ORIGINAL RESEARCH PAPER

Environmental Science

QUALITATIVE ASSESSMENT OF PHYSICOCHEMICAL PARAMETERS OF HARVESTED RAINWATER IN DIFFERENT REGIONS OF NATIONAL CAPITAL TERRITORY (NCT) AND NCR.

KEY WORDS: Rain Water, Dissolved Oxygen, Dissolved Carbon dioxide, pH, Conductivity, Physicochemical parameters, Air Pollution

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ABSTRACT

The primary objective of this work was to assess the quality of harvested rain water in different regions of Delhi and surrounding areas. Rain water samples were collected between May and September, 2018 from Shahdara, Vasant Kunj, Ashok Nagar, Seelampur, Karol Bagh, Faridabad, Bahadurgarh and Gurugram. The research methodology adopted hands on measurements of water quality parameters by using standard analytical techniques for studying pH, conductivity, temperature, dissolved oxygen (DO) and dissolved Carbon dioxide (DCO_2). The values of DO (mg/l) were found to be significantly very less in Central Delhi and NCR regions as compared to North East and South West of Delhi. The values of DCO_2 (mg/l) and conductivity (µs) were found to be significantly higher in Central Delhi and NCR regions than North East and South West of Delhi.

INTRODUCTION

Rain water harvesting is the process of collecting and storing rainwater and dissolved oxygen (DO) is the amount of oxygen measured in milligrams or millimetres dissolved in one litre of water. DO levels and concentrations are affected by plantation as more trees produce more of oxygen by photosynthesis. Due to population explosion, urbanization, industrialization, use of vehicles and other human interference for exploiting natural resources at an alarming rate, toxic pollutants are being added to the environment (Donaldson, 2004). Eventually the outcome is reduced levels of oxygen in the atmosphere and increased levels of carbon dioxide and other harmful gases emitted from various sources. Raised CO_2 has devastating impact on our planet in the form of global warming. Raised levels of dissolved oxygen in rain water shows that there is less tendency of rain water to dissolve oxygen in it from air. The solubility of gases especially DO levels in contrast decrease as the temperature of water rises. Electrical Conductivity (EC) is used in algorithms estimating salinity and TDS (total dissolved solids), both of which affect water quality and aquatic life. Salinity is important in particular as it affects DO solubility.The higher the salinity level, the lower the DO concentration.

The increasing human activities have gradually resulted in augmentation of contamination and deterioration of quality of fresh rain waters. Rain water should be free of pathogens, low in concentrations of toxic chemicals, clear, tasteless and colourless (Pangborn and Bertolero, 1972; Komabayasi, 1959). Hydrogen ion concentration of rain water plays important role in defining the toxicity of metals at low values of pH, metals are more soluble and hence more toxic in rain water. Lower pH values of water indicates its higher corrosive nature. The pH for drinking water generally lies between 6.5 and 8.0 at 25°C. Due to use of contaminated drinking water, human population suffers from several water borne diseases. It becomes essential to do qualitative analysis of rain water before it is used for human needs.

Qualitative assessment of rainwater can be done by monitoring certain physicochemical parameters such as colour, temperature, hardness, pH, dissolved oxygen (DO), Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), dissolved carbon dioxide (DCO_2) (Kasmin et. al., 2016, Kale, 2016; Ghosh and Manna, 2011). This vital study summarizes the importance of monitoring these physicochemical parameters and aims at possible risks and their implications on human health that can be associated with the use of harvested rain water as potable source without pre-treatment. The various regions across Delhi and NCR were taken since air pollution in these areas have reached alarming rates causing deterioration of rainwater quality which was once considered the purest form of natural water. Though harvested rain water can be of an alternative water supply in future having multiple economic impacts in reducing heavy water bills (Che-Ani et. al., 2009; Mohamed and Mohamed, 2012), its area wise quality assessment is important in analysing the potential of rain water as a source of potable water in enormously polluted regions like Delhi and NCR.

MATERIAL AND METHODS

The research methodology included hands on measurements of water quality parameters. The physicochemical parameters in the assessment regime were dissolved oxygen (DO) analysed by Winkler's titrimetric method and dissolved carbon dioxide (DCO_2) by standard NaOH titrations. Measurement of temperature was done by thermometer in degree Celsius scale. Conductance (µs) was assessed by using ELICO CM 180 conductivity-meter and pH was determined by ELICO LI 120 pH-meter.

The main source of rain water in regions of Delhi and NCR was its harvesting from home roof tops into storage units. The sampling regimes occurred from May, 2018 to September, 2018. Big vessels served as rain water storage units. From these rain water samples were directly transferred into standard I litre autoclave sterilized (at 121°C at 100 kPa for 10 minutes) sample bottles. Different samples were collected almost on the same day at different sites so as to minimize disparity among samples. Samples were analysed in laboratory within 6-12 hours after collection.

