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Evaluation of physicochemical properties of water from wells of different zones in Nagpur city, India

Bharati Wadjikar[1], Archana Masram[1]* and Manoj Rai[2]
[1]*L.A.D. and Smt. R.P. College for Women, Nagpur
[2]Centre for Sericulture Biological Pest Management Research, RTM Nagpur University, Nagpur
amg123321@gmail.com

Abstract :
The availability of quality water is an indispensable feature for preventing disease and living healthy and quality life. The present work designed to study the physicochemical parameters of well water for its potability of four zones namely, Dharampeth, Hanuman Nagar, Aashinagar and Satranjpura in urban area of Nagpur, Maharashtra (North Latitude 20⁰ 35'and 21⁰44 East Latitude 78⁰ 15' and 79⁰ 40'). Parameters such as temperature, turbidity, electrical conductance, total dissolved solids, pH, dissolved oxygen, chloride, total hardness, sulphate, nitrate, sodium, iron, fluoride and potassium were measured during Monsoon season (June 2016 - September 2016). The results showed that, few parameters were within the BIS permissible limits, but in most of the wells, the parameters such as total hardness, total dissolved solids, chloride, nitrate, sodium in Hanuman Nagar and Satranjipura and Sodium and nitrate in Aashinagar were way above the BIS permissible limit, where Sodium content was highest and Nitrate concentration was the lowest. In Dharampeth zone, the well water was suitable where parameters were near to permissible limits, whereas well water of three remaining zones was not suitable for human consumption. The findings of the present study indicate that, management plans for well water potability is extremely important and must be kept on priority by the local authorities to help the inhabitants use the well water during extreme conditions.

Keywords- BIS, Nagpur, physico-chemical, potability, well

Introduction :

Water is the prime necessity of life, without it, there would be no life. Water can be obtained from a number of sources, such as streams, lakes, rivers, ponds, rain, springs and wells (Omezurikeetal., 2008). Various physicochemical parameters have a significant role in determining the potability of water.Safe and wholesome drinking water is a basic need for human development, health and wellbeing, and it is an internationally accepted human right (WHO, 2001). Over burden of the population pressure, unplanned urbanization, unrestricted exploration and dumping of thepolluted water at inappropriate place enhance the infiltration of harmful compounds to the ground water (Thomas etal., 2011). The physical and chemical parameters exert their influence both, individually and collectively and their interaction create a biotic environment (Salaskar and Yeragi, 1997; Sivalingam et al., 2016). Physicochemical characters of waterbodies depend upon several factors including location of bodies type of sewage and domestic waste disposal, localized human population and their activities. (Sivalingamet.al., 2016). Ground water obtained from thewell is the chief source of drinking water in India and is only 0.61% of the total available water on earth (Singh , 2011).

The present investigation has been undertaken to analyse the variation of physicochemical parameters in four zones of Nagpur City during monsoon from June 2016 to September 2016.Present study will provide a reliable water quality data, which can be used for the assessment of precise health risks, effective management and remedial measures and also awareness regarding water quality and sanitation.

Materials and Methods:

Study Area :

The water samples were collected from wells from four zones namely, Dharampeth, Hanuman Nagar, Ashinagar andSatranjpurain Nagpur city, Maharashtra lies between north latitudes 20⁰35'and 21⁰44' and east latitudes 78⁰15' and 79⁰40'. (Source NMC)

Collection of samples :

Water samples were collected fromidentified wellfrom four zones in the pre-cleaned plastic polyethylene bottles of 1 litre capacity every month (June, July, August and September – 2016) during the early hours between 6am.to 9am.

Physicochemical analysis of water :

Physicochemical parameters such as temperature, turbidity, E.C., TDS, pH, Dissolved Oxygen, Chloride, total hardness, Sulphate, Nitrate, Sodium and Potassium, Iron and Fluoride were estimated. Temperature and pH were recorded at the time of sample collection using thermometer and digital pH meter, conductivity using conductivity meter, Dissolved Oxygenusingwinklers method, Total dissolved solids (TDS), Chlorides, Total hardness,

Sulphate, Nitrate, Sodium and Potassium were determined by using the methods of APHA (1995, 1999, 2005, 2008), Trivedi&Goel (1986); Kodarkar (1992).

