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Physico-Chemical Analysis Of Water Samples Of Mokokchung Town – A Preliminary Report

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ABSTRACT

Assessment of water quality was carried out in the Mokokchung Town of Nagaland which lies in the north-eastern part of India. Few water samples were collected from several sources like ring wells, rivers, streams and ponds. Different water quality parameters like temperature, pH, electrical conductivity, total dissolved solids, alkalinity, total hardness, chloride, fluoride, dissolved oxygen were studied. The presence of different ions like calcium, magnesium, sodium, potassium, nitrate, sulphate and phosphate etc. were measured. On comparing the results it was found that most of the physico-chemical parameters were within the permissible limits as laid by World health organization (WHO).

Keywords: Water quality parameters, Physicochemical study, Mokokchung town.

INTRODUCTION

The quality of drinking water is a powerful environmental determinant of health [1]. The World Health Organization (WHO) estimates that drinking safe water could prevent 1.4 million child deaths from diarrhoea each year [1]. Increasing population and its necessities have led to the deterioration of surface and sub surface water. In fact in a developing country like India around 80% of all diseases are direct consequence of poor drinking water quality and unhygienic conditions which is due to over exploitation and pollution of water [2].

In the state of Nagaland, the predominant sources of water are surface water from rivers, streams, ponds and natural springs and subsurface water occurring as ground water. Information of water quality in Nagaland is very scanty, as there is very little documentation on the state of rivers/ water bodies and thus monitoring is a very recent phenomenon and so far has been taken up on a very limited basis [3]. This study was considered important since Mokokchung is a fast developing town of Nagaland, where rapid urbanization is leading to rampant pollution of water sources and hence it was thought that a preliminary study of surface and ground water quality would be of value for developing management strategies for maintaining potable water quality.

Study area: Mokokchung with a Latitude of 26.33° N and Longitude of 94.53° E is situated in the North Eastern Region of Nagaland state. It is located 1325 meters above sea level and receives an annual rainfall of around 200 cm on an average [4]. The present study was planned by selecting samples (one sample from each colony/ward) from different ground and surface water sources around Mokokchung town.

MATERIALS AND METHODS

The water samples were collected from the various sources in separate sterilized polyethylene bottles of 2 litres capacity containers (pre washed with HNO_3 and thoroughly rinsed with deionised water) and stored. Parameters like water temperature, pH, electrical conductivity, total dissolved solid (TDS), alkalinity, dissolved oxygen (DO) total hardness, calcium, magnesium, chloride, sodium, potassium, phosphate, nitrate, and sulphate, fluoride were analysed as per standard procedures [5-8]. Each sample was analysed in triplicate and the mean result reported. Different instruments like Flame photometer (Systronics-130), Fluoride meter (Hannah instrument-98402), UV-VIS spectrophotometer. (Perkin Elmer- Lambda 25). All The reagents used for the analysis were AR grade and double distilled water was used for preparation of solutions. Table 1 gives the details of method of determination of various parameters of water samples. The water samples were collected during the summer period.

Table 1. Method of determination of water quality parameters

Sl.No.	Parameters	Methods of determination
1.	Temperature	Thermometer
2.	Hydrogen ion Concentration (pH)	pH metry
3.	Electrical conductivity (EC)	Conductometry
4.	Total dissolved Solids (TDS)	Evaporation method
5.	Alkalinity (ALK) as CaCO_3	Titrimetry
6.	Total Hardness (TH) as CaCO_3	EDTA –Titrimetry
7.	Calcium (Ca)	EDTA –Titrimetry
8.	Magnesium (Mg)	EDTA –Titrimetry
9.	Sodium (Na)	Flame photometry
10.	Potassium (K)	Flame photometry
11.	Chloride (Cl)	(Argentometric method) Titrimetry
12.	Nitrate (NO_3)	Spectrophotometry
13.	Sulphate (SO_4)	Spectrophotometry
14.	Phosphate	Spectrophotometry
15.	Fluoride	Fluoride meter
16.	Dissolved Oxygen (DO)	Titrimetry

RESULTS AND DISCUSSION

The physico-chemical parameters of the water samples collected from twelve different places of Mokokchung town is given in tables 2 and 3.

