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Research Article

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Physico-chemical investigation of ground water quality of some areas of Imphal east and Imphal west districts during pre-monsoon-1st phase

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ABSTRACT

Ten (10) ground water samples were collected from hand pumps of different locations of Imphal East and Imphal West districts during pre-monsoon of 2014 and they were analyzed for physico-chemical parameters such as temperature, pH, TDS (total dissolved solids), electrical conductivity, total alkalinity, CO_3^{2-}, HCO_3^-, *total hardness,* Ca^{2+}, Mg^{2+}, Na^+ *and* Cl^-. *From physico-chemical analyses point of view, the ground waters represented by S-1 to S-5, are found to be fit for drinking purpose as their physico-chemical parameters (mentioned above) values are within desirable limits of BIS standards for drinking water as well as that of WHO. But in case of ground waters represented by S-6 to S-10, their total alkalinity values are found to be beyond the desirable limit (200 mg/L) of BIS standards for drinking water and hence are unsuitable for drinking purpose. So, suitable treatment is required so as to keep the total alkalinity values of these ground waters (S-6 to S-10) within the desirable limit of BIS standards for drinking water. However, as the TDS values of all these water samples, are below 1000 mg/L, all of them are suitable for other domestic purposes. Further, some investigations are necessary so as to check whether toxic/carcinogenic metals such as As, Pb, Cd, Hg etc. are present within the desirable limit or not. Above all, ground waters represented by S-1 to S-10 are found to be fit for irrigation (or agriculture) purposes, as are evident from their electrical conductivity, RSC (residual sodium carbonate) and SAR (sodium adsorption ratio) values.*

Keywords: Physico-chemical parameters, drinking, domestic and irrigation water qualities.

INTRODUCTION

Increase of population growth all over the world day by day, leads to rapid urbanization and industrialization everywhere. Because of such urbanization and industrialization quantity of surface water is also decreasing day by day. Consequently there is increasing demand for ground water for human consumption, other domestic, irrigation as well as for industrial purposes. Ground water has also less chance of pollution compared with that of surface water. Ground water is about 0.6% of the total global water resources and out of this, only 0.3% is extractable economically[1]. Though there is less chance of pollution compared with that of surface water, sometimes such ground waters may also contain some inorganic cations (including some heavy metals) and anions due to leaching of mineral surfaces with the passage of water into aquifer. If some of the ions (including some heavy metals) are present beyond the acceptable limit, they may be toxic or carcinogenic. So, it is necessary to monitor the quality of such ground water from time to time.

With a view to this objective, researchers in many countries such as Mexico, Bangladesh, Nigeria, Nepal etc., had carried out research extensively on ground water quality for drinking, other domestic and irrigation purposes[2-5]. In India also many researchers of different states such as Maharashtra, Kerala, Chattisgarh, Rajasthan, Assam etc., had carried out researches on ground water qualities extensively to examine whether such ground waters are fit for drinking, other domestic and irrigation purposes mainly[6-11].

In Manipur also, there are many places in both Imphal East and Imphal West districts where there is very less facility of getting well treated water for drinking and other domestic purposes. The people of such areas, are very dependent on ground water from hand pumps for drinking and other domestic purposes. However, it is very much necessary to examine whether such ground waters are totally safe for drinking and other domestic purposes.

The present aim of the research work is to carry out physico-chemical investigations on ground water quality of some areas of Imphal East and Imphal West districts during pre-monsoon of 2014 so as to confirm whether they are fit for drinking, other domestic and irrigation purposes. This is in continuation of my former research work on ground water analysis of some areas of Imphal West district[12].

EXPERIMENTAL SECTION

All the chemicals for this research work, were of A.R. grade and were used as received. The ten ground water samples (S-1 to S-10) were collected from hand pumps of different locations (sampling sites) of Imphal East and Imphal West districts within pre-monsoon period (middle of April to middle of May) of 2014. The water samples were collected in well sterilized polythene bottles of one litre capacity each and guideline of sampling was strictly followed. They were analyzed for various physico-chemical parameters such as temperature, pH, TDS (total dissolved solids), electrical conductivity, total alkalinity, CO_3^{2-}, HCO_3^-, total hardness, Ca^{2+}, Mg^{2+}, Na^+ and Cl^-.

