH Water Supply Across The Sampling Sites

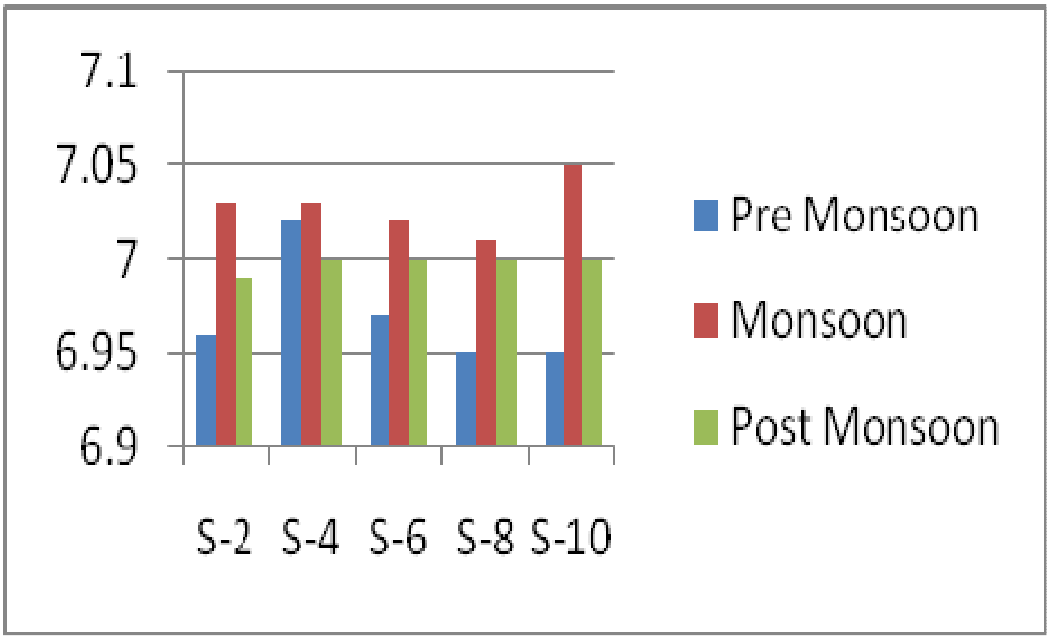

Figure 2(B) Variation In Total Hardness Levels Of pH Water Supply Across The Sampling Sites

Turbidity

Turbidity shows the presence of suspended solids and colloidal matter in water. These substances absorb and scatter light but not transmit it through water and hence shows the turbid appearance of the water body. All the samples from different sampling stations were found within the BIS and WHO standards and fit for drinking purpose. The slight turbidity value indicates the presence of a little particulates matter in the water bodies.

TDS

TDS indicates the salinity behavior of the water. In the present study the TDS value of hand-pump water supply is found higher than that of IPH water supply. The maximum value of TDS is found in hand-pump water supply during the monsoon season due to the intrusion of polluted water into the ground water, polluted by the anthropogenic and agriculture activities (Sharma and Bhattacharya, 2017). All samples of the present study were found within the BIS and WHO standards and fit for drinking purpose.

Table 5(A): IPH Water Supply Results of analysis of water sample for quality parameter (TDS value)

S.No	Season (2019)	Month	Sample No.					Min.	Max.	Mean	Std Dev.	BIS Standards	WHO Standards
			S-1	S-3	S-5	S-7	S-9						
1	Pre-monsoon	Jun.	274	257	349	220	268	220	349	273.6	47.077	500-2000 mg/L	1000 mg/L
2	Monsoon	Aug.	293	319	429	252	272	252	429	313.0	69.451		
3	Post-monsoon	Nov.	262	248	296	162	230	162	296	239.6	49.667		

Table 5(A): Hand-pump Water Supply Results of analysis of water sample for quality parameter (TDS value)

S.No	Season (2019)	Month	Sample No.					Min.	Max.	Mean	Std Dev.	BIS Standards	WHO Standards
			S-2	S-4	S-6	S-8	S-10						
1	Pre-monsoon	Jun.	404	426	228	531	320	228	531	381.8	114.215	500-2000 mg/L	1000 mg/L
2	Monsoon	Aug.	485	638	284	580	454	284	638	488.2	135.780		
3	Post-monsoon	Nov.	364	424	225	562	308	225	562	376.6	126.952		