Table: 2 Results of Physico-chemical Analysis of water samples

Sl.No.	Water Source	Ward/Colony	Temperature (°C)	pH	Electrical Conductivity μScm^{-1}	TDS mg L^{-1}	Total alkalinity (TA) mg L^{-1}
1.	Tap water	F.A.C campus	22.2	7.69	322	287	111.5
2.	Stream	Alisunkum	22.3	6.93	55.1	49.9	109
3.	Bore well	Tondentsunyoung	22.6	6.50	332	297	106
4.	Stream	Alongmen	22.5	7.52	262	234	107.5
5.	Pond	Medical	22.4	7.01	204	185	112.5
6.	Pond	Majakong	22.6	6.55	214	180	111
7.	Bore well	Salangtem	23.4	5.66	794	728	114.5
8.	Pond	Dilong	24.6	5.05	547	495	115.5
9.	Bore well	Aongza	23.7	6.35	390	351	109.5
10.	Stream	Alempang	24.1	5.51	484	530	117.5
11.	Pond	Arkong	24.3	5.10	375	342	117
12.	Bore well	Yimyu	22.3	7.16	215	189	113.5

Table3. Results of Physico – Chemical analysis water samples

Sl No.	(DO) mg L^{-1}	(TH) mg L^{-1}	Ca^{2+} mg L^{-1}	Mg^{2+} mg L^{-1}	Cl^{-} mg L^{-1}	NO_3^{-} mg L^{-1}	SO_4^{2-} mg L^{-1}	K^{+} mg L^{-1}	Na^{+} mg L^{-1}	F^{-} mg L^{-1}	PO_4^{3-} mg L^{-1}
1	7.00	125	15.23	2.92	14.21	0.194	7.83	11.00	8.00	1.76	0.75
2	7.80	100	8.01	4.87	21.31	0.113	7.79	1.00	3.00	0.43	0.41
3	9.00	145	29.65	15.10	42.63	0.010	14.01	1.00	10.00	1.24	0.30
4	13.00	130	20.04	6.33	35.52	0.016	17.46	5.00	17.00	0.41	0.80
5	6.90	55	18.43	5.84	32.66	0.080	16.60	3.00	20.00	0.57	0.70
6	12.00	60	16.03	4.38	11.36	0.191	9.86	3.00	24.00	1.90	0.84
7	12.50	85	26.45	5.36	63.90	0.005	12.76	3.00	53.00	0.15	0.42
8	14.30	95	16.83	12.18	61.06	0.021	14.45	5.00	47.00	0.18	0.55
9	15.20	125	17.86	9.49	14.20	0.028	16.54	2.00	22.00	1.35	0.40
10	8.60	150	20.84	2.90	56.80	0.015	9.67	3.00	20.00	1.95	0.65
11	14.50	70	8.21	6.81	51.12	0.141	8.47	2.00	39.00	0.19	0.59
12	12.35	60	9.61	2.43	39.76	0.098	12.67	4.00	9.00	0.83	0.45

In order to compare the results obtained with the Indian standard parameters, the Indian standard specifications are given in table 4.

Table 4. Indian standard specifications for drinking water ISI: 10500 [9]

Sl.No.	Parameters		
		Requirement(Desirable Limit)	Permissible limit in absence of alternate source
1	Temperature (°C)	-	-
2	pH	6.5-8.5	No relaxation
3	EC (μScm^{-1})	500	1000
4	TDS (mg L^{-1})	500	2000
5	Total hardness as CaCO_3 (mg L^{-1})	300	600
6	Total alkalinity (mg L^{-1})	200	600
7	Calcium (mg L^{-1})	75	200
8	Magnesium (mg L^{-1})	30	100
9	DO (mg L^{-1})	3	10
10	Chloride (mg L^{-1})	250	1000
11	Sulphate (mg L^{-1})	200	400
12	Nitrate (mg L^{-1})	45	100
13	Fluoride (mg L^{-1})	1	1.5

The results are discussed in details in the following section. For better understanding each parameter are discussed separately.