The geographical locations (longitudes and latitudes) of the ten ground water samples, were measured with the help of a GPS instrument and are shown in table-1 given below.

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

Sample Code No. (with source)	Sampling Sites	District	Longitude	Latitude
S-1 (Hand Pump)	Keikol Mayai Leikai	Imphal East	$93^0$54′34.03″E	$24^0$53′49.18″N
S-2(Hand Pump)	Awang Potsangbam Khunou Mamang Leikai	Imphal East	$93^0$54′31.29″E	$24^0$54′09.12″N
S-3(Hand Pump)	Awang Potsangbam Khunou awang Leikai	Imphal East	$93^0$54′17.58″E	$24^0$54′12.30″N
S-4(Hand Pump)	Awang Potsangbam Khunou Mayai Leikai	Imphal East	$93^0$54′20.85″E	$24^0$54′01.81″N
S-5(Hand Pump)	Kanglatongbi Bazar	Imphal West	$93^0$53′15.24″E	$24^0$58′ 21.80″N
S-6(Hand Pump)	Pheidingga Bazar	Imphal West	$93^0$53′05.73″E	$24^0$54′04.38″N
S-7(Hand Pump)	Tarung, Langol (Opposite RNBA House, Imphal)	Imphal West	$93^0$55′42.89″E	$24^0$50′08.82″N
S-8(Hand Pump)	Guigailong, Langol	Imphal West	$93^0$56′39.68″E	$24^0$50′15.60″N
S-9(Hand Pump)	Langol Tarung(Opposite Grace Colony) (near foot hill)	Imphal West	$93^0$55′36.58″E	$24^0$50′10.55″N
S-10(Hand Pump)	Laipham Khunou Mayai Leikai	Imphal East	$93^0$57′14.13″E	$24^0$49′57.59″N

Table 2 : Instruments / methods used for measurement (or determination) of different physico-chemical parameters for 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 : HI 98303) (HANNA Instruments, Romania)
Total alkalinity	By titrimetric method with standard HCl solution using phenolphthalein and methyl orange indicators
CO_3^{2-} and HCO_3^-	By calculation method from total alkalinity values
Total hardness	EDTA titrimetric method (using Eriochrome Black T indicator)
Calcium (Ca^{2+})	EDTA titrimetric method (using Murexide indicator)
Magnesium (Mg^{2+})	By calculation method
Sodium (Na^+)	By calculation method
Chloride (Cl^-)	Argentometric titrimetric method (using K_2CrO_4 indicator solution)

Parameters such as temperature, pH, TDS and electrical conductivity were measured at sampling sites while other parameters like total alkalinity (hence CO_3^{2-} and HCO_3^- values), total hardness, calcium (Ca^{2+}), magnesium (Mg^{2+}) (by calculation method) and chloride (Cl^-) were determined in the departmental research laboratory using standard methods [13]. The various instruments and brief methods used for measurement (or determination) of different physico-chemical parameters, are detailed in table-2.

The parameters such as RSC (residual sodium carbonate) and SAR (sodium adsorption ratio) for irrigation water quality of the ground waters from different locations, were calculated using the relationships given below[14-15]:

RSC (Residual Sodium Carbonate) = $\left(CO_3^{2-} + HCO_3^-\right) - \left(Ca^{2+} + Mg^{2+}\right)$

and SAR (Sodium Adsorption Ratio) = $\dfrac{Na^+}{\sqrt{\dfrac{Ca^{2+} + Mg^{2+}}{2}}}$

where the ionic concentrations were expressed in milli-equivalents/litre (meq/L).

