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Research Article

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Physico-chemical assessment of ground water quality of some areas in and around Imphal city, Manipur during monsoon

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ABSTRACT

Ten ground water samples collected from different locations in and around Imphal city of Manipur during September of monsoon period (2013), were analyzed for physico-chemical parameters such as temperature, pH, TDS (total dissolved solids), electrical conductivity, total hardness, calcium (Ca), magnesium (Mg), sodium (Na), potassium (K) and chloride (Cl). Values of percent sodium (%Na) and SAR for these ten ground water samples, were also calculated. Based on the various experimental results, it is arrived at the conclusion that the ground waters represented by S-1 (near Kwakeithel Bazar, Imphal), S-9 (Paomei Colony (1), Imphal) and S-10 (Paomei Colony (2), Imphal) are fit for drinking purpose but in case of reaming ones some suitable treatments are necessary so as to keep the values of some parameters within desirable limits of BIS standards for drinking water. Further all the ground waters (represented by S-1 to S-10) are also found to be fit for other domestic and irrigation (or agriculture) purposes.

Keywords: Ground water, physico –chemical parameters, drinking, domestic and irrigation.

INTRODUCTION

Quantity of surface water is decreasing day by day all over the world because of rapid urbanization and industrialization. Increase in population growth all over the world day by day, enhances such rapid urbanization. Because of such increasing population growth and lack of awareness among the people, the chances of surface water pollution increases to a large extent. But in many cases, the chances of pollution in ground water is relatively very low. This may also be one of the factors that accelerates the demand of the people for the ground water.

Ground water is about 0.6% of the total global water resources and out of this only 0.3% is extractable economically [1]. However it is highly needed to investigate the quality of such ground water whether they will be fit for drinking, other domestic and irrigation (or agriculture) purposes.

In many countries of the world such as Russia, Mexico, Congo, Nizeria, Algeria, Nepal etc. many researchers carried out extensive investigations regarding the quality of ground water for drinking, domestic and irrigation purposes [2-7]. Similar is the trend in India also. There is increasing demand of ground water all over India and many researchers had carried out various investigations about the ground water quality in order to examine whether they were fit for drinking, domestic and irrigation purposes [8-15].

The present aim of the research work is to carry out physico –chemical assessment of ground water quality of some areas in and around Imphal city of Manipur so as to examine whether they are suitable for drinking, other domestic and irrigation (or agriculture) purposes or not. This is in continuation of my former research work [16].

EXPERIMENTAL SECTION

All the chemical reagents used for this research work, were of AR grade quality and were used as received.

Ten (10) ground water samples were collected from different locations (sampling sites) of Imphal city of Manipur, in well sterilized polythene bottles of 1 litre capacity each during September (of monsoon period), 2013 and they were analyzed for various physico-chemical parameters. The geographical locations such as longitudes and latitudes of the various sampling sites, were measured with the help of a GPS instrument. The locations of different sampling sites, are given below in table–1:

Table -1: Locations of different sampling sites of ground water samples

Sample code No.	Sampling sites	District	Longitude	Latitude
S-1(Hand Pump)	Near Kwakeithel Bazar, Imphal	Imphal West	$93^0$55'23.72''E	$24^0$47'21.05''N
S-2(Hand Pump)	Keishamthong Elangbam Leikai, Imphal	Imphal West	$23^0$56'07.72''E	$24^0$47'30.59''N
S-3(Hand Pump)	Sangakpham, Near foothill, Imphal	Imphal East	$93^0$56'41.78''E	$24^0$49'57.56''N
S-4(Hand Pump)	Chingmeirong Kabui Khul, Imphal	Imphal East	$93^0$56'52.90''E	$24^0$49'52.61''N
S-5(Hand Pump)	Chingmeirong Mamang Leikai (1), (Near Eastern Motors), Imphal	Imphal East	$93^0$56'44.00''E	$24^0$49'51.34''N
S-6(Hand Pump)	Chingmeirong Mamang Leikai (2), Imphal	Imphal East	$93^0$56'52.49''E	$24^0$49'45.79''N
S-7(Hand Pump)	Tangkhul Avenue, Imphal	Imphal East	$93^0$56'52.85''E	$24^0$49'45.70''N
S-8(Hand Pump)	Near Sangakpham Bazar, Imphal (Opposite Don Bosco School)	Imphal East	$93^0$56'47.27''E	$24^0$49'59.84''N
S-9(Hand Pump)	Paomei Colony (1), Imphal (Mr. Paul's Residence)	Imphal East	$93^0$56'43.48''E	$24^0$50'07.06''N
S-10(Hand Pump)	Paomei Colony (2), Imphal	Imphal East	$93^0$56'43.54''E	$24^0$50'07.81''N