Results and Discussion :

The various physical parameters of the well water samples collected from four zones in Nagpur City were analyzed and the results are presented in Table-1 and chemical parameter are given in Table- 2. On the basis of average values standard deviation has been calculated and graphs are plotted accordingly. (Fig-1, 2, 3)

pH :

The standard range of pHof well water is between 6.5 and 8.5 (BIS, 2010)and EPA (2009) recommends this range of pH as a good guide for individual well . In the present study the maximum value of pH was (7.68) in the month of June in Dharampeth Zone and minimum was 7.22 in Hanuman Nagar Zone in the month of September,which indicated that pH of water was slightly alkalineduring the month of June might be due to high temperatureand lowered water volume in the well at end of summer season,reduced the solubility of carbon dioxide. The reduced rate of photosynthetic activities reduces the assimilation of carbon di-oxide and bicarbonates which are ultimately responsible for increase in pH, the low oxygen values coincided with high temperature (Kamble etal., 2009).

E.C. :

There are no prescribed standards suggested by WHO for parameter like electrical conductivity of drinking water. The electrical conductivity was highest 1822ms/cm in Hanuman Nagar Zone during September and lowest in 6.22ms/cm in Aashinagar in the month of July which indicate high variation among the well and the reason have these variations will require further investigation.

TDS :

TDS is the term used to describe the inorganic salts and small amount of organic matter present in solution of water. The permissible limit of drinking water is 500mg/lit.(WHO, 2004). The maximum value 1168mg/lit.recorded during September in Hanuman Nagar Zone and minimum value 180mg/lit.inDharampeth Zone during June, Maximum value reached in September was due to addition of water through heavy rains which increased the volume of water in wells.

Turbidity :

Suspension of particles in water interfering with passage of light is called turbidity. Turbidity is caused by wide variety of suspended particles (Dohareet.al., 2014). As per I5, 10500-2012 the permissible limits is 1 and 5 NTU respectively. The maximum turbidity value was 6.22 in Aashinagar Zone during July and minimum 0.62in Dharampeth Zone during June. High turbidity could be due to bacterial growth, which indicates treatment processes was not followed (WHO 2004).

Dissolved Oxygen :

DO indicate physical, chemical and biological activities in a water body. DO affect the solubility and availability of many nutrients and therefore productivity of aquatic ecosystem (Wetzel, 1983). In thepresent study dissolved oxygen 4.28mg/lit.was minimum during June in Dharampeth Zone while maximum 7.15mg/lit. recorded in Hanuman Nagar during the month of September. Oxygen enters into the water by aerial diffusion and as a photosynthetic pathway as a by-product of aquatic plants and algae. Theamount DO in water depend upon the temperature, salinity and pressure of the microbial load in water. The DO values indicate the degree of pollution in the water bodies (Gopalkrushna2011). DO level of studies water bodies are found within the prescribed range of BIS.

Chloride :

Chloride is not harmful to human but high concentration of chloride increases the corrosive property of water. The high concentration of chloride is due to dissolution of salt, soil erosion and discharge of effluents into water sources(Lodh et al., 2014). According to WHO maximum permissible limit for chloride is 500mg/lit. The value recorded in the present study was lowest 15.70mg/lit.inDharampethduring June and highest 288.00mg/lit.in Hanuman Nagar during the month of Augustwhich was well within the permissible limit as prescribed by BIS.

Total Hardness:

Hardness of water mainly depends upon the amount of Ca and Mg salt or both. Total hardness is a natural separation point between soft water and hard water (Sivalinagam et al., 2016). Hardness prevents lather formation with soap and increases the boiling point of water. Normally water hardness does not cause any direct health problems, but has effect oneconomic viability. Hardness below 200mg/lit.is considered potable but beyond this limit produces gastro intestinal irritation. Extremely hard water may lead to increased incidences of urolithiasis (Thomas et.,al., 2011). Higher, hardness could be due to discharge of effluents and untreated waste from polluting industries to nearby water sources (Ullah etal.,

2009). As per IS : 10500-2012 desirable limit and permissible limit for hardness is lies between 200-600mg/lit. In the present investigationthe maximum value was 668mg/lit in Hanuman Nagar Zone during Septemberwhich is much higher than permissible limits while120mg/lit.inDharampeth Zone during the month of June was with in the permissible limit.

Sulphate :

Natural water contains sulphate ions and most of these ions are also soluble in water. Many sulphate ions are produced by oxidation process of their ores, they are also present in industrial waste. (Dohare et al., 2014) As per IS : 10500-2012 the desirable limit for sulphate is 40-200mg/l. The maximum value 107.20mg/l. was recorded in Hanuman Nagar during September while minimum 14.45mg/lit.inDharampeth Zone during June.