Data generated were evaluated using means ± standard deviation. Average of triplicate was evaluated. Analysis of variance (ANOVA) was used to identify significant differences ($p< 0.05$ or $p< 0.01$). The results of the analysis were compared with the values provided by WHO guidelines in order to access the quality of water as a potable water source. The temperature and pH of potable water should be in the range of 27-31°C and 6.5-8.5 respectively. There have not been any acceptable guidelines by WHO for dissolved oxygen and dissolved carbon dioxide for potable water. (Igbinosa and Aighewi, 2017)

RESULTS AND DISCUSSIONS

Study on rooftop harvested rain water is important in analysing the potential of rain water as a source of potable water and how much important is the rain water quality assessment for human health. The pH of water determines the solubility and biological availability of chemical nutrients and heavy metals. (Saigo and Dunningham, 1997). Metals tend to be more toxic at lower pH because they are more soluble. At lower pH values the corrosive nature of water is also found to be high such as rain water samples collected in Australia were found to have pH level of 6.5 or lower having a corrosive effect. (NHMRC, NRMMC, 2011). A pH of more than 9.5 or less than 4.5 are unsuitable for aquatic organisms as ammonia becomes as toxic ammonia at such high value. (Kumar and Pun, 2012).pH for drinking water was found to lie between

6.5 and 8.0 at 25°C. For effective disinfection with chlorine, pH should be less than 8. (Kale, 2016).The pH levels of collected rain water across Delhi and NCR regions were between 4.84 ± 0.81-8.9±0.19 indicating that the rain is acidic at various regions in the study area but not strongly acidic. However the corrosive nature of these samples having value less than 6.5 was not checked. (Table 1, Fig.1)

The temperature profile of rain water during the study regime was statistically significant ($p< 0.01$) ranging from 27°C ± 0.8 to 31.8 ± 0.12 °C. Therefore, the temperature recorded from the collected rain water samples in Delhi and NCR areas conform to the WHO recommended range of 20°C to 32°C, presenting no risk to individual health when used domestically (Table 1).

Electrical conductivity estimates the overall quantity of dissolved ions or the overall liquefied salts in the water. EC values of harvested rain water samples from Delhi and NCR were in the range of 22- 76 (µs) (Table 1, Fig.2). EC values lower than 100 µs cm^{-1} signify a low mineralization of harvested rain water (Nevondo and Cloete, 1999). Lowest values of conductivity were found in North-East of Delhi while highest values were seen in central Delhi showing that the rain in East of Delhi was not charged by dissolved salts or other impurities in comparison to rain of central regions of Delhi where dissolved salts and impurities were indicated more from higher value of EC. Rain water from NCR region was found to have higher value of EC with a corresponding low dissolved oxygen (DO) and lower value of EC and corresponding higher value of DO in the central Delhi indicating that NCR rain water has more content of dissolved salts and impurities in comparison to central Delhi. The values of DO in previous case study on samples from Karachi, Pakistan were found to be between 6.3-8.2 mg/l (Chughtai et. al., 2014). The dissolved oxygen values in the present study were found in the range between 2.5 ± 0.3 and 19.0 ± 0.1 mg/litre (Table 1, Fig. 3). DO is essential for maintaining the oxygen balance in aquatic ecosystems so assessment of DO is a major characteristic in all pollution related ecological studies.

The dissolved carbon dioxide (DCO_2) values in the samples analysed were ranged between 0.99 ± 0.12 to 9.98 ± 0.20 mg/litre (Table 1, Fig. 4). The highest values of DCO_2 in NCR are in consent with corresponding low values of DO in the regions in comparison with DCO_2 of Central Delhi. While lowest values of DCO_2 were found in samples of North East regions of Delhi, followed by central Delhi and regions of South Central ridge of Delhi. These values conform to corresponding low values of DO and EC of harvested rain waters. WHO does not specify acceptable guidelines for DO, BOD (Biological Oxygen Demand) and COD (Chemical Oxygen Demand (WHO, 2011).

Since rain washes away Delhi and surrounding area's air pollution which leads to various issues related to human health, the present study emphasizes the importance of quality assessment of harvested rainwater from such highly polluted areas before using this "purest form of natural water" as potable water.

TABLE 1.Physicochemical parameters of harvested rain water samples

Sample Site	pH	Temperature (°C)	Conductivity (µs)	DO (mg/l)	DCO_2 (mg/l)
Shahdara (NE Delhi)	8.96	31	48.0	19.0	0.99
Vasant Kunj (South Central ridge of Delhi)	4.84	32	53.7	11.0	6.4
Ashok Nagar (SW Delhi)	6.50	28	25.2	22.0	2.5
Seelampur (NE Delhi)	5.54	30	22.4	15.8	2.49
Karol Bagh (Central Delhi)	6.29	32	76.1	4.4	4.49
Faridabad (SE Delhi)	6.55	29	28.1	15.4	2.49
Bahadurgarh (NCR)	7.59	31	40.4	2.4	9.98
Gurugram (NCR)	5.59	29	66.2	1.0	8.48

Values are mean ± SD obtained from different regions of Delhi and NCR. Average of triplicate was evaluated for each set of physicochemical parameter.

