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Physicochemical Assessment Of Drinking Water Quality: A Case Study Of Bilaspur District (C.G), India

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ABSTRACT: Present investigations aim to analyse the tap water quality of Bilaspur district by water quality index. Eight physicochemical parameters such as Calcium, Magnesium, Chlorine, total hardness, pH, Electrical conductivity, TDS, Turbidity and also *bacterial* contamination. Out of total parameters studies, 80% water samples were bring into being good quality and only 20% of water trials falls under temperately poor category. Therefore, prerequisite treatment of drinking water can be done before usage and also the study area has to be protected from anthropogenic contamination.

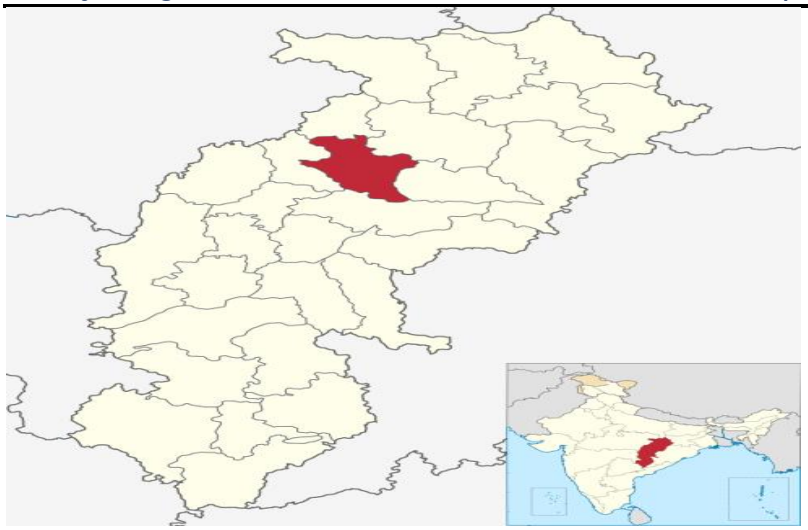
Index Terms **- Drinking water, physio-chemical, Bilaspur, water treatment.**

1. INTRODUCTION

Water plays a vital role in every aspect of human existence. Chhattisgarh is known for its forest wealth and plant resources. As the state is remodelling from agricultural to industrial proceedings, the need of water has tremendously increased. Various physicochemical parameters like pH, alkalinity, total dissolved solids, total hardness, calcium, chlorine, magnesium, etc. have a crucial role in determining the portability of drinking water (Jeyraj *et al*., 2002; Sankar *et al.*, 2002; Gupta *et al.*, 2004; Patel and Ragothaman 2005; Udhayakumar *et. al.*, 2006; Ahipathy and Puttaiah, 2006; Gawas *et al.*, 2006; Sirsath *et al.*, 2006; Venkatasubramani *et al.*, 2007; Jitendra *et al.*, 2008; Tiseer *et al.*, 2008; Solanki, 2012). In Chhattisgarh state, very fewer studies have been conducted for assessment of drinking water quality (Kumar *et al.* 2015; Kushwaha and Kushwaha, 2016; Chaturvedi, 2020: Jain *et. al.* 2021; Sharma *et al.* 2022), on physicochemical parameters of pond water (Rai and Kushwaha, 2015; Shrivastava *et. al.*2014). So, there was a need of comprehensive assessment of drinking water and their effects on human health. If needed, treatment before usage and also to protect it from contamination.

2. MATERIAL AND METHODS:

2.1 Study area: The water quality assessment was conducted in Bilaspur district of Chhattisgarh state, Central India. The study region is located in 22.0797° N, 82.1409° E. In total, 40 samples were collected from tap water sources of 10 locations of district Bilaspur in the year July 2021-Feb 2022. Physicochemical constraints like pH, calcium(Ca_2^+) hardness, Chlorides , Magnesium (Mg_2^+), residual chlorine (Cl_2), turbidity, TDS (Total dissolved solids) was investigated. Observed value was calculated using standard formula and results were compared with the values prescribed in various water quality standards as Bureau of Indian standards (BIS) and World Health Organization (WHO, 2012).



