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Research Article

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Physico-chemical study of ground water quality of some areas of Imphal city, Manipur-2nd Phase

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ABSTRACT

Ten (10) ground water samples from different location of Imphal City (2 belonging to Imphal East district and 8 belonging to Imphal West district, were analyzed for physico – chemical parameters such as temperature, pH, electrical conductivity, TDS (total dissolved solids), total hardness, calcium (Ca), magnesium (Mg), sodium (Na), potassium (K),chloride (Cl). Percentsodium (%Na) values for the ten ground water samples, were calculated. Out of these ten samples analyzed, only the ground water of Chingmeirong Napali Basti of Imphal East district (represented by S-10) has physio –chemical parameters within desirable limits of BIS standards for drinking water. It is found to be of good quality, and fit for drinking and other domestic purposes. Although ground waters represented by S-5 and S-10 are of good quality for irrigation (or agriculture), other remaining ones may also be used for irrigation (or agriculture). However, in case of ground waters represented by S-1 to S-9, some suitable treatments are required so as to keep the values of some physico-chemical parameters within the desirable limits of BIS standards for drinking water though all the samples are fit for domestic and irrigation (or agriculture) purposes.

Keywords: Ground Water, physico-chemical parameters, drinking, domestic and irrigation.

INTRODUCTION

As the population growth increases day by day all over the world, there is rapid increase of urbanization also. As a result of it, the quantity of surface water decreases everywhere. This leads to the more demand of ground water for human consumption, that is, for drinking as well as other domestic purposes, mainly. Not only this, nowadays, such ground waters are utilized for irrigation (agriculture) and industrial purposes also.

Ground water is about 0.6% of the total global water resources and out of this only 0.3% is extractable economically [1]. Researchers, all over the world, examine the quality of ground water in search of suitability for drinking and other domestic purposes, irrigation, industries etc [2-4]. In India also, there is increasing demand of ground water for drinking, domestic, irrigation (agriculture), industries etc. In order to examine whether such ground water is suitable for drinking and other domestic purposes mainly, various researchers carried out the study of ground water quality in many states of India such as Madhya Pradesh, Andhra Pradesh, Maharashtra, Bihar, Karnataka, Rajasthan and Assam [5 – 13].

In Imphal city of Manipur there is much demand of ground water by the people living in the periphery of the city because of lack of municipal supply of drinking water regularly. Not only this, there is much demand of ground water for other domestic purposes also for most of the people in this Imphal City. Because of this increasing demand of ground water, many hand pumps were installed in suitable places of the city by the PHED of state government and many people installed hand pumps of their own to meet their requirement for drinking as well as other domestic purposes. However, it is very much needed to examine whether such ground waters are suitable for drinking, other domestic and irrigation purposes mainly.

The present aim of the research work is to study the physico-chemical parameters of ground water of some selected sites of Imphal City (both Imphal East andImphal West districts) so as to examine whether such ground waters are fit for drinking, other domestic and irrigation (or agriculture) purposes. This is in continuation of my former research work [14] .

EXPERIMENTAL SECTION

All the chemical reagents were of analytical reagent (AR) grade and were used as received.

From ten (10) different locations (sampling sites) of Imphal East and Imphal West districts, ground water samples were collected (during morning time) in well sterilized polythene bottles of 1 litre capacity each and they were analyzed for various physio-chemical parameters during April-May, 2013 of pre –monsoon period. The geographical locations such as longitude and latitude of these ten sampling sites,were measured with the help of GPS (global positioning system) instrument.

The locations of different sampling sites along with their longitudes and latitudes, are detailed below in table-1:

Table – 1: Locations of different sampling sites of Ground Water

Sample Code No.	Sampling Sites	District	Longitude	Latitude
S – 1 (Hand Pump)	Premise of Chemistry Department, D.M. College of Science, Imphal	Imphal West	$93^0$56’36.67’’E	$24^0$49’21.00’’N
S – 2 (Hand Pump)	D.M. College Boys’ Hostel, Imphal (residential)	Imphal West	$93^0$56’32.16’’E	$24^0$49’26.17’’N
S – 3 (Hand Pump)	KhagempalliHuidromLeikai,Imphal (residential)	Imphal West	$93^0$56’04.04’’E	$24^0$47’11.41’’N
S-4 (Hand Pump)	Manipur College Gate, Imphal (residential)	Imphal West	$93^0$56’05.63’’E	$24^0$47’00.06’’N
S – 5 (Hand Pump)	Foot hill of Chinga Hillock, Singjamei, Imphal (residential)	Imphal West	$93^0$56’12.66’’E	$24^0$46’55.56’’N
S – 6 (Over flow)	ChangangeiMayaiLeikai, Imphal (1) (residential)	Imphal West	$93^0$53’39.96’’E	$24^0$45’54.34’’N
S – 7 (Over flow)	ChangangeiMayaiLeikai, Imphal (2) (residential)	Imphal West	$93^0$53’37.27’’E	$24^0$45’53.66’’N
S – 8 (Hand Pump)	ChangangeiAwangLeikai, Imphal (residential)	Imphal West	$93^0$53’38.97’’E	$24^0$45’58.33’’N
S – 9 (Hand Pump)	ChingmeirongManingLeikai, Imphal (residential)	ImphalEast	$93^0$56’35.38’’E	$24^0$49’40.27’’N
S – 10 (Hand Pump)	Chingmeirong Nepali Basti, Imphal (residential)	Imphal East	$93^0$56’39.97’’E	$24^0$49’53.64’’N

