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Research Article

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Physico-chemical study of ground water quality of some areas of Imphal east district, Manipur during post-monsoon-1st phase

Nandababu Singh Laishram

Department of Chemistry, D. M. College of Science, Imphal, Manipur, India

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ABSTRACT

Ten ground water samples (S-1 to S-10) were collected from different locations of Imphal East district of Manipur during November, 2013 of post-monsoon and they were analyzed for various 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). In case of ground waters represented by S-2 to S-5 and S-8 to S-10, the values of different physico-chemical parameters are within the desirable limits of BIS standards for drinking water as well as that of WHO and they are fit for drinking purpose from physico-chemical point of view. Ground waters represented by S-1, S-6 and S-7 are unfit for drinking purpose and some suitable treatments are necessary in case of them so as to keep some of the parameters within desirable limit of BIS standards for drinking water. However, all the ground waters represented by S-1 to S-10, are fit for other domestic and irrigation (or agriculture) purposes as are evident from their TDS, percent sodium (%Na) and SAR (sodium adsorption ratio) values.

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

INTRODUCTION

With the fast urbanization and industrialization because of increasing population growth all over the world, there is relatively increasing pollution in surface water compared with that of ground water. In addition to this, the quantity of surface water is also decreasing day by day because of this increasing population growth just like flood, all over the world. To meet the requirement for human consumption, other domestic, irrigation, industrial purposes etc. there is increasing demand for ground water to a large extent.

Ground water is about 0.6% of the total global water resources and out of this, about 0.3% is extractable economically [1]. There is no guarantee that ground water is always safe for drinking purpose mainly. It may be contaminated with many inorganic and organic constituents (or substances) beyond desirable limits and they may become health hazardous. Therefore, it is very much essential to examine such ground water whether they are fit for drinking, other domestic, irrigation and industrial purposes. With this objective many researchers, all over the world, carried out various investigations in order to examine the qualities of ground water for drinking, domestic and irrigation purposes etc. [2-7]. In India also, there is increasing demand for ground water for drinking, other domestic and irrigation purposes mainly. Many researchers had carried out extensive investigations in many states of our country to ascertain the suitability of such ground waters for drinking, other domestic and irrigation purposes mainly [8-16].

The present aim of the research work is to carry out a thorough physico-chemical investigation of ground waters of some areas of Imphal East district during post-monsoon, where local people have much demand for such ground

water for drinking, other domestic, irrigation (or agriculture) purposes. This is in continuation of my former research work on ground water [17].

EXPERIMENTAL SECTION

All the chemical reagents used in this research work, were of AR grade and were used as received. The ten ground water samples were collected from different locations (sampling sites) of Imphal East district of Manipur in the month of November, 2013 (of post-monsoon period). The ground water samples were collected in well sterilized polythene bottles of 1 litre capacity each and they 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). The geographical locations such as longitudes and latitudes were measured with the help of a GPS instrument.

The locations of different sampling sites of the ten ground water samples are detailed 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)	Forest Training School, Luwangsangbam	Imphal East	93°55'01.17"E	24°52'33.14"N
S-2(Hand pump)	LuwangsangbamManingLeikai (Aenon Village)(1)	Imphal East	93°54'51.86"E	24°52'23.73"N
S-3(Hand pump)	LuwangsangbamManingLeikai (near foothill)(2)	Imphal East	93°54'50.32"E	24°52'16.71"N
S-4(Hand pump)	Mantripukhri (near northern side of pond)	Imphal East	93°56'14.59"E	24°50'58.58"N
S-5(Hand pump)	MantripukhriChumbreithong (near NRL Oil pump)	Imphal East	93°55'58.93"E	24°51'19.45"N
S-6(Hand pump)	Campus of IPD-I Office, PHE Department, Chingmeirong	Imphal East	93°56'47.41"E	24°49'55.49"N
S-7(Hand pump)	Deulahland Mao Union	Imphal East	93°56'49.03"E	24°49'22.38"N
S-8(Power pump)	Tiny Tots' Unique School, Deulahland	Imphal East	93°57'00.95"E	24°49'22.56"N
S-9(Hand pump)	MongjamManingLeikai	Imphal East	93°56'15.00"E	24°53'35.58"N
S-10(Hand pump)	Koirengei (near Satjal)	Imphal East	93°55'37.32"E	24°53'41.19"N

Parameters such as temperature, pH, TDS and electrical conductivity were measured at the time of sampling in each sampling site while parameters like total hardness, calcium (Ca), magnesium (Mg)(by calculation method) and chloride (Cl) were determined in departmental research laboratory using standard methods [18]. However, parameters like sodium (Na) and potassium (K) were determined with the help of flame photometer.