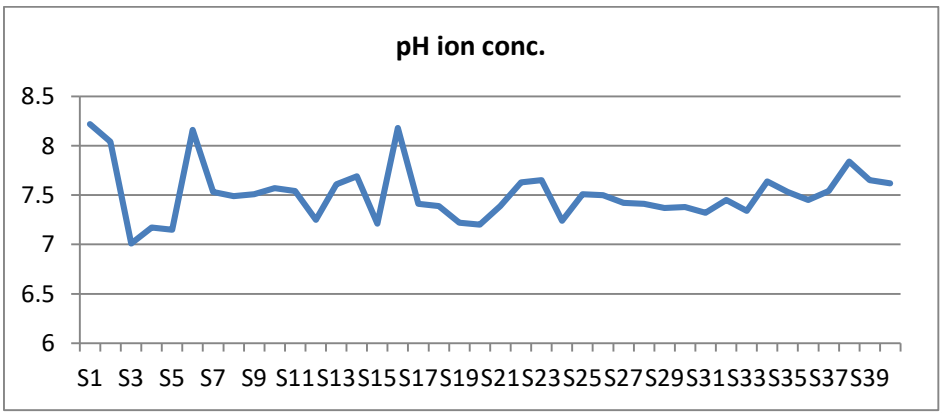
Source: https://commons.wikimedia.org/wiki/File:Bilaspur_in_Chhattisgarh_%28India%29.svg

2.2 Physicochemical analysis

1. Physical parameters- Hydrogen ion concentration (pH) and electrical conductivity (EC) was recorded.
2. Chemical parameters-
   (i) Total dissolved Solid (TDS): It was measured by Gravimetric method.
   (ii) Total hardness of water was calculated using the formula given below:
   Total hardness (mg/l) = ml of EDTA x 1000 ml of water sample.
   (iii) Calcium hardness: To determine Calcium hardness, 50ml of water sample was taken in a conical flask and 2 ml of NaOH was added to it, then ammonium perpetrate was added drop by drop as an indicator till the violet colour changes to pink.
   Calcium hardness = ml of titrant x 1000 ml of water sample.
   (iv) Magnesium hardness: It was calculated by subtracting calcium hardness from total hardness.
   Mg hardness (mg/l) = total hardness – Ca hardness.
3. Coliform bacteria contamination: Qualitative analysis was done to detect the presence of bacterial contamination. Sterilized glass bottles sealed with stopper was used to collect water sample and brought to laboratory for microscopic analysis.
4. In-situ parameters like pH and electrical conductivity were examined using HQ40d portable handheld multi meter at collection sites.
5. Turbidity: It is caused due to the presence of particles and coloured substances in water which is determined by using spectrophotometer.

3. RESULTS AND DISCUSSION:

3.1 pH of water: It is an important parameter to evaluate the acidic and basic nature of water. WHO has recommended maximum permissible limit of pH from 6.5 to 8.5 ion concentration. In present study, pH value was found within the range of WHO limit i.e., 7 to 8.2.



