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Kavindra J
Research Scholar, Dept. of Aquaculture, College of Fisheries, MPUAT, Udaipur, Rajasthan, India

Anil Churniya
Research Scholar, Dept. of Aquaculture, College of Fisheries, MPUAT, Udaipur, Rajasthan, India

Ravindra
Research Scholar, Dept. of Aquaculture, College of Fisheries, MPUAT, Udaipur, Rajasthan, India

Vimala Gatiyala
Research Scholar, Dept. of Chemistry, SPC Govt. College, MDSU, Ajmer, Rajasthan, India

Kailash Chaudhary
Research Scholar, CSIR-National Geophysical Research Institute (NGRI), Uppal Road, Hyderabad, Telangana, India

SK Sharma
Head, Dept. of Aquatic Environment Management, College of Fisheries, MPUAT, Udaipur, Rajasthan, India

Corresponding Author:
Kavindra J
Research Scholar, Dept. of Aquaculture, College of Fisheries, MPUAT, Udaipur, Rajasthan, India

Evaluation of TDS and electrical conductivity in groundwater's of Udaipur, Rajasthan and Its significance

Kavindra J, Anil Churniya, Ravindra, Vimala Gatiyala, Kailash Chaudhary and SK Sharma

Abstract
Due to rapid industrialization and over exploitation of ground water resources, there is a drastic change taking place in environment. Now a day's water pollution is a major problem. Samples were analyzed for EC and TDS as water quality parameters. From the study 52 per cent of total collected samples parameter indicates the quality of drinking water were in permissible level which is 500 – 1000 mg/L of Indian Standards (ISI) for drinking water and WHO guidelines for drinking water. So ground water in Udaipur (Rajasthan), most of samples are in permissible level for drinking.

Keywords: Total dissolved solids, world health organization, electrical conductivity, ground water, Udaipur

Introduction
Water is a good solvent and picks up impurities easily. Pure water- tasteless, colorless, and odorless- is often called the universal solvent. Dissolved solids" refer to any minerals, salts, metals, cations or anions dissolved in water. Groundwater is an essential and vital component of any life support system. It is not only the basic need for human existence but also a vital input for all development activities.

Groundwater used for domestic and irrigation purposes can vary greatly in quality depending upon type and quantity of dissolved salts. It contains a wide variety of dissolved inorganic chemical constituents in various concentrations, resulting from chemical and biochemical interactions between water and the geological materials. Dissolved salts should be present in irrigation water in relatively small but significant amounts. They originate from dissolution or weathering of the rocks and soil, including dissolution of lime, gypsum and other slowly dissolved soil minerals.

The total dissolve solids in a water body are sum of dissolved salts *viz*; sulphates, phosphates, carbonates, bicarbonates, chlorides, nitrates of calcium, magnesium, sodium, iron etc. The higher values of total dissolved solids in natural waters are generally due to increased anthropogenic activity, stagnation and concentration of water, which hampers water quality (Manickam *et al.*, 2014) [12].

In Rajasthan, for the estimation of fish production potential of different water bodies, their physico-chemical and primary productivity have been studied by several workers Nayer (1968) [13], Vyas (1968) [21], Vyas & Kumar (1968) [22] and Durve (1976) [5].

Sharma *et al.*, (2008) [15] enlightens that the seasonal variation of limnological parameters along with their interrelationship is important for checking the water quality for public water supply and also for fish production.

Water containing not less than 250 parts per million (mg/L) total dissolved solids (TDS), coming from a source tapped at one or more bore holes or springs, originating from a geologically and physically protected underground water source, may be "mineral water." Mineral water shall be distinguished from other types of water by its constant level and relative proportions of minerals and trace elements at the point of emergence from the source, due account being taken of the cycles of natural fluctuations. No minerals may be added to this water (USFDA 2017) [20].

Materials and Methods
Study Area
The study area lies in Udaipur district of Southern Rajasthan. Udaipur district is located between 23°46' & 25°05' North latitude and 73°09' & 74°35' East longitude covering an area of 13419 square km [Fig 1]. The district is part of Udaipur Division. Average annual rainfall of the district is 637.0 mm. The climate of the district is dry except south west monsoon season. The cold season is from December to February and is followed by summer from March to June. Period from mid of September to end of November constitutes post monsoon season.

Sample collection
A total of 21 samples were collected from 21 sites of Udaipur City during April, 2019 to June, 2019. The duration represent pre monsoon in the particular locality.

Methodology
The TDS and electrical conductivity (EC) were measured in situ by using pan type digital EC and TDS meter. Electrical conductivity of water is directly related to the concentration of dissolved ionized solids in the water. Ions from the dissolved solids in water create the ability for that water to conduct an electric current, which can be measured using a conventional conductivity meter or TDS meter.