Temperature: Temperature is a significant factor which influences the abiotic and biotic components of the water. It helps in controlling the solubility of gases. The temperature of the water samples analysed did not have much variation and was between 22.2°C to 24.6°C which indicated that the water samples were in the natural state with less contamination from the effluents.

pH: pH is an important factor which expresses the acidic or alkaline nature of a solution. The pH of a water body is very important in determination of water quality since it affects other chemical reactions such as solubility and metal toxicity. The pH values vary from 5.10 to 7.62 where water samples collected from Salangtem, Dilog, Aongza, Alempang and Arkong(sample no.7, 8,9,10 and 11) . The values were found below the prescribed limit. This lower limit indicates the corrosive nature of the water samples collected which is not fit for drinking purpose and its prolong use may cause serious health problems.

Electrical Conductivity (EC): Conductivity is the ability of water to carry an electrical current. It is a rapid method to measure the total dissolved ions and is directly related to the amount of total dissolved salts. An observation of the results reveals the non uniformity in the variation of EC values in all samples. EC values in water samples ranged from 55.1 to 794 $\mu\text{mhos cm}^{-1}$. Most of the water samples collected lies in the range of excellent and good category and can be used for both drinking as well for irrigation purpose.

Total Dissolved solids (TDS): Total dissolved solids indicate the nature of salinity in water. It also gives an idea about suitability of the water for various uses. Dissolved solids tend to increase with increasing pollution of water. TDS above 500 mg L^{-1} is not considered desirable for drinking. The TDS values for study area have varied from 49.9 to 728 mg L^{-1} . Most of the watersamples lie below the permissible limit. High TDS values for Salangtem and Dilog (samples 7 and 10) could be due to presence of high content of Ca^{2+} , Cl^{-} and Na^{+} ions in the water.

Total Alkalinity(TA) :Alkalinity of water is a measure of its capacity to neutralize strong acids and is due to the presence of bicarbonate, carbonate and hydroxide compound of calcium, sodium and potassium ions. The observed values of alkalinity ranged between 106 to 117.5 mg L^{-1} in water. According to United States environmental protection agency (USEPA), the maximum permissible limit of total alkalinity is 120 mg L^{-1} [9]. Here the observed values are within the permissible limit.

Dissolved Oxygen (DO) :Dissolved oxygen refers to the amount of oxygen dissolved in the bodies of water. It is a relative measure of the amount of oxygen that is dissolved or carried in a given medium. Insufficient oxygen often caused by the decomposition of organic matter tends to suppress the presence of aerobic organism. The levels of dissolved oxygen varied from 6.90 to 15.20 mg L^{-1} , which is within the desirable limit as prescribed by ISI (Indian Standard Institute).The high value of DO for the water samples may be due to wave action, pollution load, organic matter and photosynthetic activity.

Total Hardness (TH) : Total hardness is determined by the concentration of multivalent cations (usually Mg^{2+} and Ca^{2+}) in water. It is usually expressed as the equivalent of CaCO_3 concentration. Hardness is commonly understood as a property of water, which prevents the lather formation with soap. Total hardness for the samples under study were found to vary between soft and moderately soft category with their hardness values in the range of 55-150 mg L^{-1} .

Cations: The cations analysed in the present study includes calcium, magnesium, sodium and potassium. For the present study the concentration of calcium has varied from 8.01 to 29.65 mg L^{-1} which is well

below the permissible limit (IS 10500-92 recommended its desirable upper limit at 75mg L^{-1}). Whereas, the concentration of magnesium varies from 2.43 to 15.10 mg L^{-1} in the study area. For the study area, water is in the range of soft and moderately soft category which is due to the low concentration of calcium and magnesium ions present in the water. Potassium content in the water samples varied from 1.0 mg L^{-1} to 11.0 mg L^{-1} which is well below the recommended limit, whereas the concentration of sodium ranges from 3.0 to 53.0 mg L^{-1} in the study area.