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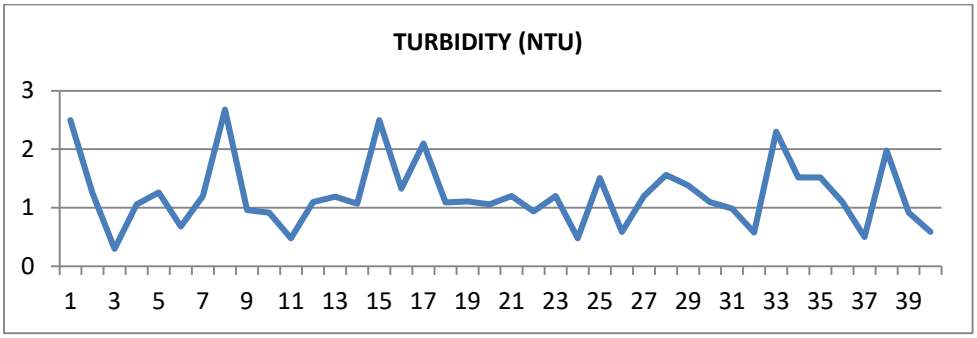
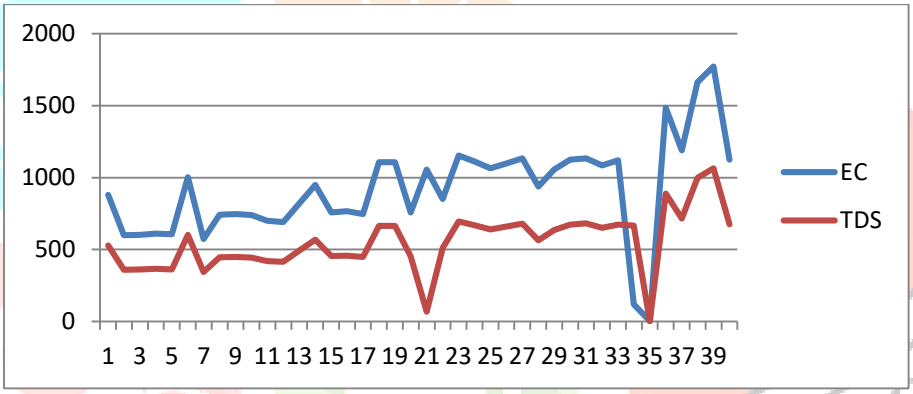
3.2 Turbidity – Turbidity of water depends on the quantity of solids dissolved in the suspended form. It indicates the quality of waste discharge w.r.t colloidal matter. Mean value obtained in Bilaspur district was (1.22 NTU) which is within the permissible perimeter (i.e., 5.0 NTU) of WHO.



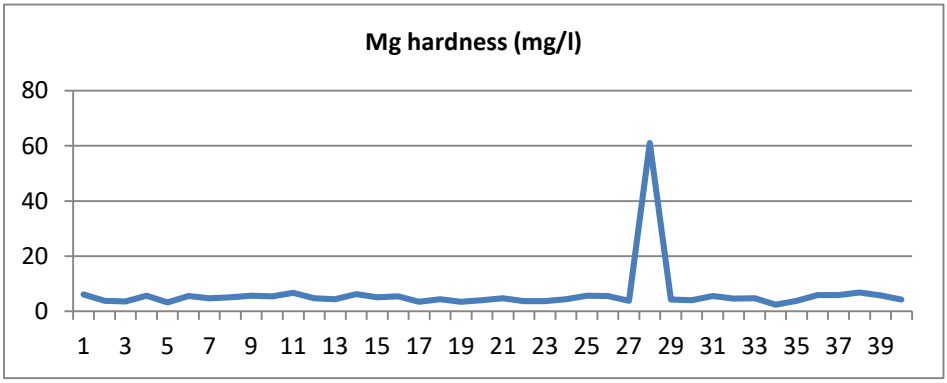
3.3 Total dissolve solids (TDS) - Water is a universal solvent and allow both organic and inorganic solids which produce bad odour and taste and changes the appearance of water. TDS in study area ranges from 68 to 1065 mg/l which exceeds the permissible limit.

3.4 Electrical conductivity (EC)- In present investigation, observed EC value ranges from 118 to 1772 µS/cm with an average value of 919.75 which exceeds desirable limit as suggested by WHO (200-800µS/cm). The result indicates that the water of study area was highly ionised and has the high level of ionic concentration activity due to large solids dissolved.

