Correlation Study of Drinking Water in North Indore City (M. P.)

Ram Prajapati[1], Ram Singh Muzalda[3]

Department of Zoology, Govt. Holkar Science Autonomous College, Indore (M.P.), India

Abstract: *Drinking water of various samples namely tap water, boring water and hand pumps water were taken from different locations of North Indore city. Total 64 samples were collected in different seasons in 2010-2011. Water samples were analyzed for various water quality parameters like pH, TDS, EC, Total Hardness, calcium, magnesium, Total Alkalinity, Bicarbonate, Carbonate, Nitrates, Chlorides, Fluorides, Sulphates, Sodium, Potassium, Iron, Copper, Zinc, Lead, Cadmium and Mercury. Much higher values of TDS Varied from 296 mg/l to 1702 mg/l during summer season, it crossed the standard permissible limit as 500 mg/l. In the summer season the range of total hardness from 188 mg/l to 706 mg/l that was much higher than the standard permissible limit (300 mg/L) (BIS, 1998). In the present study only 1.56%, of drinking water samples for copper crossed the permissible limit as 0.05 mg/l. (BIS, 1998) in Rainy season and 20.31%, 15.62% and 18.75% of drinking water samples for Mercury crossed the permissible limit as 0.001 mg/l (WHO, 2004) in Rainy, winter and summer seasons respectively. In the present study none of water samples crossed the standard permissible limit for Fluoride, Nitrates, Sulphates, Sodium and heavy metals namely Iron, Zinc, Lead and Cadmium.Pearson's correlation coefficient (r) values among various water quality parameters of all the samples were computed.*

Keywords: Drinking water, Physico-chemical parameters, Heavy metals and Correlation.

1. Introduction

Indore is the metropolitan city and industrial centre of Madhya Pradesh and lies in the heart of Malwa plateau. The Indore is located at 22o26'24" N latitude and 75o30'E longitude and occupies an area of about 130 km2. It is the commercial capital of the state of Madhya Pradesh. The population pressure on the city is ever growing. The behavior of heavy metals in the environment depends on their inherent chemical properties. Trace metal contaminations are important due to their potential toxicity for the environment and human beings (Wong C. S. C. *et al.,* 2003).The use of untreated or inadequately treated groundwater has been responsible for waterborne diseases including gastroenteritis, cholera, hepatitis, typhoid fever and giardiasis, the causative agents are bacterial and viral pathogens as well as protozoan parasites. In contrast to chemical hazards that may pollute groundwater, resulting in a long-range influence on public health in terms of time, microbiological pollution of groundwater sources has an immediate effect on large numbers of people. (Close M *et al.*, 2008 and Erah PO *et al.,* 2002)

2. Material and Method

Drinking water samples were analyzed physically and chemically by Standard method of water and waste water by (APHA, 1989). pH, total dissolved solids and electrical conductivity were measured by pH meter, TDS meter and conductivity meter respectively. The concentrations of Na and K were estimated by flame photometer. Spectrophotometer was used to determine by concentration of sulphate, nitrate, fluoride, iron and mercury. The concentrations of zinc, lead, copper, mercury and cadmium were estimated by Atomic Absorption Spectrophotometer.

3. Result and Discussion

Pearson's correlation coefficient (r) values among various water quality parameters of all the drinking water samples were computed. The significance correlation coefficient values are reported in the table -1, 2 and 3. In the present study the values of pH ranged from 7.12 to 8.63, 7.34 to 8.76 and 7.42 to 8.82 during Rainy, winter and summer seasons respectively. In the present study only 1.56%, 3.12% and 12.5% of drinking water samples for pH crossed the permissible limit as 8.5 (WHO, 2004) in Rainy, winter and summer seasons respectively.

The values of Total dissolved solids ranged from 262 mg/l to 1293 mg/l, 259 mg/l to 1395 mg/l and 296 mg/l to 1702 during Rainy, winter and summer seasons respectively. This range is much lower than the one reported by K. Ravichadran and M. Jayprakash (2011) (242 mg/l to 5225 mg/l) in ground water of an Industrial area of North Chennai, India. Only 81.25%, 84.37% and 84.37% of drinking water samples for TDS crossed the permissible limit as 500 mg/l (BIS, 1998) in Rainy, winter and summer seasons respectively. In the study area of North Indore city total dissolve solids of drinking water showed highest positive correlation with electrical conductivity (0.99, 0.99 and 0.99), total hardness (0.79, 0.82 and 0.85), calcium hardness (0.67, 0.55, and 0.67), magnesium hardness (0.57, 0.80 and 0.80), total alkalinity (0.74, 0.69 and 0.63), chloride (0.91, 0.92 and 0.92), sodium (0.79, 0.84 and 0.84) and bicarbonate (0.74, 0.69 and 0.62) during rainy, winter and summer seasons respectively.