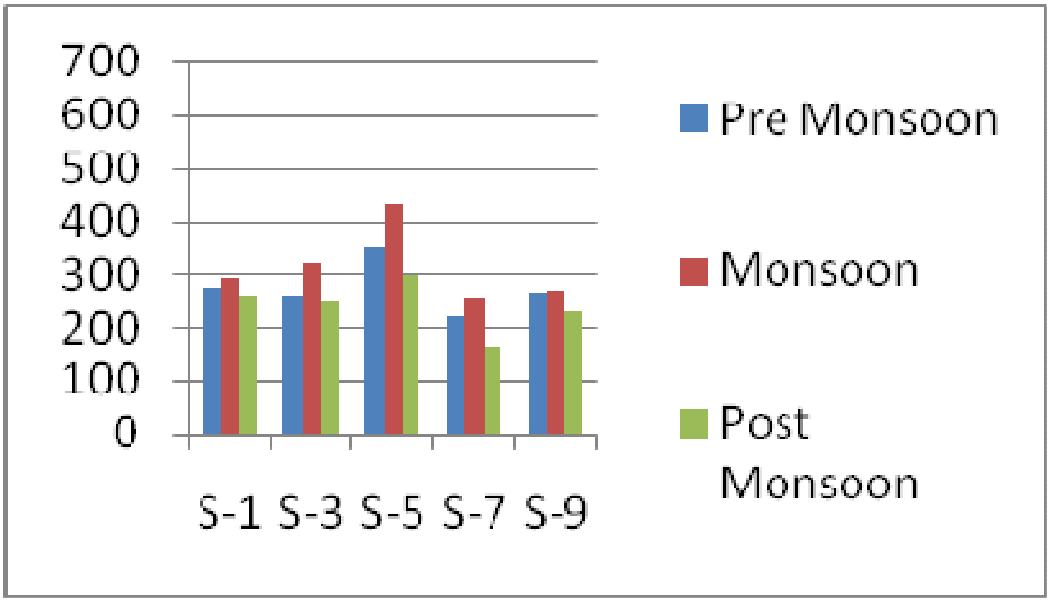

Figure 3(A) Variation In TDS Levels Of IPH Water Supply Across The Sampling Sites

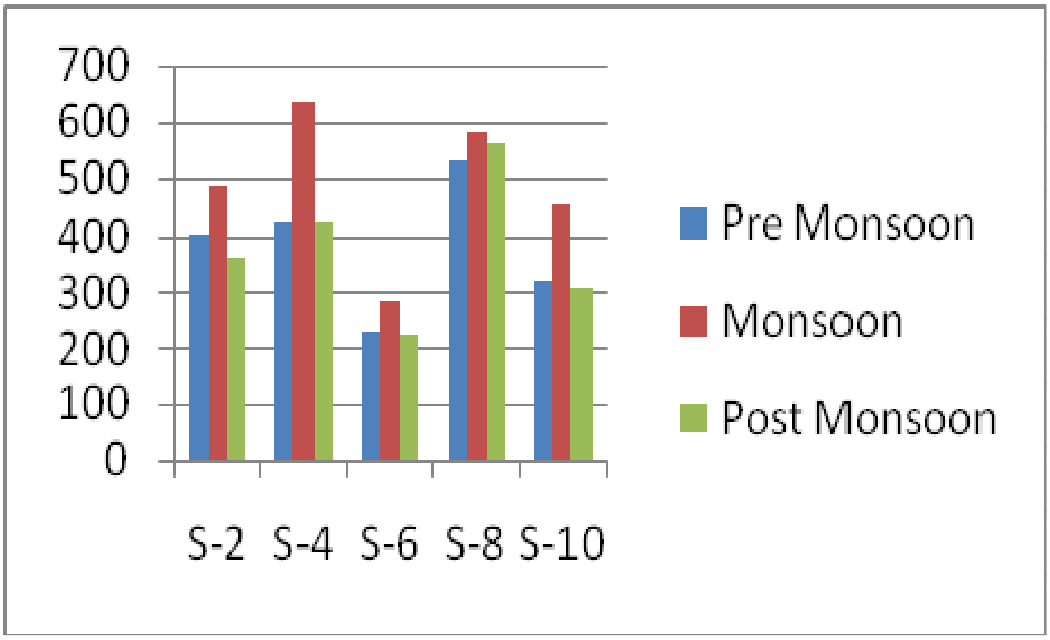

Figure 3(B) Variation In TDS Levels Of Hand- Pump Water Supply Across The Sampling Sites

TSS

TSS is taken as an indicator for the water quality as it affects the life. It represents the suspended silts and organic matter in the water. Water samples from different sampling stations showed lower concentration of TSS and are well within the permissible limits of WHO. Minimum variation was observed between the IPH and hand-pump water supplies.