Anions: In the present study, the anions analysed were chloride, sulphate, phosphate, nitrate and fluoride. The concentration of chloride in all the samples in the study area ranges from 11.36 to 63.90 mg L^{-1} (Permissible value for drinking water standard as per IS10500-91 is 250mgL^{-1}); which indicates the low level of pollution by sewage disposals (the concentration of chloride in water serves as an indicator of pollution by sewage). Whereas the concentration of sulphate, phosphate and nitrate were found to be 7.79 to 17.46 mg L^{-1} , 0.30 mg L^{-1} to 0.84mg L^{-1} , 0.005 to 0.194 mg L^{-1} respectively. These values were well below the permissible limits and their presence could only be from the natural sources. The concentration of fluoride in all the samples in the study area has varied from 0.15 to 1.95 mg L^{-1} . Fluoride content in FAC campus, Majakong and Alempang were found to be above permissible limits, which may be due to weathering of minerals, rock dissolution where fluorine is leached out and dissolved in ground water.

Correlation studies

Determination of correlation is important in finding out the strength of the relationship between the two inter dependent variables. There is a direct correlation between two parameters if change in one of the variable affects the other in a linear way [10-12].

The Correlation coefficient is defined only if both of the standards are finite and both are non zero, where its absolute value cannot exceed 1. The correlation coefficient is symmetric: $\text{corr}(X, Y) = \text{corr}(Y, X)$.

If we have a series of 'n' measurements of X and Y written as x and y

The sample correlation coefficient (r) is written as:

$$r = \frac{n \cdot \sum x \cdot y - \sum x \cdot \sum y}{\sqrt{(n \sum x^2 - (\sum x)^2)(n \sum y^2 - (\sum y)^2)}}$$

Where x and y are the sample means of X and Y,

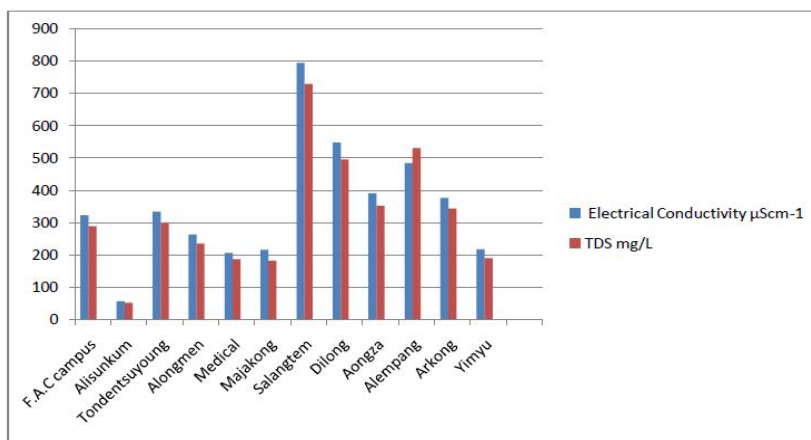


Fig 1. Correlation between Electrical Conductivity and TDS at different location

A high correlation coefficient (nearly 1 or -1) means a good relationship between two variables, and a correlation coefficient around zero means no relationship. Positive value in the range of $+0.8$ - 1.0 characterizes a strong correlation between the parameters, while negative values of r indicate an inverse relationship.