The values of conductivity ranged from 442 μ mhos/cm to 2155 μ mhos/cm, 437 μ mhos/cm to 2301 μ mhos/cm and 483 μ mhos/cm to 2840 μ mhos/cm during Rainy, winter and summer seasons respectively. This range is much lower than those reported by S. Arul Antony *et.al.* (2008) varied from (2331 μ mhos/cm to 9797 μ mhos/cm) in Ground water of Manali Petroleum region in Tamil Nadu, India. In drinking water of North Indore city positive correlation obtained between electric conductivity and total hardness (0.78, 0.80 and 0.84), calcium hardness (0.66, 0.53 and 0.65), magnesium hardness (0.56, 0.79 and 0.80), total

1972

alkalinity (0.74, 0.70 and 0.62), chloride (0.90, 0.92 and 0.91), sodium (0.77, 0.83 and 0.82) and bicarbonate (0.74, 0.70 and 0.61) during rainy, winter and summer seasons respectively.

The values of Total hardness ranged from 120 mg/l to 680 mg/l, 156 mg/l to 689 mg/l and 188 mg/l to 706 mg/l during Rainy, winter and summer seasons respectively. This range is much higher than those reported by Rizwan Reza1 and Gurdeep Singh (2009) varied from (102 mg/l to 105 mg/l) in Ground water of Angul Talcher region in Orissa. Only 78.12%, 96.87% and 96.87% of drinking water samples for Magnesium hardness crossed the permissible limit as 30 mg/l. (BIS, 1998) in Rainy, winter and summer seasons respectively. In drinking water of North Indore city total hardness showed highest positive correlation with calcium hardness (0.89, 0.73 and 0.76), magnesium hardness (0.58, 0.95 and 0.95), total alkalinity (0.67, 0.62 and 0.62), bicarbonate (0.67, 0.62 and 0.62), chloride (0.53, 0.59 and 0.67) and sodium (0.50, 0.59 and 0.66) during rainy, winter and summer seasons respectively.

The values of Total Alkalinity ranged from 110 mg/l to 452 mg/l, 117 mg/l to 478 mg/l and 135 mg/l to 534 mg/l during Rainy, winter and summer seasons respectively. In drinking water of North Indore city total alkalinity showed positive correlation with sodium (0.61, 0.61 and 0.60) and bicarbonate (0.99, 0.99 and 0.99) during rainy, winter and summer seasons respectively.

The values of Chloride ranged from 38.99 mg/l to 567.2 mg/l, 46 mg/l to 572 mg/l and 56 mg/l to 590 mg/l during Rainy, winter and summer seasons respectively. Only 68.75%, 70.31% and 73.44% of drinking water samples for Chloride crossed the permissible limit as 250 mg/l. (BIS, 1998) in Rainy, winter and summer seasons respectively. In drinking water of North Indore city the chloride showed highly positive correlation with sodium (0.78, 0.81 and 0.81) during rainy, winter and summer seasons respectively.

The values of Potassium ranged from 1 mg/l to 4 mg/l, 1 mg/l to 5 mg/l and 1 mg/l to 6 mg/l during Rainy, winter and summer seasons respectively. Jain *et al.,* (2006) reported that the values of Potassium varied from (1 mg/l to 3 mg/l) in Ground water of Kosamghat region, Jabalpur, M.P.

The values of Copper ranged from 0.0001 mg/l to 0.084 mg/l, 0.001 mg/l to 0.007 mg/l and 0.001 mg/l to 0.013 mg/l during Rainy, winter and summer seasons respectively. In the present study only 1.56%, of drinking water samples for copper crossed the permissible limit as 0.05 mg/l. (BIS, 1998) in Rainy season. The values of Mercury ranged from BDL to 0.004 mg/l, BDL to 0.005 mg/l and BDL to 0.004 mg/l during Rainy, winter and summer seasons. In the present study only 20.31%, 15.62% and 18.75% of drinking water samples for Mercury crossed the permissible limit as 0.001 mg/l (WHO, 2004) in Rainy, winter and summer seasons respectively.