Table 6(A): IPH Water Supply

Results of analysis of water sample for quality parameter(TSS value)

S.No	Season (2019)	Month	Sample No.					Min.	Max.	Mean	Std Dev.	BIS Standards	WHO Standards
			S-1	S-3	S-5	S-7	S-9						
1	Pre-monsoon	Jun.	0.223	0.235	0.224	0.242	0.223	0.223	0.242	0.229	0.009	100 mg/L	No stand.
2	Monsoon	Aug.	0.321	0.323	0.228	0.329	0.227	0.227	0.329	0.286	0.053		
3	Post-monsoon	Nov.	0.214	0.23	0.214	0.238	0.224	0.214	0.238	0.224	0.010		

Table 6(A): Hand-pump Water Supply
Results of analysis of water sample for quality parameter(TSS value)

S.No	Season (2019)	Month	Sample No.					Min.	Max.	Mean	Std Dev.	BIS Standards	WHO Standards
			S-2	S-4	S-6	S-8	S-10						
1	Pre-monsoon	Jun.	0.414	0.427	0.228	0.432	0.441	0.228	0.441	0.388	0.090	100 mg/L	No stand.
2	Monsoon	Aug.	0.521	0.532	0.546	0.679	0.544	0.521	0.679	0.564	0.065		
3	Post-monsoon	Nov.	0.411	0.434	0.385	0.621	0.411	0.385	0.621	0.452	0.096		

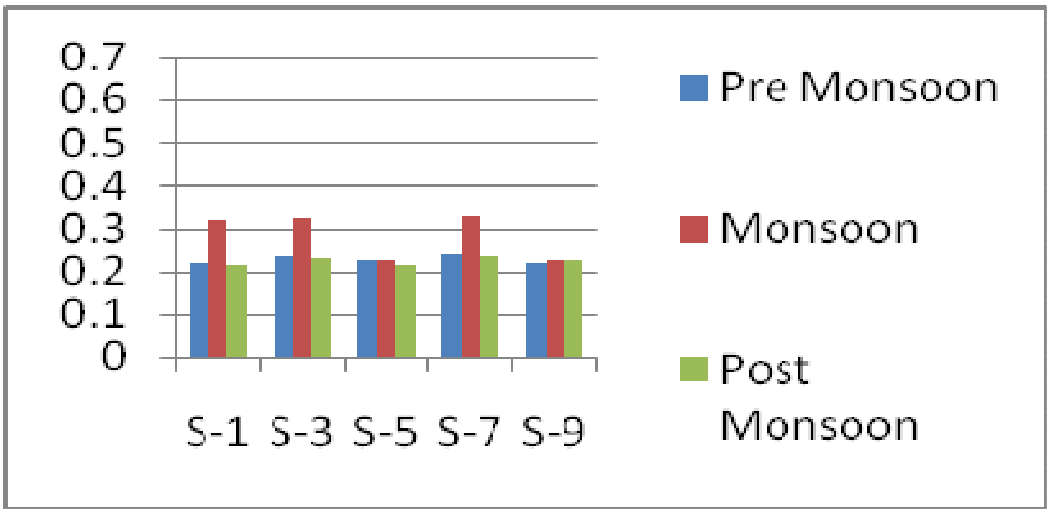

Figure 4(A) Variation In TSS Levels Of IPH Water Supply Across The Sampling Sites

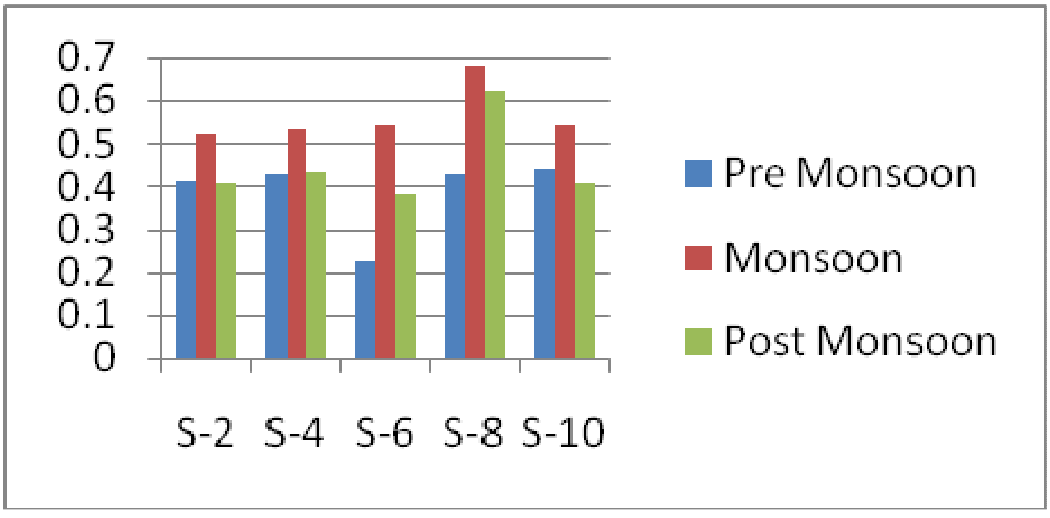

Figure 4(B) Variation In TSS Levels Of Hand-PumpWater Supply Across The Sampling Sites