Parameters such as temperature, pH, TDS (total dissolved solids) and electrical conductivity of the ten different samples, were measured at the ten different sampling sites (spots) while other remaining parameters–total hardness, calcium, magnesium (by calculation) and chloride were determined in departmental research laboratory using standard methods [17]. Bur sodium and potassium were determined using 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 (DiST3: HI98303) (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 (Systronics, India)
Potassium (K)	Flame Photometer 128 (Systronics, India)
Chloride (Cl)	Argentometric Titrimetric Method (Using K_2CrO_4 indicator solution)

Further the parameters percent sodium (%Na) of the ten ground water samples, were calculated using the relationship [18]:

$$\%Na=\frac{Na+K}{Ca+Mg+Na+K}\times 100,$$ where ionic concentrations of Na, K, Ca and Mg were expressed in milli–equivalents/litre(meq/L).

And the parameter SAR (sodium absorption ratio) of the various ground water samples, were calculated using the relationship [18]:

$$SAR=\frac{Na}{\sqrt{\frac{Ca+Mg}{2}}}$$, where the ionic concentrations of Na, Ca and Mg, were expressed in meq/L as that of percent sodium.

RESULTS AND DISCUSSION

All the ground water samples are found to be colourless and odourless. The various experimentally found data of different physico-chemical parameters for the ten (10) ground water samples, are shown in table–3 below:

Table – 3: Values of various physico-chemical parameters of different ground water samples

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)
S-1	25.7	7.5	265	526	70	8	12.2	78.0	1.3	5.7
S-2	24.4	7.9	644	1253	160	22.4	25.4	201.4	1.3	131.9
S-3	23.7	6.9	462	910	282	37.7	45.9	80.4	1.3	106.4
S-4	24.3	7.4	491	997	406	68.9	57.1	47.8	1.0	113.4
S-5	25.2	7.4	471	903	346	52.1	52.7	63.4	1.2	170.2
S-6	23.6	7.8	416	817	320	54.5	44.9	47.3	1.0	96.4
S-7	23.5	7.8	557	1094	302	48.1	44.4	108.8	1.3	157.4
S-8	23.1	7.0	284	560	114	16.8	17.6	48.5	1.3	35.5
S-9	23.7	7.6	385	774	170	24.0	26.8	104.1	1.1	15.6
S-10	23.5	7.6	403	805	182	25.7	28.8	107.1	1.1	18.4

Again, various calculated values of percent sodium (%) and SAR (sodium absorption ratio) for the ground water samples, are given in table–4 below:

Table – 4: Values of percent sodium (%Na) and SAR for different ground water samples

Sample Code No.	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10
Percent sodium (%Na)	70.9%	73.3%	38.4%	20/6%	28.7%	24.5%	44%	48.4%	57.2%	56.2%
SAR	4.1	6.9	2.1	1.0	1.5	1.1	2.7	2.0	3.5	3.4

Discussion based on the results shown in table–3 and table–4 mentioned above, are detailed below.

Temperature

Water has more dissolved oxygen at low temperature and has a good taste than that of at higher temperature [19]. The temperatures of the ten ground water samples (S-1 to S-10) range from 23.1 – 25.7^{0}C (table–3). S–1 has the highest temperature while that of S-8 is the lowest.

P^H Values

The pH values of the ten ground water samples (S-1 to S-10) are in the range 6.9-7.8 (table–3). S-3 is very slightly acidic; S-8 is neutral while S-1, S-2, S-4 to S-7 and S-9 to S-10 are slightly alkaline.

All the pH values of the different ground water samples (S-1 to S-10) are within the desirable limit (6.5 – 8.5) of BIS standards for drinking water as well as that of WHO [20-21].

TDS (Total dissolved solids)

TDS is another important parameter which is used to dictate whether the water is fit for drinking and other domestic purposes or not. The TDS values of the ten samples (S-1 to S-10) range from 265–644 mg/L (table–3). TDS values of S-1, S-3 to S-6 and S-8 to S-10 are within the desirable limit (500 mg/L) while that of S-2 and S-7 are within the permissible limit (2000 mg/L) of BIS standards for drinking water [20].