Nitrate :

Nitrates represent the final product of the biochemical oxidation of Ammonia. It is the main nutrient that accelerates the growth of hydrophytes and algae (Lodh etal., 2014). In urban areas sewage water rich in nitrates contaminate the water thus increases the nitrate amount (Tank, 2013;GopalKrishna, 2011). In the present study the maximum value 115.12mg/lit.was recorded in Satranjipura Zone during September, and minimum value 3.62mg/lit.duringAashinagarduring the month of June. Largestamount of Nitrate is found in the Satranjipura Zone during September which is beyond prescribed by BIS. (Thomas et al.,2011)

Sodium :

The sodium iron is ubiquitous in water. Most water supplies contain less than 20mg of sodium per litre, but in some countries levels exceed 250mg/lit (WHO, 1996). The maximum value was 104.00mg/lit.inSatranjipura Zone during September and minimum 15.40mg/lit.inDharampeth Zone during June.

Iron :

Iron is common in ground water contaminant,higher level of iron in ground water lead to decolouration and metallic taste of water (Jamir et al., 2011)Iron contend was lowest 0.04mg/lit in Dharampeth Zone during June and highest 0.18mg/lit. inHanumannagar Zone during July and the similar results were observed in the wells of Digdoh village, Hingna MIDC in Nagpur region. (Masram2014) and for the Wells of NildohNagpur also (Wadjikar andMasram2017).

Fluoride :

Fluoride is released into air in gaseous state and in particulate matter from factories producing phosphatic fertilizers (Sharma etal. 2004; Thomas etal., 2011). This might cause contamination of soil, water and forage not only in the vicinity of the plant, but several kilometres from the factory. (Radostits etal., 2007). Among factors which control the concentration of fluoride are the climate of the area and the presence of accessory minerals in the rock minerals assemblage through which the ground water is circulating. As per IS: 10500-2012 desirable limit for fluoride is 1 and 1.5mg/lit. is in permissible limit. The minimum value was 0.27mg/lit.inDharampeth Zone during June and maximum 1.45mg/lit.inAashinagarduring September recorded during present, study which indicate that the fluoride level is well within the permissible limit.

Potassium :

Potassium is a component of fertilizers and animal waste. The natural sources of potassium in water are the minerals of local igneous rocks such as feldspars (orthoclase and microcline) mica and sedimentary rocks as well as silicate and clay minerals (Roshinebegam etal.,2014). The minimum value of potassium content was 0.16mg/lit. inDharampeth Zone during June and maximum 80.48mg/lit in Satranjipura Zone during September.

Conclusion :

The present investigation suggest that the quality of water samples was not acceptable due to high level total hardness, total dissolved solids, chloride, nitrate, sodium especially in HanumannagarZone, sodium and nitrate in Satranjipura Zone and sodium in Aashinagar Zone while nitrate was lower.It was observed that the water from well of Dharampeth Zoneonly is suitable for drinking and livingpurposes,where asfrom remaining three zones wasunfit for human use. Well water with least and slightly affected zones require treatments such as filtration, chlorination, alum treatment, aeration, neutralization, softening and chemical precipitation to minimise contamination and make them fit for drinking or other use.

Table 1 : Physical parameters of well water recorded from four zones in Nagpur city

Sr. No	Parameter*	Dharampeth Zone	Hanumannagar Zone	Sataranjipura Zone	Aashinagar Zone	S.D
1	pH	7.52	7.33	7.57	7.40	±0.11
2	E.C.(ms/cm.)	344.25	1788.30	1404.75	1036.75	±614.88
3	TDS (mg/lit.)	197.25	1109.00	780.00	492.50	±390.41
4	Temperature ^{0}c	25.00	25.25	24.75	24.75	±0.24

*Note- The figures represent mean of 3 samples in each zone recorded over four months. (June-September)

Table 2 : Chemical parameters of well water analysed from four zones of Nagpur city

Sr. No	Parameter*	Dharampeth Zone	Hanumannagar Zone	Sataranjipura Zone	Aashinagar Zone	S.D
1	Turbidity (NTU)	0.89	2.52	4.27	5.91	±2.17
6	DO (mg/lit.)	5.30	5.93	6.60	5.30	±0.62
7	Chloride (mg/lit.)	18.29	258.27	149.89	79.65	±102.98
8	Total Hardness	132.75	633.00	372.75	265.00	±212.15
9	Sulphate (mg/lit.)	15.77	104.73	92.42	53.78	±40.28
10	Nitrate(mg/lit.)	24.89	74.47	103.86	3.88	±45.63
11	Sodium (mg/lit.)	16.37	74.59	99.75	89.56	±37.26
12	Iron (mg/lit.)	0.06	0.13	0.16	0.08	±0.05
13	Fluoride (mg/lit.)	0.34	0.82	0.10	1.27	±0.52
14	Potassium (mg/lit.)	0.20	1.23	74.11	2.02	±36.49

