Performance assessment of urban water supply to households in Varanasi, U.P., India

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ABSTRACT *The present work is concerned with evaluation of piped water supply at three locations of Varanasi. The water samples were analyzed for 9 parameters i.e. pH, Total dissolved solids (TDS), Turbidity, Total alkalinity (TA), Total hardness (TH), Chloride, Fluoride, Iron and Sulphate as per American Public Health Association (APHA) standard procedure. The Water quality results were analyzed for descriptive statistic using data analysis tool of MS Excel 2010 and compared with WHO standard for drinking water. The value of water parameters were found on higher side at Khojwa. The observed value of total dissolved solid (1500±65.2), total hardness (640±12.78), and total alkalinity (570±14.56) was found close to excessive limit of WHO for drinking water. The reason behind the higher value of water parameters may be the contamination in water distribution system. The study revealed that the regular monitoring of piped water supply can provide a useful mean for improving water quality at household level. Therefore it can be concluded that drinking water quality assessment at source and tail end of distribution network is important to control health hazard and also the efficiency of water supply system.*

Keywords: *Turbidity, Descriptive statistic, APHA, WHO, Contamination, Hazard*

Introduction

River Ganga, tube well and hand pumps are the major source of drinking water in Varanasi. There has been a tremendous increase in the demand for fresh water due to rapid growth of population and the accelerated pace of urbanization in the last few decades. The water quality of river Ganga is deteriorating due to discharge of urban drains and performing various ritual at Ganga ghat round the year (Dabgerwal and Tripathi, 2016; Tripathi and Tripathi, 2016; Singh et.al, 2018; Singh et.al, 2018; Tripathi, 2018). The water supply system of Varanasi was introduced in the year 1892 and it was designed for the population of 2 lacks with a treatment plant of 33 MLD constructed at Bhelupur.[CDP] This water distribution system was reorganized in 1954 to increase the water supply at the rate of 200 liter per capita per day (lpcd) for 4.6 lac population. The whole system of raw water treatment and its distribution is operated by Jalkal department of Urban local body of Varanasi, Uttar Pradesh (Raju and Bhatt, 2015; Singh, 2017). The water contamination of river Ganga due to various anthropogenic activities at upstream affect the treatment efficiency of water treatment plant. The water distribution line pass through sewer lines, open drains and nallas which contaminate the treated water. Leakages in the water supply network leads to case water losses (Wakode et.al, 2018).

In the present study, the quality of piped water supply to household of Pandeypur, Khajuri and Khojwa area of Varanasi district was monitored by analyzing physico-chemical parameters. The household water quality assessment is very important for the evaluation of performance of water distribution system. Such studies are also useful for the policy maker for up gradation of existing water related infrastructure.

Material and methods

The physico-chemical characteristic of household water supply was monitored in selected area of Varanasi for three months (Jan-Mar, 2018). Three sites i.e. Pandeypur, Khajuri and Khojwa were selected for this study. Water supply samples from 10 households per study site were collected on fortnightly basis for three months. The water samples were analyzed for 9 parameters i.e. pH, Total dissolved solids (TDS), Turbidity, Total alkalinity (TA), Total hardness (TH), Chloride, Fluoride, Iron and Sulphate as per American Public Health Association (APHA) standard procedure (Achari et.al, 2017; Jena and Sinha, 2017). The results were compared with WHO standard for drinking water (Tripathi and Vishwakarma, 2015; Khalid et.al, 2018). Statistical analysis including arithmetic mean and standard deviation of all parameters tested were calculated using data analysis tool of MS Excel 2010.

Result and discussion

The water quality monitored in present study was noticed to be higher than the permissible limit but lower than the excessive limit of WHO for drinking water. The results of water samples observed at all three study area of Varanasi are shown in the table-1.