Conductivity

Electrical conductivity represents the concentration of the dissolved salts in water (Purandara et.al, 2005). It is taken as useful tool for assessing the purity of water. The conductivity was lower in IPH water supply than that of hand-pump water supply. The higher conductivity values of water sample in pre monsoon season might be due to the dissolution of more substances during rainfall and higher temperature as compared to those of monsoon season. The highest conductivity values for water samples in the post monsoon season were attributed to the higher concentrations of already dissolved substances in monsoon season and no rainfall and loss of water as vapour from the water bodies in the post monsoon season. The conductivity values showed that the contamination due to the dissolved ions, waste run-off or leaching to the ground water had made water a little saline.

Table 7(A): IPH Water Supply

Results of analysis of water sample for quality parameter(Conductivity value)

S.No	Season (2019)	Month	Sample No.					Min.	Max.	Mean	Std Dev.	BIS Standards	WHO Standards
			S-1	S-3	S-5	S-7	S-9						
1	Pre-monsoon	Jun.	312	293	387	251	308	251	387	310.2	49.261	300 µS/cm	400 µS/cm
2	Monsoon	Aug.	529	495	602	317	441	317	602	476.8	106.711		
3	Post-monsoon	Nov.	345	327	473	278	350	278	473	354.6	72.044		

Table 7(A): Hand-pump Water Supply

Results of analysis of water sample for quality parameter(Conductivity value)

S.No	Season (2019)	Month	Sample No.					Min	Max	Mean	Std Dev.	BIS Standards	WHO Standards
			S-2	S-4	S-6	S-8	S-10						
1	Pre-monsoon	Jun.	460	497	285	616	371	285	616	445.8	125.741	300 µS/cm	400 µS/cm
2	Monsoon	Aug.	708	781	376	972	563	376	972	680.0	224.919		
3	Post-monsoon	Nov.	641	748	339	858	488	339	858	614.8	205.985		

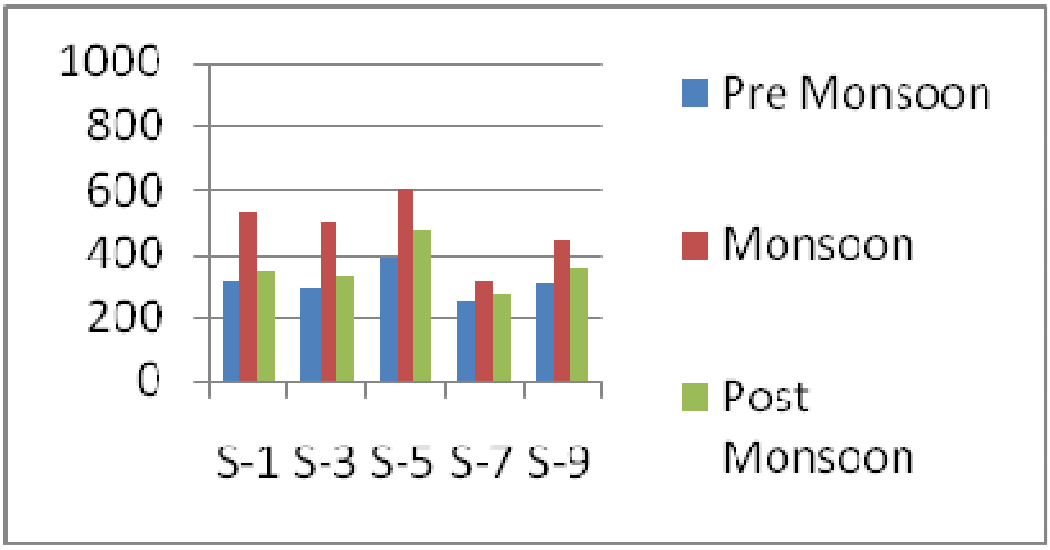

Figure 5(A) Variation In Conductivity Levels Of IPH Water Supply Across The Sampling Sites.