Since TDS values of the ground water samples (S-1 to S-10) are less than 1000mg/L, all of them may be used for domestic purpose [22].

Electrical conductivity

The values of electrical conductivity of the ten ground water samples are in the range 526-1253 μs/cm (table-3). S-2 has the highest value while S-1 has the least value.

Total hardness

The total hardness values of the ground water samples (S-1 to S-10) range from 70-406 mg/L (table – 3). S-1 has the lowest value while that of S-4 is the highest. Only S-1 is within soft water category (0-75 mg/L); S-8 belongs to moderately hard water category (75-150 mg/L); S-2 to S-3 and S-8 to S-10 are within hard water category (150-300 mg/L) but S-4 to S-7 belong to very hard water category [22].

The total hardness values of S-1 to S-3 and S-8 to S-10 are within the desirable limit (300 mg/L) while that of S-4 to S-7 are within the permissible limit (600 mg/L) of BIS standards for drinking water [20].

Calcium (Ca)
The values of calcium of the ten sample (S-1 to S-10) are in the range 8-68.9 mg/L (table-3). S-1 has the lowest value while S-4 has the highest value. However, all the values of the ten samples are within the desirable limit (75mg/L) of BIS standards for drinking water [20].

Magnesium (Mg)
As shown in table–3, the values of magnesium of the ten ground water samples (S-1 to S-10) range from 12.2 -57.1 mg/L. S-1 has the lowest value while S-4 has the highest value. Only the values of Mg of S-1 to S-2 and S-8 to S-10 are within the desirable limit (30 mg/L) but that of S-3 to S-7 are within the permissible limit (100 mg/L) of BIS standards for drinking water [20].

Sodium (Na)
About the sodium contents of the ten ground water samples (S-1 to S-10), the values of sodium are in the range 47.3 – 201.4 mg/L (table – 3). S-6 has the lowest value while that of S-2 is the highest. Except the sample S-2, other samples namely S-1 and S-3 to S-10 have their values of sodium within the threshold limit (200 mg/L) of WHO [21].

Potassium (K)
Regarding the potassium contents of the different ground water samples, all of them (S-1 to S-10) have low values ranging from 1.0 – 1.3 mg/L (as shown in table-3).

Chloride (Cl)
For the ten ground water samples (S-1 to S-10), the values of chloride range from 5.7 – 170.2 mg/L (table – 3). S-1 has the lowest value while that of S-5 is the highest. All the values of chloride of the different ground water samples, are within the desirable limit (250 mg/L) of BIS standards for drinking water [20].

Ground water quality for irrigation (or agriculture)
Regarding the qualities of the different ground waters for irrigation (or agriculture) purpose based on the values %Na and SAR (table–3), ground waters represented by S-3 to S-10 are of good quality as the values of percent sodium (%Na) of these eight samples are less than 60% [18]. However, the SAR (sodium absorption ratio) values of the ten samples, are within the excellent water class (SAR value upto 10) as shown in table–4 [1]. So, all the ground waters represented by S-1 to S-10 are fit for irrigation (or agriculture) purpose.

CONCLUSION

From the above discussion based on various experimental results, it is concluded that ground waters represented by S-1 (near Kwakeithel Bazar, Imphal), S-9 (Paomei Colony (1), Imphal) and S-10 (Paomei Colony (2), Imphal), are fit for drinking purpose from physico–chemical analyses point of view. But in case of S-8 (near Sangakpham Bazar, opposite of Don Bosco School), the colour of water changes to reddish brown after keeping for somewhat longer period showing high percentage content of iron (not exactly determined). So, it is unfit for drinking purpose though it seems to be fit for drinking purpose from physic-chemical analysis point of view. In addition to this, other ground waters represented by S-2 to S-7 are unfit for drinking purpose as the values of some parameters in case of them, are not within the desirable limits of BIS standards for drinking water. So in case of S-2 to S-7, some suitable treatments are necessary so as to keep the values of some parameters within the desirable limits of BIS standards for drinking water.

Again, all the ground waters represented by S-1 to S-10 are also fit for other do mestic and irrigation (or agriculture) purposes.

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