Parameters such as temperature, pH, TDS, (total dissolved solids) and electrical conductivity, were recorded at sampling sites while other remaining parameters such as total hardness, calcium, magnesium (by calculation) and chloride, were determined at departmental research laboratory using standard methods [15]. But sodium and potassium were determined by flame photometer.

The various instruments and brief methods used for measurement (or determination)of various physico – chemical parameters, are shown in table -2 below :

Table – 2 : Instruments/methods used for measurement (or determination) of various physico-chemical parameters of different ground water samples

Parameters measured/determined	Instruments/methods used
Temperature	TDS Meter (TDS-3) (TDS/temp.) (HIMEDIA, India)
pH	pHep® pocket sized pH Meter (HI98107) (HANNA Instruments, Romania)
TDS (total dissolved solids)	TDS Meter (TDS – 3) (TDS/Temp.) (HIMEDIA, India)
Electrical conductivity	Conductivity Tester (DiST 3 : H198303) (HANNA Instruments, Romania)
Total Hardness	EDTA Titrimetric Method (using EBT indicator)
Calcium (Ca)	EDTA Titrimetric Method (using Murexide indicator)
Magnesium (Mg)	Calculation Method
Sodium (Na)	Flame Photometer 128 (Sytronics, India)
Potassium (K)	Flame Photometer 128 (Sytronics, India)
Chloride (Cl)	Argentometric Titrimetric Method (using K_2CrO_4 indicator solution)

The parameter percent sodium (%Na) of various ground water samples, were calculated using the relationship [16]:

$$\% \text{ Na} = \frac{\text{Na+K}}{\text{Ca+Mg+Na+K}} \times 100$$

Here ionic concentrations of Na, K, Ca and Mg were expressed in milli- equivalents per litre (meq/l). This percent sodium parameter is used for deciding whether the water may be used for irrigation/agricultural purposes or not.

The various values of percent sodium (% Na) of various ground water samples, are shown in tables -3.

RESULTS AND DISCUSSION

All the ten samples are found to be colourless and odourless. The various experimentally found data of different physico-chemical parameters along with percent sodium values of all the ten ground water samples, are shown in table – 3 below:

Table -3: Values of various physico – chemical parameters of different ground water samples with corresponding percent sodium values

Sample Code No.	Temperature (^{0}C)	pH	TDS (mg/l)	Electrical conductivity μ s/cm)	Total hardness (mg/l, as $CaCO_3$)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Cl (mg/l)	Percent sodium (% Na)
S – 1	23.4	7.1	693	1348	250	32.1	41.5	181.4	1.8	171.8	61.3
S – 2	24.0	7.6	733	1449	258	32.9	42.9	206.5	2.4	210.2	63.6
S – 3	23.2	7.7	744	1453	150	20.8	23.9	276.2	1.9	166.1	80.1
S – 4	23.4	7.8	826	1615	164	24.8	24.9	289.9	1.7	286.8	79.4
S – 5	24.2	7.2	358	708	264	44.1	37.6	40.4	1.1	71	25.2
S – 6	23.8	7.0	525	1061	156	16.8	27.8	143	3.4	4.3	66.9
S – 7	24.0	6.7	520	1050	142	14.4	25.9	164.1	2.8	5.7	71.7
S – 8	24.0	6.8	546	1084	156	16.0	28.3	161.2	3.4	7.1	69.4
S – 9	22.9	7.4	480	971	208	24.8	35.6	119.9	1.4	41.2	55.8
S – 10	23.3	7.6	263	492	206	33.7	29.8	28.4	0.8	25.6	23.3

Temperature:
At low temperature water has more dissolved oxygen and has good taste than that at higher temperature [17]. The temperature of the ten samples (S-1 to S-10) are in the range 22.9^{0}C to 24.9^{0}C (table-3). S-9 has the lowest temperature while S-5 has the highest temperature.

pH Values:
The pH values of the ten samples (S-1 to S-10) range from 6.7 to 7.8 (table -3). S-7 and S-8 are found to be slightly acidic but S-1, S-2, S-3, S-4, S-5, S-9 and S-10 are found to be slightly alkaline However S-6 is found to be neutral. All the pH values of the ten ground water samples are within desirable limit (6.5 – 8.5) of BIS standards for drinking water as well as that of WHO [18-19].