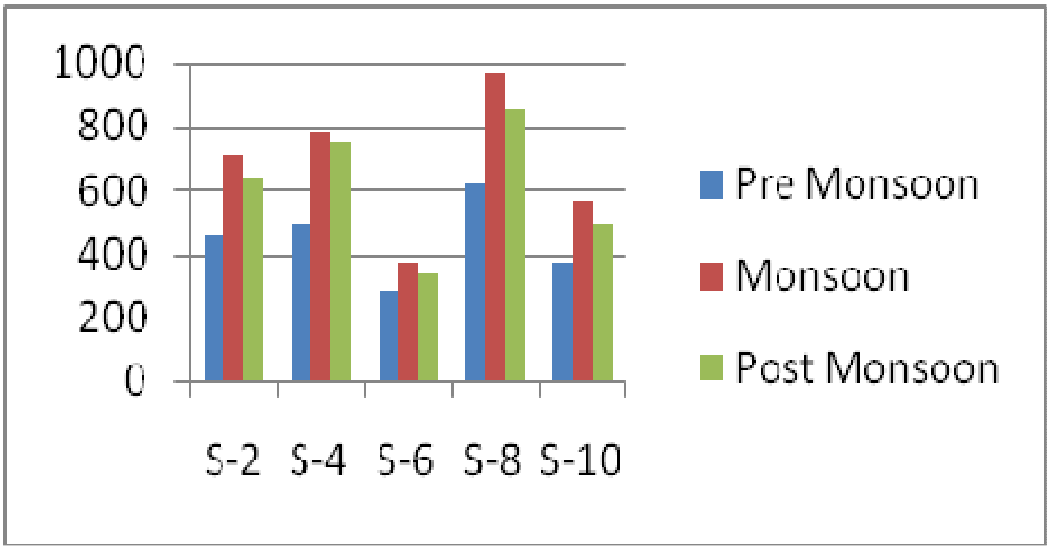

Figure 5(B) Variation In Conductivity Levels Of Hand-Pump Water Supply Across The Sampling Sites.

Total Hardness

The total hardness is the quality parameter of water which decides its use in the domestic, industrial and agricultural purposes. It is due to the presence of calcium and magnesium ions in the water. The IPH water supply was found to be hard whereas hand-pump water supply as very hard yet they were well within the permissible limits of BIS and WHO. No water sample was found soft and also moderate. No water sample was found extremely hard. Long term consumption of extremely hard water causes many health disorders. The analysed water samples are safe for drinking purpose.

Table 8(A): IPH Water Supply: Results of analysis of water sample for quality parameter(Total hardness value)

S.No	Season (2019)	Month	Sample No.					Min.	Max.	Mean	Std Dev.	BIS Standards	WHO Standards
			S-1	S-3	S-5	S-7	S-9						
1	Pre-monsoon	Jun.	130	120	240	90	124	90	240	140.8	57.560	600 mg/L	500 mg/L
2	Monsoon	Aug.	136	182	248	86	116	86	248	153.6	63.268		
3	Post-monsoon	Nov.	146	194	250	88	160	88	250	167.6	59.890		

Table 8(A): Hand-pump Water Supply: Results of analysis of water sample for quality parameter(Total hardness value)

S.No	Season (2019)	Month	Sample No.					Min.	Max.	Mean	Std Dev.	BIS Standards	WHO Standards
			S-2	S-4	S-6	S-8	S-10						
1	Pre-monsoon	Jun.	280	320	140	326	240	140	326	261.2	76.074	600 mg/L	500 mg/L
2	Monsoon	Aug.	260	140	150	108	212	108	260	174.0	61.090		
3	Post-monsoon	Nov.	280	260	170	320	280	170	320	262.0	55.857		