*Note- The figures represent mean of 3 samples in each zone recorded over four months. (June-September)

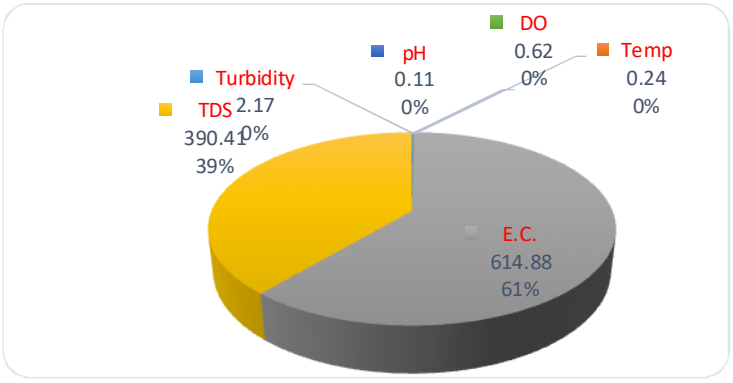

Figure 1: Biostatistical representation of physical parameters of well water of four zones of Nagpur city

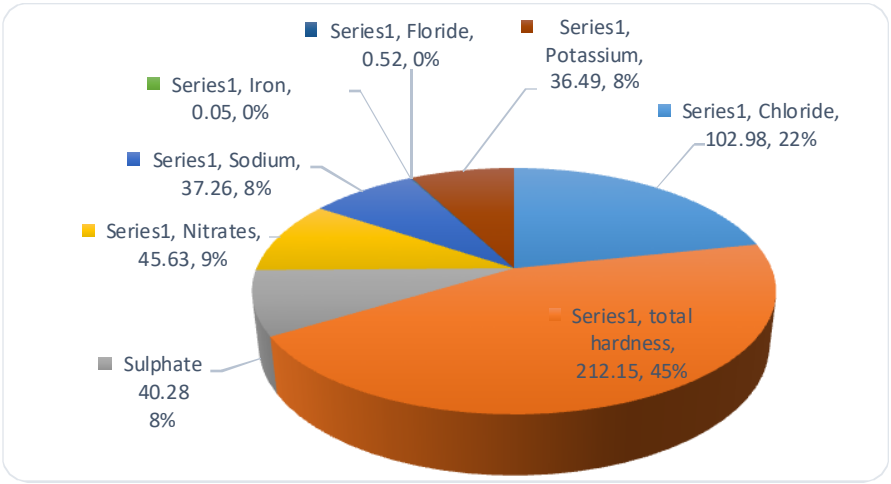

Figure 2: Biostatistical representation of chemical parameters of well water of four zones of Nagpur city

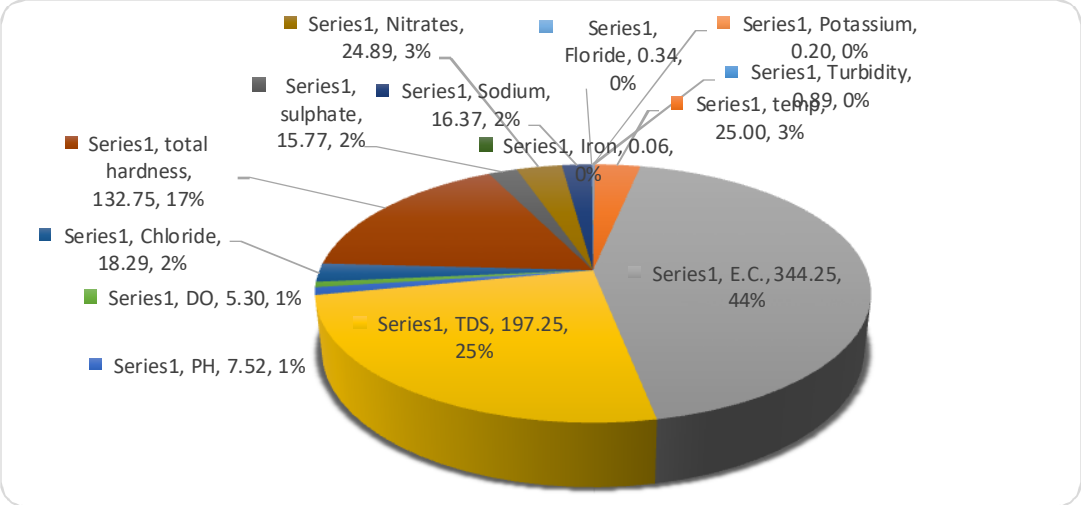

Figure 3: Biostatistical representation of physico-chemical parameters of well water of four zones of Nagpur city

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