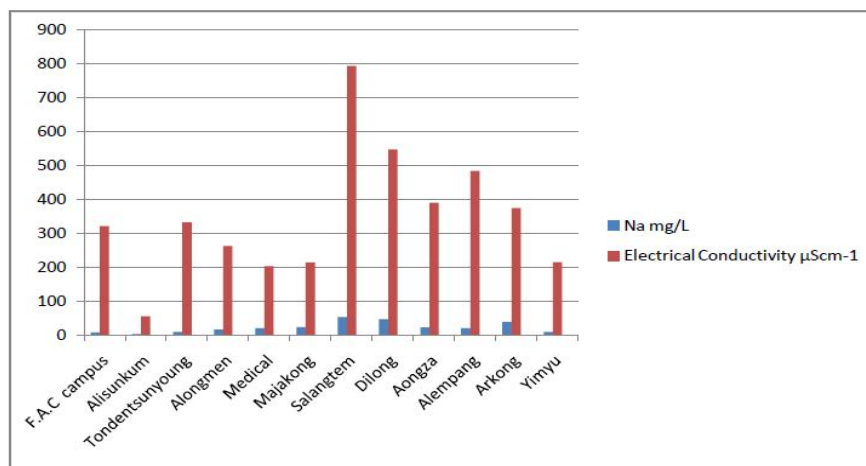


Fig 2. Correlation between Electrical (EC) and Na at different locations

The correlation coefficients (r) among various water quality parameters were calculated and presented in table 5. The values indicated high positive relation is observed between EC and TDS (0.99013), EC and Na (0.8084). From these values it can be suggested that, EC is highly dependent on the amount of dissolved solids (such as salt) in the water, and Na^+ ions contributing a major role in electrical conductivity. Interrelationship studies between different variables are very helpful tools in promoting research and opening new frontiers of knowledge. The study of correlation reduces the range of uncertainty associated with decision making. Figures 2 and 3 gives the correlation between EC and TDS and also between EC and Na ions.

APPLICATIONS

In the state of Nagaland, the predominant sources of water are surface water from rivers, streams, ponds and natural springs and subsurface water occurring as ground water. Information of water quality in Nagaland is very scanty, thus this study was considered important as it has given general information about the quality of water in and around Mokokchung Town. This preliminary study of surface and ground water quality would be of value for developing management strategies for maintaining potable water quality of the Town by the policy maker.

Table 5: The Correlation coefficient (r) values for different water parameters

	pH	EC	TDS	TH	TA	F	Cl	DO	NO_3^-	SO_4^{2-}	PO_4^{3-}	Cu	Mg	Na	K
pH		-0.051	-0.0713	0.04995	-0.0649	0.24930	-0.0956	-0.4709	0.3312	0.1177	0.2590	-0.093	-0.332	-0.775	0.3971
EC			0.99013	0.17178	0.4895	-0.17633	0.696	0.37731	-0.316	0.1290	-0.209	0.5364	0.1976	0.8084	0.0744
TDS				0.2287	0.53812	0.11751	0.72151	0.3201	0.5397	0.0809	0.180	0.5341	0.1465	0.7686	0.0548
TH					-0.5745	0.578271	0.03117	-0.1715	-0.4504	0.0607	-0.165	0.4874	0.3011	-0.784	0.1731
TA						-0.122	0.58660	0.18271	0.05419	-0.334	0.1542	-0.270	-0.363	0.5821	0.0960
F							-0.4931	-0.3412	0.30289	-0.279	0.2805	0.1611	-0.229	-0.466	0.2351
Cl								0.23548	0.6051	0.10985	0.273	0.3095	0.2141	0.6126	0.190
DO									-0.7376	0.11075	-0.177	-0.103	0.7781	0.5071	-0.700
NO_3^-										-0.0551	0.4000	-0.639	-0.498	-0.290	0.57195
SO_4^{2-}											-0.089	0.4691	0.4645	0.1473	-0.1516
PO_4^{3-}												-0.17	-0.480	-0.017	0.52361
Cu													0.4701	0.2133	-0.0865
Mg														0.2168	-0.5427
Na															-0.0954
K															

CONCLUSIONS

The analysis of the water quality parameters from different places around Mokokchung Town indicates that electrical conductivity, TDS, total alkalinity, total hardness, calcium, magnesium, chloride, sodium, potassium, dissolved oxygen and sulphate is well within the permissible limits. However, some of the water samples collected showed low pH value indicating the corrosive nature of this water samples which may be due to the presence of toxic metals such as Pb and Cu. Low degree of effluents sources of nitrate and phosphate was observed as concentration of nitrate and phosphate in water was minimal. Fluoride content in three of the water samples collected was above the permissible limit.

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