Results and Discussion
In early studies, inverse relationships were reported between TDS concentrations in drinking water and the incidence of cancer, coronary heart disease, arteriosclerotic heart disease, and cardiovascular disease. Total mortality rates were reported to be inversely correlated with TDS levels in drinking-water (WHO, GDWQ 2003) [24].
The specific status of limnological characteristic and diversity of plankton in lake Pichhola studied by Riddhi *et al.,* (2011) [17]. They found that the water remained moderately alkaline (pH 7.5) while electrical conductance (0.3958 mS/cm), TDS (237.5mg/l), chloride (176mg/l), hardness (174.33mg/l) and alkalinity (207.16mg/l) showed low mean values. Groundwater is one of the major sources of drinking water all over the world (Bear 1979) [2].

Electrical conductivity
Electrical conductivity is a measure of water capacity to convey electric current. The most desirable limit of EC in drinking water is prescribed as 1.50 mS/cm (WHO 2004) [24]. Results of the investigation depicted in table 1.
52 per cent results were in permissible limit (Table 2). Higher EC in the study area indicates the enrichment of salts in the groundwater. It depends upon temperature, concentration and types of ions present (Hem 1985) [8].
The EC can be classified as
Type I, if the enrichments of salts are low (EC < 1.50 mS/cm);
Type II, if the enrichment of salts are medium (EC 1.50 to 3.00 mS/cm); and
Type III, if the enrichments of salts are high (EC > 3.00 mS/cm).
According to the above classification of EC, 76 % of the total groundwater samples come under the type I, 13 % under type II and 1% comes under type III. The effect of saline intrusion may be the reason for medium enrichment of EC in the study area. The effect of pH may also increase the dissolution process, which eventually increases the EC value.

Total Dissolved Suspends
TDS is not considered a primary pollutant with any associated health effects in human drinking water standards, but it is rather used as an indication of aesthetic characteristics of drinking water and as a broad indicator of an array of chemical contaminants.
According to WHO specification TDS up to 500 mg/l is the highest desirable and up to 1,500 mg/l is maximum permissible. In the study area the TDS value varies between a minimum of 370 mg/l and a maximum of 2400 mg/l, indicating that most of the groundwater samples lies within the maximum permissible limit (Table 3).
Since the beginning of time, water has been both praised and blamed for good health and human ills. We now know the real functions of water in the human body are to serve as a solvent and medium for the transport of nutrients and wastes to and from cells throughout the body, a regulator of temperature, a lubricator of joints and other tissues, and a participant in our body's biochemical reactions.
Worldwide, there are no agencies having scientific data to support that drinking water with low TDS will have adverse health effects. There is a recommendation regarding high TDS, which is to drink water with less than 500mg/L. Some people speculate that drinking highly purified water, treated by distillation, reverse osmosis, or deionization, "leaches" minerals from the body and thus causes mineral deficiencies with subsequent ill health effects. Our results shows that 14% of total sample were desirable drinking level which is <500 mg/L, 52% samples were permissible drinking level which range was 500- 1000 mg/L.
The scope of this paper is limited to answering whether low TDS water contributes to the loss of minerals from body tissues, producing associated harmful side effects. The types of minerals-e.g., calcium versus sodium, or hard water versus soft water and the toxicity of minerals e.g., lead, cadmium, brackish, or saline waters are not an issue in this report. Information on the body's homeostasis mechanisms, community water supplies with natural TDS less than 50mg/L, historic use of distilled water with less than 3mg/L TDS on board Navy ships, the United states Environmental Protection Agency's (USEPA) response to this issue, and other evidence are presented to demonstrate that the consumption of water with low levels of minerals is safe (Lee *et al*., 1993) [15].
The kidneys control the overall concentration of the constituents of body fluids. It filters about 180 liters (165 quarts) of water per day, but over 99% is reabsorbed and only 1.0-1.5 liters are eliminated as urine. If the osmolality of the fluid to be filtered by the kidney is lower than normal (low solute concentration-such as low TDS water) nervous and hormonal feedback mechanisms cause the kidney to excrete more water than normal and thus maintain the ion concentration in the body fluid to normal values. The opposite is true if the ion concentration of the fluid to be filtered is higher than normal. This kidney homeostatic mechanism keeps the body fluid osmolality normal. The osmolality of the fluid to be filtered by the kidney is controlled to ± 3% to maintain it at the normal level of 300mOsm/L. The three basic hormonal and nervous control systems triggered by abnormal ion concentration in the body fluids to be filtered by the kidney are antidiuretic hormone (ADH) from the pituitary gland, aldosterone from the adrenal glands, and thirst (as