Table-1: Physico-chemical analysis of water samples

Sr. No.	Parameter	Study Sites			WHO Standard	
		Pandeypur (1) (Mean±SD)	Khojwa (2) (Mean±SD)	Khajuri (3) (Mean±SD)	Permissible units	Excessive units
1	pH	8.74±0.8	8.00±0.5	7.8±0.9	7-8.5	6.5-9.2
2	TDS (mg/l)	700±50.5	1500±65.2	250±15.2	500	2000
3	Turbidity (NTU)	4.20±0.7	2.00±0.54	1.8±0.45	5	25
4	Total alkalinity (mg/l)	243.20±43.7	570±14.56	214.40±54.23	200	600
5	Total hardness (mg/l)	312±10.56	640±12.78	269±14.56	300	600
6	Chloride (mg/l)	138.8±4.33	191.5±3.23	347.6±5.11	200	600
7	Fluoride (mg/l)	0.6±0.25	0.5±0.14	0.5±0.17	0.5	1.0-1.5
8	Iron (mg/l)	0.3±0.1	0.23±0.1	0.3±0.1	0.3	1.0
9	Sulphate (mg/l)	32.0±7.2	28.8±8.4	30.0±6.5	200	400

pH measures acidity or alkalinity of water (Mativenga and Marnewick, 2018). pH value of site-1 was observed higher than the other two sites. However the average pH values of all three sites were within the WHO standard. Total dissolved solids (TDS) measures the total amount of inorganic chemicals in water samples (Naveen et.al, 2017). Total dissolved Solid of site-2 was found comparatively higher (1500±65.21) than the other two sites i.e. Site-1 (700±50.5) and Site-3 (250±15.2). High value of TDS can cause adverse effect on taste, domestic use and human health (Haydar et.al, 2016). Turbidity measures the clarity of water and it indicates the presence of suspended material such as clay, slit, finely divided organic material, planktons & other inorganic materials in water (Parra et.al, 2018). The average turbidity value of all three sites was observed below the normal range shows no contamination with sewer water or urban drain. Turbidity more than 5 NTU is usually objectionable for aesthetic reason, if turbidity is high, be aware of bacterial contamination (Kale, 2016; Bari and Rajon, 2016). Alkalinity of water measures its capacity to neutralize acids. It is caused due to the presence of hydroxides, carbonate & bicarbonates (Abril et.al, 2015). Total Alkalinity of Site-2 was found comparatively higher (570 ±14.56) than the other two sites i.e. Site-1 (243.20±43.7) and Site-3 (214.40±54.23). The total alkalinity of drinking water should not be more than 600 mg/l. Hardness in water is is primarily due to the presence of salts of calcium and magnesium (Naik and Suresh, 2015; Carpenter et.al, 2018). Total hardness of site-2 was found comparatively higher (640±12.78) than the other two sites i.e. Site-1 (312±10.56) and Site-3 (269±14.56). This higher value of total alkalinity and total hardness may increase the gastro related problems in the particular area. The hardness of good quality water should not exceed 300 mg/l.

The average value of Chloride at site-3 was found slightly on higher site (347.6±5.11) in comparison to the other two sites i.e. Site-1 (138.8±4.33) and Site-2 (191.5±3.23). High concentration of chloride ions may result in an objectionable salty taste to water & the corrosion in the water distribution system. It may also produce a laxative effect (Logeshkumaran et.al, 2015). The concentration of Fluoride, Iron and Sulphate at all three sites was observed within the WHO limit. The Fluoride concentration greater than 1.0 mg/l, may increase the incidence of dental cavity and over 1.5 mg/l fluorosis (mottling) of teeth may occur (Gopal and Ghosh, 2014; Khandare et.al, 2018). Similarly the Iron concentration greater than 0.3 mg /l in water may cause brown & black stains on laundry, plumbing fixtures & sinks. A metallic taste may also be present and it may affect the taste of beverages made from such water sources (Bhutiani et.al, 2016; Bora et.al, 2018).

Conclusion

From the present study it was concluded that drinking water supply in household of Pandeypur, Khajuri and Khojwa is normal and below the WHO standard prescribed for drinking water. The overall water quality at Khojwa was observed higher (TDS 1500±65.2, total hardness 640±12.78, total alkalinity 570±14.56) than the other two sites. Therefore regular monitoring of household water supply is required to

improve the water quality. Leakage reduction is also required to strengthen the water distribution network and also to control water borne infections.

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The gem cannot be polished without friction, nor man perfected without trials.

~ Chinese Proverb