TDS (total dissolved solids):
TDS is another important parameter which is used to dictate whether the given water sample may be used for drinking and irrigation (or agriculture) or not. Regarding the present work, the TDS values of the ten samples (S – 1 to S – 10) range from 263 mg/l to 826 mg/l (table – 3). Only S-5, S-9 and S-10 have TDS values within desirable limit (500 mg/l) while that of S-1, S-2, S-3, S-4, S-6, S-7 and S-8 are within the permissible limit (2000 mg/l) of BIS standards [18]. Since TDS value of each of them is less than 1000 mg/l, all of them may be used for domestic purpose [20].

Electrical Conductivity:
Electrical conductivity value is also another parameter for deciding whether the water may be used for irrigation/agriculture. Here, the electrical conductivity values of the ten ground water samples (S-1 to S-10) range from 492 μ s/cm to 1615 μ s/cm (table–3). From electrical conductivity point of view, ground waters represented by S- 5 and S – 10 are good for irrigation while remaining eight samples are in permissible class for irrigation [20].

Total hardness:
The total hardness values (mg/l, as $CaCO_3$) of the ground water samples (S – 1 to S-10) range from 142 mg/l to 264 mg/l (table – 3). S – 3 and S – 7 are moderately hard while S – 1, S-2, S-4, S-5, S-6, S-8, S-9 and S – 10 are hard [16,20]. The total hardness values of all the ten samples (S-1 to S-10) are within the desirable limit (300 mg/l) of BIS standards for drinking water [18].

Calcium (Ca):
The values of calcium of the ten samples (S – 1 to S- 10) are in the range 14.4 mg/l to 44.1 mg/l (table – 3) and all these values are within the desirable limit (75 mg/l) of BIS standards of drinking water [18].

Magnesium (Mg):
The values of magnesium of the ten samples (S – 1 to S – 10) range from 23.9 mg/l to 42.9 mg/l (as shown in table – 3). From this table – 3, it is clearly seen that for the ground water samples S-3, S-4, S-6, S-7, S-8 and S-10, their corresponding values of magnesium, are within the desirable limit (30 mg/l) while that of S-1, S-2, S-5 and S-9 are within the permissible limit (100 mg/l) of BIS standards for drinking water [18].

Sodium (Na):
Regarding sodium content of the ten ground water samples (S-1 to S-10), the values are in the range 28.4 mg/l to 289.9 mg/l (table – 3).According to WHO, the threshold value for sodium is about 200 mg/l for drinking water [19]. For the samples S-1, S-5, S-6, S-7, S-8, S-9 and S-10 the values for sodium are below this threshold value (200 mg/l) while that of the samples S-2, S-3 and S-4 are above this threshold value. Percent sodium values of the ten samples are also shown in table – 3, ranging from 23.3 % to 80.1%.

From these percent sodium values, it is seen that only S – 5 and S – 10 are of good quality for irrigation (or agriculture) purposes and that of sample S – 9, the value is within permissible limit [16].This shows that out of the ten ground water samples (S-1 to S-10) only the ground waters represented by S-5, S-9 and S-10, may be used for irrigation (or agriculture) purposes very well.

Potassium (K) :
All the ten ground water samples (S-1 to S-10) have low values of potassium ranging from 0.8mg/l to 3.4mg/l (as shown in table-3).

Chloride (Cl) :
Regarding the chloride contents of the ten ground water samples (S-1 to S-10), the values are in the range 4.3 mg/l to 286.8 mg/l (table-3). Except the sample S-4 (286.8 mg/l), other remaining nine ground water samples have their corresponding values for chloride within the desirable limit (250 mg/l) but that of S-4 (286.8 mg/l) is within the permissible limit (1000 mg/l) of BIS standards for drinking water[18].

CONCLUSION

From the discussions of the experimental results of various physico-chemical parameters of ten (10) ground water samples, it is found that only the ground water represented by S-10 (Chingmeirong Nepali Basti, Imphal), it is good quality for drinking and domesticpurposes. From electrical conductivity and percent sodium point of views, it is further concluded that ground water represented by S-5 and S-10 are of good quality for irrigation/ agricultural purposes. However, from electrical conductivity point of view, ground waters represented by S-1, S-2, S-3,S-4,S-6,S-7,S-8 and S-9 may also be used for irrigation (or agricultural) purposes. Lastly, in case of ground waters represented by S-1 to S-9, some suitable treatments are necessary so as to keep their qualities within desirable limits of BIS standards for drinking water.

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