In the present study none of water samples crossed the standard permissible limit for Fluoride (1.5 mg/l) (WHO, 2004), Nitrates (45 mg/l) (BIS, 1998), Sulphates (200 mg/l) (BIS, 1998), Sodium (200 mg/l) (WHO, 2004) and heavy metals namely Iron (0.3 mg/l) (WHO, 2004), Zinc (5 mg/l) (WHO, 2004) , Lead (0.05 mg/l) (WHO, 2004) and Cadmium (0.01 mg/l) (BIS, 1998).

The values of Iron ranged from 0.0001 mg/l to 0.009 mg/l, 0.001 mg/l to 0.013 mg/l and 0.001 mg/l to 0.015 mg/l during Rainy, winter and summer seasons respectively. Manoj Kumar Meena *et al.,* (2010) reported the values of iron ranging from (0.03 mg/l to 0.083 mg/l) in Ground water of Ajmer city Rajasthan, India. In the present study, the statistical data obtained that the drinking water quality is poor as it is polluted with high amount of TDS, TH, chloride, total alkalinity and Electrical conductivity. Most of the parameters were either more than permissible limit or excessive limit. Therefore, the drinking water in the study area is not potable before treatment. To maintain quality of drinking water, the continuous monitoring of Physico-chemical parameters should be done. On the basis of the present study, it is recommended that the drinking water in the study area should be treated before it is used for drinking and other domestic purposes.

References

[1] A.P.H.A. (1989). American Public Health Association, Standard methods for Examination of water and waste water, APHA, AWWA, WPCF, New York, 17th Ed.

[2] B.I.S. (1998). Specification for drinking water, Bureau of Indian standard, New Delhi, 171-178.

[3] Close M, Dann R, Ball A, Pirie R, Savill M and Smith Z. (2008). Microbial groundwater quality and its health implications for a border-strip irrigated dairy farm catchment, South Island, New Zealand. J Water Health. 6(1): 83–98.

[4] Erah PO, Akujieze ChN and Oteze GE. (2002). The Quality of groundwater in Benin City: a baseline study on inorganic chemicals and microbial contaminants of health importance in boreholes and open wells. Trop. J. Pharm. Res. 1(2): 75–82.

[5] Jain Nidhi, Shikha Saxena, A.N. Singh. And R.K. Srivastava (2006). Studies on the underground water quality of Earthquake affected Kosamghat region of Jabalpur District. Nature Environ. and Poll. Tech. 5(1): 123-127.

[6] K. Ravichandran and M. Jayaprakash (2011). Seasonal variation on Physico-chemical parameters and trace metals in groundwater of an industrial area of north Chennai, India. Indian J. Sci. Technol. 4(6): 646-649.

[7] Manoj Kumar Meena, Subroto Dutta and Rashmi Pradhan (2010). Environmental Impact of waste water Irrigation on Groundwater Quality –A Case Study of Ajmer City, Rajasthan (India). EJEAFChe. 9(4): 760-766.

[8] Rizwan Reza1 and Gurdeep Singh (2009). Physico-Chemical Analysis of Ground Water in Angul-Talcher Region of Orissa, India. Journal of American Science. 5(5): 53-58.

[9] S. Arul Antony, M. Balakrishnan, S. Gunasekaran and R.K. Natarajan (2008). A correlation study of the ground water quality in the Manali Petroleum Industrial Region in Tamil Nadu, India. Indian J. Sci. Technol. 1(6): 1-11.

[10] W.H.O. (2004). Guideline for drinking water quality,

Third edition (Recommendations), World Health Organization, Geneva.

[11] Wong C. S. C., Li X. D., Zhang G., Qi S. H. and Peng X. Z. (2003). Atmospheric deposition of heavy metals in the Pearl River Delta, China, Atmos. Environ. 37(6).