The various instruments and brief methods used for the 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 (H198107)(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)

The parameters such as percent sodium (%Na) and SAR (sodium adsorption ratio) of the ten ground water samples were calculated using the relationships given below [19] :

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

and

$$\mathrm{SAR} = \frac{\mathrm{Na}}{\sqrt{\frac{\mathrm{Ca}+\mathrm{Mg}}{2}}}$$

where the ionic concentrations of Na, K, Ca and Mg were expressed in milli-equivalents/litre (meq/L).

RESULTS AND DISCUSSION

All the ground water samples (represented by S-1 to S-10) are found to be colourless and odourless. The various experimentally found values of different physico-chemical parameters (except the values of magnesium(Mg) which were obtained by calculation method) for the ten ground water samples, are shown in table -3 given below :

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

Sample Code No.	Temperature (°C)	pH	TDS (mg/L)	Electrical conductivity (µS/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	23.1	7.7	190	396	138.0	16.0	23.9	29.6	1.0	7.1
S-2	22.5	7.5	187	379	144.0	28.1	18.1	30.7	1.1	5.7
S-3	23.0	7.9	183	373	124.0	15.2	21.0	36.7	1.0	5.7
S-4	22.1	7.6	345	687	154.0	26.5	21.5	95.0	1.4	7.1
S-5	23.0	7.7	221	450	84.0	12.8	12.7	63.1	1.3	5.7
S-6	24.6	7.7	333	666	194.0	31.3	28.3	55.4	3.0	55.3
S-7	21.7	7.8	627	1216	224.0	31.3	35.6	185.8	2.1	82.2
S-8	22.5	7.6	391	773	136.0	19.2	21.5	111.3	1.6	15.6
S-9	22.9	8.1	229	476	136.0	26.5	17.1	54.3	1.0	8.5
S-10	23.1	7.3	147	295	58.0	8.8	8.8	34.2	1.2	5.7

Further, various calculated values of percent sodium (%Na) and SAR (sodium adsorption ratio) for the ten ground water samples, are shown 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)	32.2%	32.0%	39.5%	57.4%	62.3%	39.0%	64.4%	64.2%	46.7%	56.6%
SAR	1.1	1.1	1.4	3.3	3.0	1.7	5.4	4.1	2.0	2.0

Discussion based on the experimental results shown in table-3 and table-4 (shown above), are detailed as under :

Temperature

At low temperature, water has more dissolved oxygen and has a good taste than that of at higher temperature [20]. The temperatures of the ten ground water sample (S-1 to S-10) are in the range 21.7 – 24.6 °C (table-3). S-6 has the highest temperature while that of S-7 is the least.

pH Values

The pH values of the ten ground water samples range from 7.3 to 8.1 (table-3). S-10 has the least pH value while that of S-9 is the highest. From the pH values (shown in table-3), it is evident that all the ground waters represented by S-1 to S-10, are slightly alkaline in nature. And all these values are within the desirable limits of BIS standards for drinking water and that of WHO limit respectively [21-22].

TDS (Total dissolved solids)

TDS is one of the parameters, which is used to dictate whether the ground water may be used for drinking and other domestic purposes. Regarding this present investigation, the values of TDS for all the ten ground water samples (S-1 to S-10) are in the range 147-627 mg/L (table-3). S-10 has the lowest TDS value while that of S-7 is the highest. Except S-7, the values for other remaining nine ground water samples are within the desirable limit (500 mg/L) of BIS standards for drinking water [21]. As the TDS value of each of ground water sample, is less than 1000mg/L, ground waters represented by S-1 to S-10 may be used for other domestic purpose [23].