RESULTS AND DISCUSSION

All the water samples are found to be colourless and most of the samples are found to be odourless (except in some cases having slight earthy smell). The values of various physico-chemical parameters for the ten ground water samples (S-1 to S-10) are shown in table-3 given below :

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

Sample Code No.	Temp. (^{0}C)	pH	TDS (mg/L)	Electrical Conductivity (μS/cm)	Total alkalinity (as $CaCO_3$) (mg/L)	CO_3^{2-} (mg/L)	HCO_3^- (mg/L)	Total hardness (as $CaCO_3$) (mg/L)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	Na^+ (mg/L)	Cl^- (mg/L)
S-1	23.3	7.1	116	253	120	0	146	38	8.8	3.9	40.7	4.3
S-2	23.4	6.9	94	202	75	0	91.5	28	6.4	2.9	33.6	4.3
S-3	23.0	6.8	103	225	85	0	103.7	34	6.4	4.4	36.1	5.7
S-4	22.8	7.0	118	247	125	0	152.5	42	8.8	4.9	37.4	4.3
S-5	22.7	6.7	134	285	85	0	103.7	78	20.0	6.8	29.7	21.3
S-6	22.9	7.0	226	483	225	0	274.5	142	31.3	15.6	45.7	31.2
S-7	23.9	7.4	213	456	250	0	305	186	36.1	23.3	19.4	5.7
S-8	23.4	7.6	222	479	265	0	323.3	178	38.5	19.9	28.3	2.8
S-9	23.1	7.6	223	463	250	0	305	156	32.1	18.5	34.7	18.5
S-10	23.0	7.2	363	743	415	0	506.3	172	26.5	25.8	91.7	8.5

Discussion based on the values of different physico-chemical parameters (shown in table-3) for the ten ground water samples, are detailed below:

Temperature :
The temperatures of the ten samples (S-1 to S-10) range from 22.7 – 23.9^{0}C (table-3). Sample S-5 has the lowest temperature (22.7^{0}C) while sample S-7 has the highest temperature (23.9^{0}C).

pH values :
The pH values of the ten ground water samples, are in the range 6.7 – 7.6 (table-3). S-5 has the lowest pH value (6.7) while that of S-8 and S-9 are highest (7.6 each). The ground waters represented by S-2, S-3 and S-5 are slightly acidic while that of S-1 and S-7 to S-10 are found to be slightly alkaline. But for S-4 and S-6, each has pH value equal to 7.0. All these pH values are within desirable limit (6.5-8.5) of BIS standards for drinking water as well as that of WHO[16-17].

TDS (Total dissolved solids):
The TDS values of the ten ground water samples range from 94 – 363 mg/L (table-3). S – 2 has the lowest value (94 mg/L) while S-10 has the highest value (363 mg/L). All these values are within the desirable limit (500 mg/L) of BIS standards for drinking water [16].The TDS value of each of ground water sample, is less than 1000 mg/L; all the ground waters (S-1 to S-10) may also be used for other domestic purpose[18].

Electrical conductivity :
The electrical conductivity values of the ten ground water samples, are in the range 202 – 743 μS/cm(table-3). S-2 has the lowest value (202 μs/cm) while S-10 has the highest value (743μS/cm). S-2 to S-4 have excellent water quality for irrigation purpose as their electrical conductivity values are below 250μS/cm while that of S-1 and S-5 to S-10 have very good water quality for irrigation because in case of them, electrical conductivity values are within the range 250-750μS/cm [15].

Total alkalinity:
The total alkalinity values of S-1 to S-10, are in the range 75-415 mg/L (table-3). S-2 has the lowest value (75mg/L) while S-10 has the highest value (415mg/L). Total alkalinity values of S-1 to S-5, are within the desirable limit (200mg/L) while that of S-6 to S-10, are within the permissible limit (600 mg/L) of BIS standards for drinking water [16].

Carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-):

The carbonate (CO_3^{2-}) values of all the ten ground water samples are found to be zero as the phenolphthalein alkalinity (P-alkalinity) of these water samples, are zero. But the biocarbonate values (calculated from total alkalinity) of these ten ground water samples (S-1 to S-10), are found to be in the range 91.5-506.3 mg/L (table-3). S-2 has the lowest value of HCO_3^- (91.5 mg/L) while that of S-10 (506.3 mg/L) is the highest one.

