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Hydrochemistry of Groundwater and its Suitability for drinking in Vaishali, Bihar, India

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ABSTRACT

Groundwater contains a wide variety of dissolved inorganic constituents as a result of chemical interactions with geological materials and to lesser extent contributions from the atmosphere. The study of hydrochemistry is of prime importance in deciding about the quality of groundwater supply. The present paper aimed at assessing the *hydrochemistry* and the water quality of the *groundwater* in the rural areas of district Vaishali, Bihar. In this area, groundwater was once considered to be free from pollution. But now a days, due to excess population, advancement of human civilization and transport of organic and inorganic pollutants has made a paradigm shift to the concept. In order to ensure the portability of groundwater, ten groundwater samples from the village areas of district Vaishali were collected and their physic-chemical and microbiological properties were analyzed. The results were compared with standards of WHO, ICMR, IS for time to time reliable monitoring of groundwater of this rural area for keeping close watch on water quality and health environment.

Keywords: *Groundwater, Inorganic constituents, Hydrochemistry, Pollution, Pollutants.*

INTRODUCTION

Groundwater is an important source of water supply throughout the world. Polluted groundwater is a major cause for spread of epidemics and chronic disease in man and terminating the quality of life of the people. On the other side, the climate change and increasing disruptions in the rainfall patterns, temperature and soil moisture directly impacted the water availability and its quality for drinking, livestock use, agriculture and various other purposes, and in this respect, the latest patterns of climate changes and water deficit reflected the depletion of water sources and deterioration of water quality in many parts of the world. Determination of groundwater composition and its interpretation is very important for the evaluation of its suitability for domestic, irrigation and industrial uses. Thus, knowledge on hydro-chemical processes that control groundwater chemical evolutions could lead to improved understanding of characteristics of an aquifer, and these would become a very important contribution for the effective management and development of new aspects of groundwater resources. (Allan, 2002; Al-Ahmadi,2013; Raju *et al*., 2014 and Toumi *et al*., 2015).

MATERIALS AND METHODS

Ten groundwater samples were collected from shallow tube wells from different following ten places in and around Mirnagar village areas of district Vaishali, Bihar : S_1-Mirnagar central portion-100 meters southeast from Birra Middle School; S_2 -Telia Sarai-28 meters from presently in NH 22; S_3-Dhobaghatti Shiv Mandir Chawk; S_4-Sonartoli Chawk, Dhobapatti; S_5-250 meters northeast to Bajitpur School; S_6-75 meters northeast to Panapur Primary School;S_7-Yadavtola, Mirnagar;S_8-Birra Southern Mohalla apart; S_9-50 meter east to

Birra Pokhar and S_{10}-Mirnagar North Mohalla. The samples were collected during month of March and April, 2020. Physico-chemical characteristics such as pH, EC, TDS, TA, Acidity, TH, Ca,

Mg, Fe, NH_3 , NO_2, Cl, F and SO_4 were determined and bacteriological analysis such as DO, COD and BOD were carried out and MPN index was calculated using methods (APHA, 2005) . Groundwater suitability for drinking was evaluated based on the World Health Organization (WHO).

RESULTS AND DISCUSSION

Table 1

Physico-chemical Parameters of water samples.

Parameters	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
pH	7.15	7.3	7.0	7.1	7.1	6.95	7.1	7.21	7.0	7.5
EC (μ mho/cm)	1700	1380	4000	1290	1180	850	2000	500	2000	700
TDS (mg/l)	220	224	1300	685	620	440	1280	810	1420	410
TA (mg/l)	25	37	20	200	285	180	170	140	190	102
Acidity (mg/l)	11	18	13	13	13	38	28	20	35	13
TH (mg/l)	830	445	1190	341	140	330	400	422	480	300
Calcium (mg/l)	190	34	285	60	52	56	138	88	88	80
Magnesium (mg/l)	80	82	110	44	15	46	16	50	65	24
Iron (mg/l)	0.15	0.17	0.20	0.16	0.08	0.75	0.16	0.0	0.16	0.16
Manganese (mg/l)	0.001	0.007	0.009	0.006	0.005	0.004	0.001	0.002	0.001	0.004
Sulphate (mg/l)	90	85	270	120	110	47	320	170	70	35
Chloride (mg/l)	350	220	820	110	90	105	330	175	350	90
Fluoride(mg/l)	0.2	0.5	0.2	0.0	0.1	0.5	0.0	0.4	0.6	0.2
Nitrate (mg/l)	7	10	2	3	8	14	12	14	15	12
Nitrite (mg/l)	0.05	0.02	0.03	1.20	0.25	0.05	0.05	0.03	0.05	0.02
Ammonia (mg/l)	0.20	0.05	0.05	0.05	0.46	0.13	0.25	0.30	0.05	0.02
DO (mg/l)	6.0	6.4	4.6	6.0	6.0	6.2	5.6	6.2	6.3	6.5
BOD (mg/l)	1.7	1.0	4.0	2.6	2.2	0.8	3.0	0.8	1.1	0.7
COD (mg/l)	4.0	3.0	8.0	6.0	4.0	2.2	6.0	2.0	3.0	2.2

The results of physico-chemical analysis of different groundwater samples are presented in Table 1. In the present study, pH were varies from 6.95-7.5. The samples having pH>7 were found to be weakly alkaline. This may be attributed to unreacted waste discharge into the water bodies, though the pH has no effect on the human health. Electrical conductivity (EC) values of water samples are exceeding the standard limits. The high value of EC are due to high concentration of ionic constituents present in the water bodies and reflect the pollution by domestic wastes(Narsimha, 2003 and Singh *et al.*, 2015). Total dissolved solids (TDS) indicates the general nature of quality or salinity. Concentration of TDS were in the range between 220-1300mg/l (except S_9). High alkalinity (TA) is good to have in our drinking water because it keeps the water safe for us to drink. The amount of alkalinity that should be in our water is 20-200 mg/L for typical drinking water. Alkalinity is basically dissolved minerals in the water that help neutralize the water we drink. Alkalinity in S_5 is exceeding the limit only. Hardness is most commonly expressed as milligrams of calcium carbonate equivalent per litre. The hardness of your water is a measure of the amount of lime dissolved in the water. Water with a calcium hardness of less than 100 ppm (mg/l) is described as soft water. Total hardness can be reduced by dilution with fresh water and increased with the addition of calcium chloride (WHO, 2009). Total hardness varied from 140-1190mg/l which are not totally up-to the mark. Calcium, magnesium, iron and manganese were exceeding in some samples also. High

concentration of manganese imparts highly objectionable (Kaka *et al*., 2011;Adimalla *et al.*, 2018 and Sreeja *et al*., 2018). A few sulphate and chloride concentration site samples were of low concentration, fluoride,nitrite and ammonia values were in their permissible limit except some samples. The investigation of DO revealed that values lie between 4.6-6.5. The maximum value was recorded as 6.5 of $S_{10.}$ The high value of DO means the rate of oxygen replenishment in water is greater than the oxygen utilization. BOD and COD values ranging 0.7-4.0mg/l and 2.0-8.0mg/l. All the samples lie within the permissible limit.

CONCLUSION

The work showed that the water quality from different areas in Mirnagar was somehow and someway going on the way of environmental degradation. Hence, it is suggested that the water samples should be used after time to time some pre-treatment like osmosis, electrodialysis, ion exchange and solar distillation, which is very essential to make aware of water utility, contamination and portability of adjacent village areas tube well drinking water.

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