Electrical conductivity

The electrical conductivity values of the ten ground water samples range from 295 µs/cm to 1216 µs/cm(table-3). S-7 has the highest value of electrical conductance while that of S-10 is the least one.

Total hardness

The values of total hardness for all the ten ground water samples (S-1 to S-10) are in the range 58-224mg/L (table-3). S-10 has the least value of total hardness while that of S-7 is the highest. From table-3, it is clearly seen that only S-10 belongs to soft water category (0-75 mg/L); S-1 to S-3, S-5 and S-8 to S-9 belong to moderately hard water category (75-150mg/L) while S-4 and S-6 to S-7 belong to hard water category (150-300mg/L)[23]. However, the total hardness values of all the ten samples (S-1 to S-10) all within the desirable limit (300mg/L) of BIS standards for drinking water [21].

Calcium (Ca)
The values of calcium of the ten ground water samples (S-1 to S-10) range from 8.8.-31.3mg/L (table-3). S-10 has the lowest value of calcium while that of S-6 and S-7 have equal and highest values. However, all the values of calcium of the ten ground water samples are within the desirable limit (75mg/L) of BIS standards for drinking water [21].

Magnesium (Mg)
The values of magnesium of the ten ground water samples (S-1 to S-10), are in the range 8.8-35.6mg/L (table-3). S-10 has the lowest value of magnesium while that of S-7 is the highest. Out of ten ground water samples, nine samples (S-1 to S-6 and S-8 to S-10) have their values of magnesium within desirable limit (30mg/L) while that of S-7 is within the permissible limit (100 mg/L) of BIS standards for drinking water [21].

Sodium (Na)
Regarding the sodium contents of the ten ground water samples (S-1 to S-10), the values of sodium range from 29.6mg/L to 185.8 mg/L (as shown in table-3). S-1 has the lowest value of sodium while S-7 has the highest value of sodium. However, for all the ten ground water samples (S-1 to S-10), the values of sodium are within the threshold limit (200 mg/L) of WHO [22].

Potassium (K)
About potassium contents of the ten ground water samples (S-1 to S-10), the values of potassium are in the range 1-3 mg/L (as shown in table-3) and thus all the ten ground water samples have low values of potassium.

Chloride (Cl)
The ten ground water samples (S-1 to S-10) have their values of chloride ranging from 5.7-82.2 mg/L (table-3). S-7 has the highest value of chloride while S-2,S-3,S-5 and S-10 have equal and lowest values of chloride. In case of these ten ground water samples, their values of chloride are within the desirable limit (250 mg/L) of BIS standards for drinking water [21].

Ground water quality for irrigation (or agriculture)
As is evident from the values of percent sodium (%Na) and SAR (sodium adsorption ratio) of the ten ground water samples (shown in table-4), ground waters represented by S-1 to S-4, S-6 and S-9 to S-10 have their values of percent sodium (%Na) less than 60%, and are fit for irrigation from percent sodium point of view [19]. However, the SAR values of the ground waters represented by S-1 to S-10 have their values in the range 1.1-5.4 which are within the excellent water class for irrigation (SAR value upto 10)[1]. So, all the ground waters represented by S-1 to S-10 may be used for irrigation (or agriculture) purpose.

CONCLUSION

Based on the discussion of various experimental results of different ground waters represented by S-1 to S-10, it is concluded that ground waters represented by S-2 to S-5 and S-8 to S-10 are fit for drinking purpose from physico-chemical analyses point of view. But ground water represented by S-7 is unfit for drinking purpose and some suitable treatments are necessary so as to keep the values of some paremeters such as TDS and Mg within desirable limits of BIS standards for drinking water. But in case of S-1 and S-6, iron contents are very high (not exactly determined) as the colour changes to reddish brown in each case, after keeping for some time and finally leading to settlement of reddish brown substances. So, ground waters represented by S-1 and S-6 are also unfit for drinking purpose. However, all the ground waters represented by S-1 to S-10, are suitable for other domestic purpose and well fit for irrigation (or agriculture) purpose also.

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