Table 1

	pH	TDS	EC	TH	Ca	Mg	TA	HCO₃	CL	F	NO₃	SO4	Na	K	Fe	Cu	Zn	Pb	Cd	Hg
pH	1	0.11	0.12	0.04	-0.04	0.24	0.06	0.06	0.11	0.11	-0.07	0.06	0.03	-0.25	0.26	-0.02	-0.08	0.28	0.35	0.08
Total dissolved solids		1	0.99	0.79	0.67	0.57	0.74	0.74	0.91	0.08	-0.04	0.18	0.79	0.06	0.13	-0.27	0.006	0.05	-0.08	0.002
Electrical conductivity			1	0.78	0.66	0.56	0.74	0.74	0.9	0.07	-0.07	0.19	0.77	0.06	0.13	-0.27	-0.02	0.05	-0.07	-0.004
Total hardness				1	0.89	0.58	0.67	0.67	0.53	0.07	-0.01	-0.04	0.50	0.24	-0.02	-0.21	0.15	-0.09	-0.17	-0.13
Calcium hardness					1	0.48	0.53	0.53	0.40	0.07	0.08	0.01	0.40	0.26	-0.09	-0.20	0.15	-0.14	-0.19	-0.19
Magnesium hardness						1	0.58	0.58	0.47	0.30	0.04	-0.03	0.39	0.15	0.56	-0.03	0.007	0.40	0.41	0.30
Total alkalinity							1	0.99	0.61	0.18	-0.22	0.12	0.61	0.15	0.16	-0.06	-0.05	0.03	0.001	0.09
Bicarbonate								1	0.61	0.18	-0.22	0.12	0.61	0.15	0.16	-0.06	-0.05	0.03	0.001	0.09
Chloride									1	0.07	-0.04	0.16	0.78	-0.08	0.17	-0.26	-0.09	0.09	-0.05	0.08
Fluoride										1	0.07	0.03	0.05	-0.08	0.40	0.002	0.02	0.06	0.16	0.04
Nitrate											1	0.07	-0.09	0.01	0.06	-0.09	0.195	0.19	0.07	0.23
Sulphate												1	0.18	-0.26	0.17	-0.06	-0.07	0.04	0.11	0.13
Sodium													1	0.01	0.14	-0.22	-0.02	0.08	0.001	0.06
Potassium														1	-0.10	0.41	-0.01	-0.03	-0.13	-0.11
Iron															1	0.007	-0.03	0.54	0.53	0.55
Copper																1	-0.03	0.02	0.02	-0.01
Zinc																	1	-0.05	-0.05	-0.07
Lead																		1	0.53	0.46
Cadmium																			1	0.61
Mercury																				1

CORRELATION COEFFICIENT (r) OF DRINKING WATER OF NORTH INDORE CITY IN THE RAINY SEASON

Table 2

	pH	TDS	EC	TH	Ca	Mg	TA	HCO₃	CO₃	CL	F	NO₃	SO₄	Na	K	Fe	Cu	Zn	Pb	Cd	Hg
pH	1	0.26	0.28	0.11	-0.13	0.20	0.28	0.29	0.22	0.29	0.008	0.12	0.05	0.19	0.01	0.07	0.09	-0.14	-0.06	-0.08	-0.09
Total dissolved solids		1	0.99	0.82	0.55	0.80	0.69	0.69	-0.24	0.92	0.13	0.22	0.34	0.84	-0.08	-0.03	-0.07	0.01	0.09	-0.14	-0.06
Electrical conductivity			1	0.80	0.53	0.79	0.70	0.70	-0.31	0.92	0.13	0.22	0.35	0.83	-0.09	-0.03	-0.05	0.01	0.12	-0.17	-0.07
Total hardness				1	0.73	0.95	0.62	0.62	-0.22	0.59	0.16	0.22	0.17	0.59	-0.03	-0.01	0	0.15	0.04	-0.08	-0.18
Calcium hardness					1	0.48	0.34	0.34	-0.42	0.36	0.14	0.38	0.22	0.37	-0.01	-0.11	0.072	0.06	-0.05	-0.03	-0.28
Magnesium hardness						1	0.63	0.64	-0.10	0.60	0.14	0.11	0.11	0.59	-0.03	0.04	-0.04	0.17	0.07	-0.08	-0.02
Total alkalinity							1	0.99	-0.27	0.59	0.04	0.01	0.15	0.61	-0.19	0.09	-0.03	-0.06	-0.08	0.04	0.15
Bicarbonate								1	-0.3	0.58	0.04	0.02	0.15	0.61	-0.19	0.10	-0.02	-0.06	-0.07	0.04	0.13
Carbonate									1	-0.09	-0.36	-0.24	-0.49	-0.30	0.16	0.10	-0.17	0.22	-0.27	-0.23	0.94
Chloride										1	0.11	0.13	0.28	0.81	-0.08	-0.07	-0.14	-0.07	0.06	-0.12	-0.03
Fluoride											1	0.23	0.13	0.15	0.03	0.26	0.03	0.31	-0.07	0.14	0
Nitrate												1	0.19	0.26	0.04	0.10	-0.06	0.07	-0.08	-0.06	0.22
Sulphate													1	0.21	-0.08	0.19	0.03	-0.03	0.13	-0.13	-0.20
Sodium														1	-0.20	-0.05	-0.17	0.005	-0.02	-0.25	0.15
Potassium															1	0.07	-0.07	0.32	-0.15	0.16	0.06
Iron																1	-0.18	-0.01	0.20	0.001	0.11
Copper																	1	0.11	0.10	0.17	-0.09