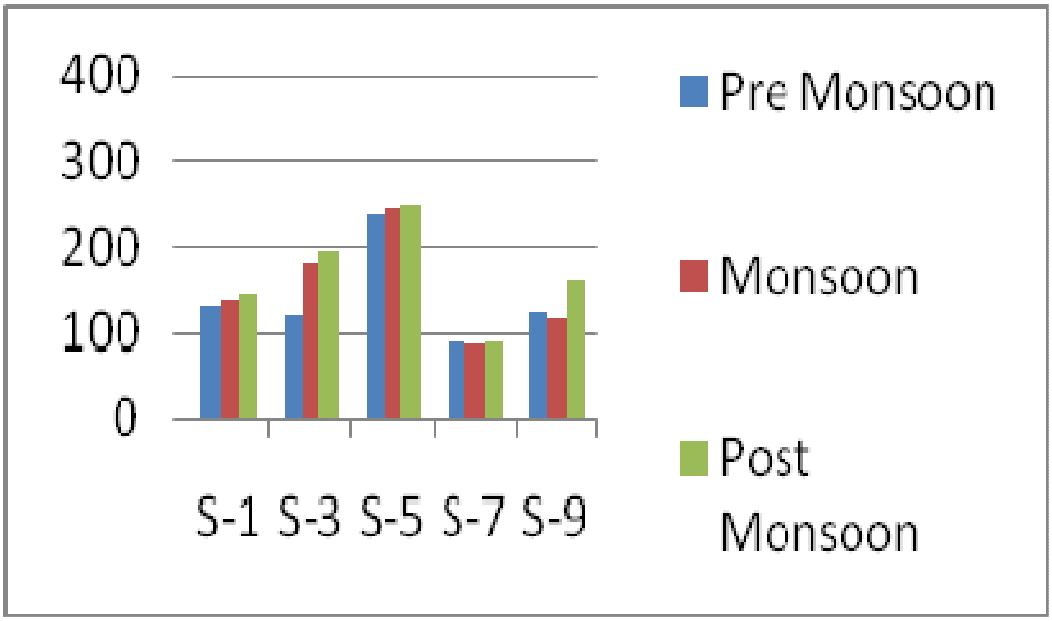

Figure 6(A) Variation In Total Hardness Levels Of IPH Water Supply Across The Sampling Sites

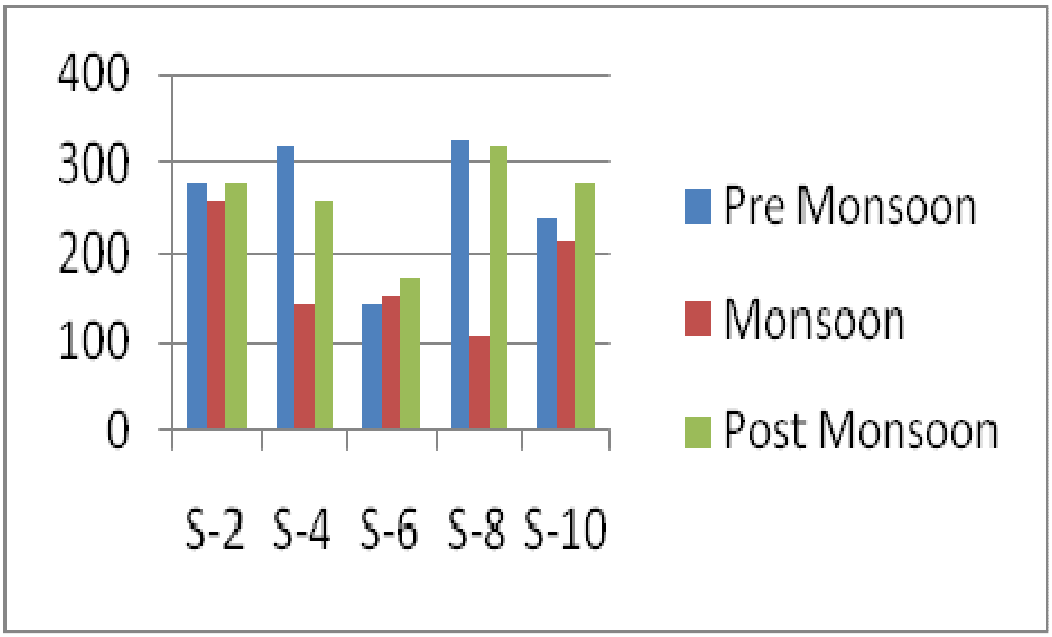

Figure 6(B) Variation In Total Hardness Levels Of Hand-Pump Water Supply Across The Sampling Sites

Alkalinity

The alkalinity of water is caused by the dissolution of carbonates, bicarbonates, hydroxides and phosphates. Decomposition of organic matter, photosynthesis and denitrification are the main factors for increasing alkalinity whereas respiration and nitrification factors for decreasing alkalinity (Bhattacharyya and Ghosh, 2018). Analyzed water samples showed the alkaline nature of water supplies but were within the permissible limits for drinking purpose.

Table 9(A): IPH Water Supply: Results of analysis of water sample for quality parameter(Alkalinity value)

S.No	Season (2019)	Month	Sample No.					Min.	Max.	Mean	Std Dev.	BIS Standards	WHO Standards
			S-1	S-3	S-5	S-7	S-9						
1	Pre-monsoon	Jun.	180	226	326	152	194	152	326	215.6	67.222	600 mg/L	No Stand.
2	Monsoon	Aug.	123	107	181	87	113	87	181	122.2	35.400		
3	Post-monsoon	Nov.	125	140	211	90	117	90	211	136.6	45.379		

Table 8(A): Hand-pump Water Supply: Results of analysis of water sample for quality parameter (Alkalinity value)