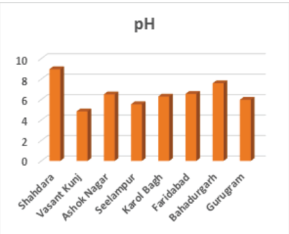

Fig.1. Alterations in pH of rain water samples collected from different regions of Delhi and NCR

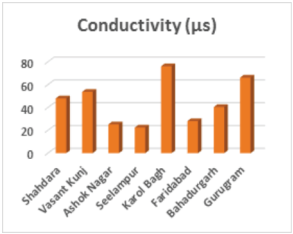

Fig.2. Conductivity (µs) of rain water samples collected from different regions of Delhi and NCR

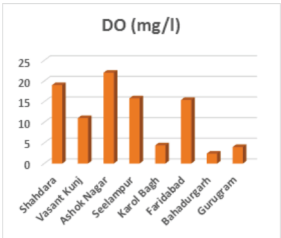

Fig.3. Dissolved Oxygen (DO) (mg/l) of rain water samples collected from different regions of Delhi and NCR

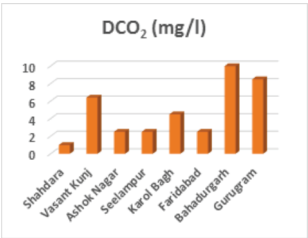

Fig.4. Dissolved Carbon Dioxide DCO_2, (mg/l) of rain water samples collected from different regions of Delhi and NCR

ACKNOWLEDGEMENTS

Authors would like to acknowledge the facilities available in college under grant of DBT (Department of Biotechnology) - Star College Scheme Funds.

REFERENCES

1. Che-Ani A I, Shaari N, Saini A, Zain M F M and Tahir M. (2009). Rainwater Harvesting as an Alternative Water Supply in the Future. European J. Sci. Res. 34(1): 132-140.
2. Chughtai M, Mustafa, S and Mumtaz M. (2014). Study of Physicochemical Parameters of Rainwater: A case Study of Karachi, Pakistan. Am. J. Anal. Chem.5, 235-242.
3. Donaldson S. (2004). The effects of Urbanization on the Water Cycle. Presentation for NEMO Project. USA: The University of Nevada.
4. Ghose K C and Manna B. (2011). Water Analysis. In: Practical Zoology. New Central Book Agency (P) Ltd. Publishers. 602p (ISBN: 81-7381-182-2).
5. Igbinosa I H and Aighewi I T. (2017). Assessment of the Physicochemical and Heavy Metal Qualities of Rooftop Harvested Rainwater in a Rural Community. Global Challenges. 1, 1700011 (1-7).
6. Kale V S. (2016). Consequences of Temperature, pH, Turbidity and Dissolved Oxygen Water Quality Parameters. Int. Adv. Res. J. in Sci., Eng. Tech. 3 (8): 186-190.
7. Kasmin H, Baker N H and Zubir M. (2016). Monitoring on the quality and Quantity of DIY Rainwater Harvesting System. IOP Conf. Ser. Mater. Sci. Eng.136 012067.
8. Komabayasi M. (1959). Dissolved oxygen in Rainwater and Its Relation to the Raincloud structure (I). Precipitation from September to March. J. Met. Soc. Japan. 37 (1): 22-33.
9. Kumar Manoj and Pun Avinash. (2012). "A review of permissible limits of drinking water". Indian J. Occup. Environ. Med. 16 (1): 40-44.
10. Mohamed S F and Mohd Raid N F. (2012). Potential of Rainwater harvesting implementation from multiple economic impacts measure. OIDA Int. J. Sust. Dev. 4 (8): 65-70 (ISSN 1923-6654)
11. Nevondo T S and Cloete, T E. (1999). Water SA, 25, 215.
12. NHMRC, NRMMC. (2011). Australian Drinking Water Guidelines. Paper6. National Water Quality Management Strategy, National Health and Medical Research Council, National Resource Management Ministerial Council Commonwealth of Australia, Canberra.
13. Pangborn R M and Bertolero L I. (1972). Influence of temperature on taste intensity and degree of liking of drinking water. J. Am. Water Works Assoc.64: 511.
14. Saigo B W and Dunningham W P. (1997). Environmental Science. 4th ed. WCB/ Mc. Graw Hill, New York, p. 399.
15. Saini Kalawati and Sonkar S M. (2015). Determination of water quality parameters of the river Yamuna at different locations of Delhi by using Vernier sensors. Int. J. Eng. Sci. Innov. Tech. 4 (2): 335-342.
16. WHO (World Health Organization) (2011) Guidelines for Drinking-Water Quality. 4th ed., World Health Organization, Geneva.