osmolality rise of about 1% causes thirst) (Lee *et al.*,1993) [15]. Because of these kidney control mechanisms, drinking one liter of water would cause the urine output to increase about nine times after about 45 minutes (due to absorption of water in the gut) and continue for about two hours. Thus, the concentrations of solutes in the blood and other body fluids are quickly maintained by the kidney through homeostasis. These control mechanisms keep the sodium concentration at ±7%. Calcium secretion is controlled by Parathyroid hormone to ± a few percent in the extracellular body fluid. Also, saliva increases the ion concentrations during water intake. The concentration of sodium chloride in saliva is typically 15 milliequivalents per liter (mEq/L) or 877mg/L; that of potassium ion is about 30mEq/L (1170mg/L). As low TDS water is consumed, it is combined with saliva which increases the TDS before it reaches the gut to be absorbed, (e.g., each one mL of saliva can increase the TDS level in eight ounces of water consumed by about 10mg/L) (Lee *et al.*,1993) [15].
Therefore, it is evident that consumption by a healthy person of low TDS water alone cannot cause unhealthy systems. 'Healthy person' means free of disease, hormonal problems, etc., and not necessarily a healthy diet. Homeostasis is maintained by diet as are other body functions. If homeostasis is not maintained because of major diet deficiencies, disease, or hormonal dysfunction, consuming low TDS water would be a minor (if any) factor in any observed symptoms. Our most of samples are from permissible range so it was advised that water would be used after treatment.

Table 1: Sampling Sites and respective values

S. No.	Location	TDS (mg/l)	EC mS/ cm
1.	Mali Colony	900	1.330
2.	Tekari	1000	1.490
3.	Kumharo ka Bhatta	1680	2.510
4.	Bhuwana	2400	3.592
5.	Shobhagpura	950	1.425
6.	Ashok Nagar	1000	1.470
7.	Rampura	1790	2.682
8.	Amal ka Kanta	785	1.191
9.	Fatehpura	735	1.175
10.	Delhi Gate	817	1.230
11.	Hathipole	825	1.260
12.	Dewali	728	1.160
13.	Bhopalpura	710	1.120
14.	Hiran Magari Sector 14	800	1.210
15.	Sundarwas	1200	1.810
16.	Kalka Mata Road	1800	2.690
17.	Saheliyo ki Bari	770	1.180
18.	Goverdahan Sagar	760	1.178
19.	Fatehsagar	380	0.540
20.	Dudh Talai	460	0.670
21.	Lake Pichola	370	0.538

Table 2: Classification of groundwater based on TDS (Davis and De Wiest 1966) [4]

S. No	TDS level (mg/l)	Water type	% of sample
1.	< 500	Desirable for drinking	14%
2.	500- 1000	Permissible for drinking	52%
3.	<3000	Use for irrigation	34%
4.	>3000	Unfit for drinking and irrigation	--

Table 3: Groundwater samples of the study area exceeding the permissible limits prescribed by WHO (2004) [22] and ISI (2004) [9] for drinking purpose

S. No.	Water Quality parameters	WHO International Standard (2004)		Indian Standard (IS 10500 : 2012)		Range In study area
		Most desirable limit	Max. allowable limit	Highest desirable	Max. permissible	
1.	EC (mS/cm)	1.40	–	–	–	0.538- 3.592
2.	TDS (mg/l)	500	1,500	500	2,000	370-2400

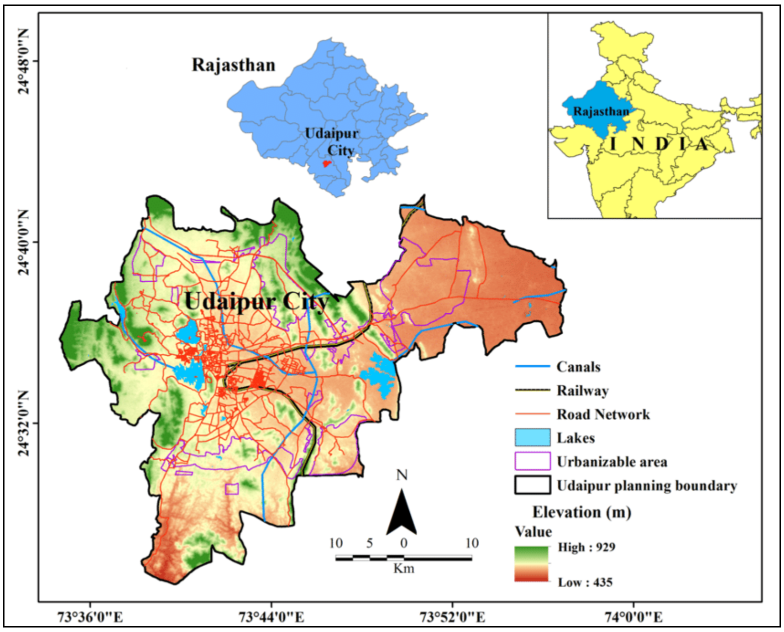

Fig 1: Map of Udaipur (Rajasthan), India

Conclusion
TDS of collected 52% samples were found within the permissible limits(<500 mg/L) so this water is suitable for drinking purposes and in case of TDS 34% samples contained high amount of TDS that means >1000mg/L. It was advised that water would be used after treatment.

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