S.No	Season (2019)	Month	Sample No.					Min.	Max.	Mean	Std Dev.	BIS Standards	WHO Standards
			S-2	S-4	S-6	S-8	S-10						
1	Pre-monsoon	Jun.	250	326	202	306	224	202	326	261.6	52.960	600 mg/L	No Stand.
2	Monsoon	Aug.	200	252	146	143	186	143	252	185.4	44.719		
3	Post-monsoon	Nov.	218	290	169	260	204	169	290	228.2	47.499		

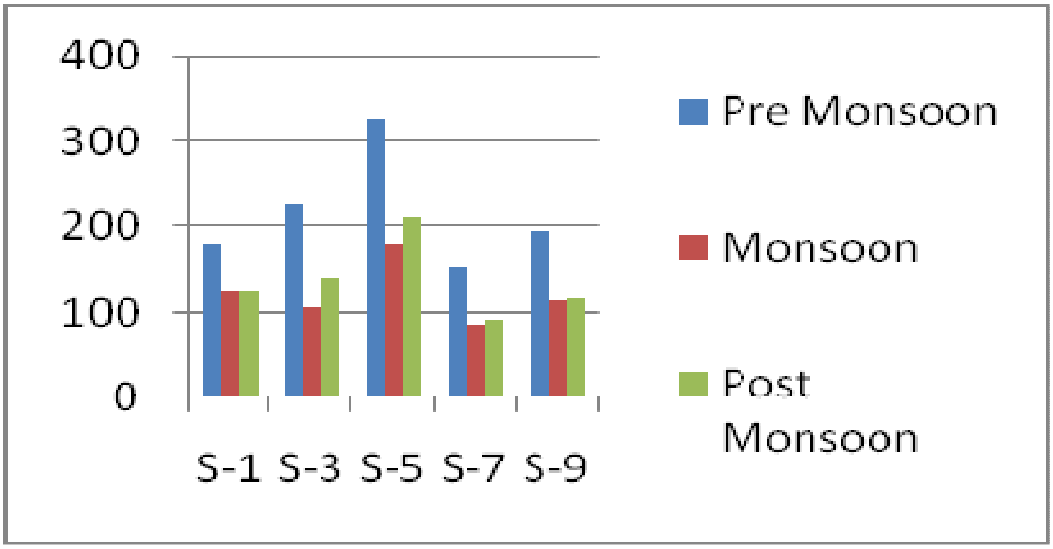

Figure 7(A) Variation In Alkalinity Levels Of IPH WaterSupply Across The Sampling Sites

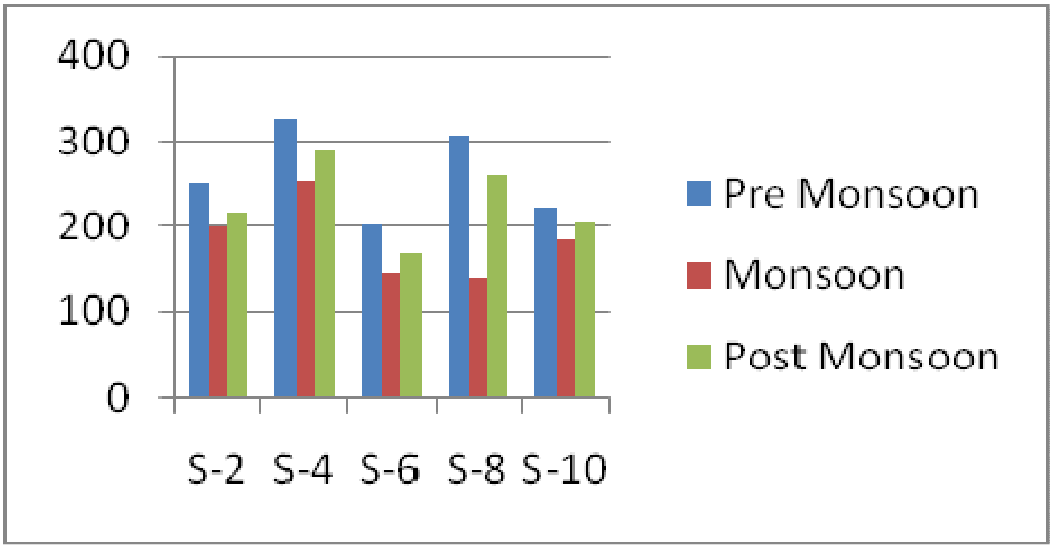

Figure 7(B) Variation In Alkalinity Levels Of Hand-Pump Water Supply Across The Sampling Sites

4. CONCLUSION

Water samples from IPH and hand-pump water suppies of ten locations were analysed for the selected ten quality parameters (Colour, Odour, Temperature, pH, Turbidity, TDS, TSS, Conductivity, Total hardness and Alkalinity) to decide the water quality status of Balh Tehsil, District Mandi, H.P (India).Most of quality parameters were within the prescribed limits of BIS and WHO for drinking purpose. From the quality parameter values it was found that the two water supplies differed slightly in their quality for drinking purpose in which IPH water supply found to be better one and preferred than hand-pump water supply. In the water analysis we found that there were no health problems associated with water quality in all the three seasons. The survey of water revealed that the people faced the particulate matter in drinking water during monsoon season thereby necessitating the use of filters during the monsoon season.