Paper ID: SUB155472

1974

																		Zn	Pb	Cd	Hg
Zinc																		1	-0.13	0.15	-0.03
Lead																			1	-0.15	-0.08
Cadmium																				1	-0.06
Mercury																					1

CORRELATION COEFFICIENT (r) OF DRINKING WATER OF NORTH INDORE CITY IN THE WINTER SEASON

Table 3

	pH	TDS	EC	TH	Ca	Mg	TA	HCO$_3$	CO$_3$	CL	F	NO$_3$	SO$_4$	Na	K	Fe	Cu	Zn	Pb	Cd	Hg
pH	1	0.19	0.2	0.1	0.1	0.2	0.3	0.32	0.004	0.2	0.17	0.11	0.05	0.17	0.01	0.09	0.04	-0.1	-0.1	-0.2	0.13
Total dissolved solids		1	1	0.9	0.7	0.8	0.6	0.62	-0.03	0.92	0.28	0.37	0.47	0.84	0.11	0.02	0.2	0	0.02	0.14	0.23
Electrical conductivity			1	0.8	0.7	0.8	0.6	0.61	-0.04	0.91	0.26	0.36	0.47	0.82	0.1	0.01	0.21	0	-0.1	0.13	0.19
Total hardness				1	0.8	1	0.6	0.62	-0.23	0.67	0.26	0.35	0.34	0.66	0.18	0.12	0.25	0.12	0	0.23	0.4
Calcium hardness					1	0.5	0.4	0.4	-0.59	0.47	0.05	0.41	0.37	0.45	0.14	0.09	0.14	0.03	0.16	0.26	0.01
Magnesium hardness						1	0.6	0.62	-0.02	0.66	0.32	0.27	0.27	0.65	0.17	0.12	0.26	0.14	-0.1	0.16	0.5
Total alkalinity							1	0.99	0.29	0.57	0.3	0.08	0.25	0.6	0.07	0.1	-0	-0.1	-0.2	-0.1	0.2
Bicarbonate								1	0.26	0.56	0.3	0.09	0.26	0.61	0.07	0.11	0	-0	-0.2	-0.1	0.2
Carbonate									1	0.42	0	-0.3	-0.5	0.14	0.16	0.42	-0.1	-0	0.34	0.54	-0.4
Chloride										1	0.27	0.25	0.41	0.81	0.03	-0.1	0.13	-0.1	0.11	0.18	0.24
Fluoride											1	0.12	0.06	0.2	0.07	0.06	-0	-0.1	-0.1	0.11	0.45
Nitrate												1	0.34	0.22	0.02	0.18	0.03	0.07	-0.1	0.2	0.21
Sulphate													1	0.32	0	0.3	0.25	-0.1	-0.1	-0.1	-0.3
Sodium														1	0.2	0	-0	-0	0.06	0.03	0.41
Potassium															1	-0.1	0.27	0.18	-0.1	-0.2	0.12
Iron																1	0.19	0.05	0.01	-0.2	-0.2
Copper																	1	0.08	-0.1	-0.3	-0.1
Zinc																		1	-0	0	0.11
Lead																			1	0.1	0.04
Cadmium																				1	0.12
Mercury																					1

Correlation Coefficient (r) of Drinking Water Of North Indore City in the Summer Season

Paper ID: SUB155472