Total hardness :
The total hardness values of the ten ground water samples are in the range 28-186 mg/L (table-3). S-2 has the least value (28 mg/L) of total hardness while S-7 has the highest value (186 mg/L). All these values of total hardness for the ten ground water samples (S-1 to S-10), are within the desirable limit (300 mg/L) of BIS standards for drinking water[16].

The ground waters represented by S-1 to S-4 belong to soft water category (0-75 mg/L); samples represented by S-5 to S-6 belong to moderately hard water category (75-150 mg/L) while samples represented by S-7 to S-10 belong to hard water category (150-300 mg/L)[18].

Calcium (Ca^{2+}):
The values of calcium for the ten ground water samples are found to be in the range 6.4-38.5 mg/L (table-3). Both S-2 and S-3 have equal and least value (6.4 mg/L) but that of S-8 is the highest (38.5 mg/L). All these values are within the desirable limit (75 mg/L) of BIS standards for drinking water[16].

Magnesium (Mg^{2+}):
All the ten ground water samples have their values of magnesium in the range 2.9 – 25.8 mg/L (table-3). Sample S-2 has the lowest value (2.9 mg/L) while sample S-10 has the highest value of magnesium (25.8 mg/L). All these values for the ten ground water samples, are within the desirable limit (30 mg/L) of BIS standards for drinking water[16].

Sodium (Na^+):
About sodium contents for the ten ground water samples, the values of sodium are in the range 19.4 – 91.7 mg/L (table-3). S-7 has the least value of sodium (19.4 mg/L) while that of S-10 is the highest (91.7 mg/L). For the ten ground water samples, the values of sodium are within the threshold limit (200mg/L) of WHO[17].

Chloride (Cl^-):
All the ten ground water samples (S-1 to S-10) have their values of chloride ranging from 2.8-31.2mg/L (table-3). Ground water represented by S-8, has the lowest value (2.8 mg/L) while S-6 has the highest value of chloride (31.2 mg/L). All these values of chloride for the ten ground water samples, are within the desirable limit (250 mg/L) of BIS standards for drinking water[16].

Ground water quality for irrigation (or agriculture):
The values of RSC (residual sodium carbonate) and SAR (sodium adsorption ratio) for the ten ground water samples (S-1 to S-10) are given below in table-4:

Table-4 : Values of RSC 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
RSC (meq/L) (Residual Sodium Carbonate)	1.6	0.9	1.0	1.7	0.1	1.7	1.3	1.7	1.9	4.9
SAR (Sodium Adsorption Ratio)	2.9	2.8	2.7	2.5	1.5	1.7	0.6	0.9	1.2	3.0

As it was already discussed, ground waters represented by S-2 to S-4 have excellent quality while that of S-1 and S-5 to S-10 have very good quality for irrigation purpose from electrical conductivity values point of view.

Based on RSC values, ground waters represented by S-1 to S-9 are suitable for irrigation purposes as their values of RSC are less than 2.5meq/L but S-10 has high value i.e. 4.9mg/L (above 2.5 mg/L)[14].

However, SAR values for S-1 to S-10 range from 0.6-3.0 which are within the excellent water class for irrigation (SAR value upto 10) [1].

Summing up, all the ground waters represented by S-1 to S-10 are found to be fit for irrigation (or agriculture) purposes.

CONCLUSION

Based on the discussion of various experimental results of different physico-chemical parameters for the ten ground water samples, it is concluded that the ground waters represented by S-1 to S-5 are fit for drinking purpose from physico-chemical analyses point of view but for ground waters represented by S-6 to S-10, suitable treatment is required to keep their total alkalinity values within desirable limit of BIS standards for drinking water. But all the ground waters (represented by S-1 to S-10) are suitable for other domestic purposes also.

However, some investigations are necessary so as to confirm whether toxic/carcinogenic metals such as *As, Pb, Cd, Hg* etc. are present within desirable limit or not.

Further, all the ground waters represented by S-1 to S-10 are found to be fit for irrigation (or agriculture) purposes as are evident from their electrical conductivity, RSC and SAR values.

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