ACKNOWLEDGEMENT

We are thankful to the Department of Chemistry, School of Basic Sciences, Abhilashi University, Chailchowk, Mandi, Himachal Pradesh, India for providing necessary facilities to perform this resesearch work. We are grateful to CSIR-Institute of Himalyan Bioresource Technology Palampur H.P for providing necessary laboratory facility.

Funding: No funding has been obtained to carry out this research work.
Conflict of Interest: There is no conflict of Interest.

REFERENCES

A.S. Adekunle, "Effects of industrial effluent on quality of well water within Asa dam industrial estate, Iiorin, Nigeria", Nature and science, vol 7, no.1, ***(2009****), pp. 39-43.*

S. Basavaraja, S.M. Hiremath, K.N.S. Murthy, K.N. Chandrashekarappa , N.P. Anil et al. , "Analysis of Water Quality Using Physico-Chemical Parameters Hosahalli Tank in Shimoga District, Karnataka, India", Global Journal of Science Frontier Research, vol. 11, no.3, ***(2011)****, pp. 31-34.*

Bhattacharyya,B.,Ghosh, Physico chemical analysis of pond water in Purba Barddhaman ,West Bengal, International Research Journal of Environmental Sciences vol. 7, no.2, ***(2018)****, pp. 54-59.*

S. Gangwar, "Water resource of India :from distribution to management", Int.J.Inform .Comput. Technol.vol. 3, no.8 , ***(2013)****, pp. 845-850*

T. Harter, Groundwater Quality and Groundwater Pollution, University of California", FWQP, ANR Publication, ***(2003),*** *pp. 808.*

H. Joshua Nizel and M. Nazrul Islam , "Water Pollution and its Impact on the Human Health, Journal of Environment and Human, vol. 2, no.1, ***(2015)****, pp.36-46.*

D. Keerthika, K. Gokulpriyan, I. Harini and V. Karthikeyan , "Studies on Physicochemical Analysis of Water from Different Sources", International Journal of Environment Agriculture and Biotechnology , vol. 4, no. 2, ***(2019****), pp. 310-313.*

A.Kumar and G. Tripathi, "Water Pollution: Assessment and Management. Daya Publishing House, New Delhi, India", ISBN-13: 9788170353386, ***(2004****), pp. 520.*

B. Nabila, B. Ahmed and M. Kacem , "An assessment of the physico-chemical parameters of Oran sebkha basin". Applied Water Science , vol. 4, no. 4, ***(2014),*** *pp. 351-356.*

K. S. Pandey, S. Tiwari, "Physico chemical analysis of ground water of selected area of Ghazipur city-a case study". Nature and Science, vol. 7, no. 1, ***(2009).***

B.K. Purandara, N. Varandrajan. and K. Jayshree, " Impact of sewage on ground water , a case study" , poll.res. vol. 22, no. 2, ***(2005),*** *pp.189-197.*

*S.S. Sagar, R.P. Chavan, C.L. Patil , D.N. Shinde and S.S. Kekane, "Physico-chemical parameters for testing of water-A review", International Journal of Chemical Studies, vol. 3, no.4, (****2015****), pp. 24-28.*

B. Sharma and S. Bhattacharya , "Seasonal variation of physico chemical properties of ground water in rainfed agricultural area of Shivalik foot hills at pandoga sub watershed, Una district of Himachal Pradesh", international Journal of Engineering Science Invention, vol. 6, no. 12 , ***(2017)****, pp.75-81.*

V. Sharma and Y.K. Walia, "Water quality assessment of Gobind Sagar Lake during rainy season in Himachal Pradesh, India",Biological Forum, vol.8, no. 1, ***(2016)****, pp.559-564.*

D.Shukla, K. Bhadresha, N.K. Jain and H.A. Modi, "Physicochemical Analysis of Water from Various Sources and Their Comparative Studies ", IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT), vol. 5, no. 3, ***(2013)****, pp. 89-92.*

R. Suhag, "Overview of Ground Water in India", PRS, ***(2016).***

Water and related related statistics, ***(2013)****. http://cwc.gov.in/publications.*