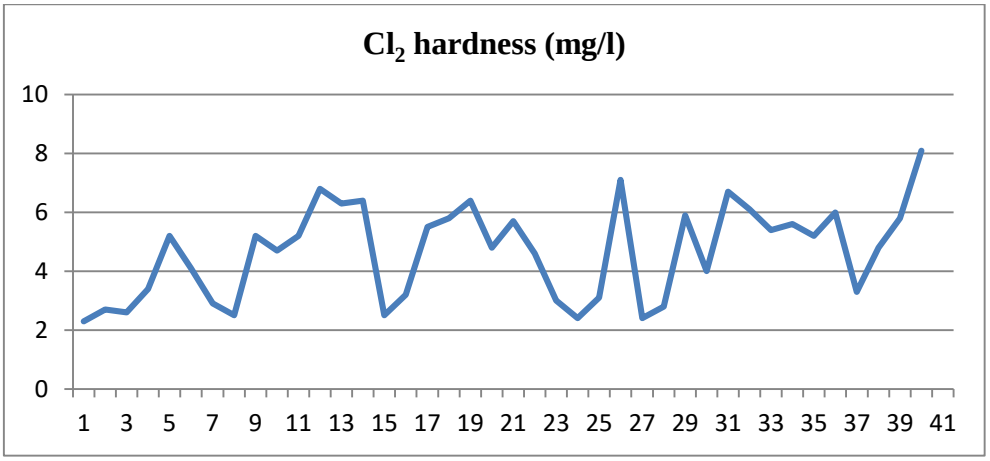


3.5 Calcium (Ca) - Calcium is an important element for teeth, bones and human cell physiology and may cause rickets in infants, cardiovascular diseases, bones fracture etc., while exceeding limit of calcium affects many bodily systems. As per WHO standards (2012), permissible limit of Calcium is 75mg/l, whereas in study area, its concentration in drinking water is within permissible range i.e., 2.3 – 20 mg/l.

3.5 Magnesium (Mg)- Magnesium ranks 8th most abundant element of earth crust. Human body contain about 25 g of magnesium. According to WHO standards, the acceptable limit of drinking water should be 50mg/l. In study areas magnesium ranged from 2.4 to 61 mg/l and mean value was found to be 6.18 mg/l which is less than the standard limits. Only in one location, the concentration of magnesium was found 60 mg/l which exceeds the WHO limit.



3.6 Chloride (Cl_2)- Chloride concentration in drinking water mainly increases due the dissolution of salts of $NaCO_2$, NaCl discharged from sewage industrial waste etc. Nevertheless, risk of chloride adulteration decreases in surface water in comparison with ground water. Present study reported Chloride concentration range (2.3 – 8.1 mg/l) which is below permissible limit of WHO standards (250 mg/l).



3.7 Total hardness- The presence of bivalent ions mainly Ca_2^+ and Mg_2^+ with their compounds causes hardness in drinking water. On the basis of calcium carbonate concentration total hardness is considered soft, hard or moderately hard. In study area, total hardness of drinking water value ranges from 8.4 to 76 mg/l which is within the desirable limit of WHO standards i.e., 500 mg/l. Below 75 mg/l is generally considered as soft. Hardness of water physical damages to pipes and boilers. Moderate hard water do not affect human physiology but long-term consumption of hard water can cause kidney dysfunction.

3.8 Bacterial contamination – Presence of coliform bacteria is a primary indicator of disease occurrence and suitability of water for consumption. To determine bacterial contamination, qualitative analysis was done. Large number of coliforms indicates probability of other pathogenic impurity. However, in study sites, out of 40 samples, only six trails comprise coliform bacteria in fewer amounts which is acceptable.

Table 1. Comparison of observed data (physic-chemical properties of drinking water from different study area) with standards recommended by WHO

S. N	Physico-chemical parameters	Study area	Standard WHO	Within Permissible limit
1	pH	(7-8.22)	(6.5-8.5)	Yes
2	Chloride (mg/L)	(2.3 - 8.1 ppm)	4 ppm	Yes
3	Total hardness mg/l	8.4 to 76	500	Yes
4	Ca hardness (mg/L)	(2.3-22)	200	Yes
5	Mg hardness(mg/L)	(2.4-61)	50	No
6	Electrical Conductivity (EC)	(118-1772) µS/cm	(200-800) µS/cm	No
7	Turbidity (NTU)	(0.3-2.68)	1	No
8	Total dissolved solids (TDS) (mg/L)	68-1065	500-1000	No

4. CONCLUSION: The World Health Organization estimated that up to 80% of all sicknesses and diseases in the world are caused by inadequate sanitization, polluted water or unavailability of water (WHO 1997). Present study concluded that in spite of variations, the observed value of physicochemical parameters of drinking water of Bilaspur district was found within the permissible limit of WHO standards accept four parameters that are Magnesium hardness, electrical conductivity, turbidity, total dissolved solids. High turbidity in drinking water can shield bacteria or other

microorganism which may cause symptoms like nausea, cramps and headaches etc. in humans. TDS and EC are directly proportional to each other which are used to describe salinity level. High conductivity generally does not have direct health impact however it should not be used for irrigation purpose and drinking.

Hence, it can be concluded that drinking water of some area are not suitable for drinking but can be utilized for domestic purpose and need necessary treatment.

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