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Original Research Paper

An Evaluation of Physico-Chemical Properties to Asses Well Water Quality in Some Areas of Ernakulam District, Kerala, India

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ABSTRACT

Five samples of home well water from various regions and one sample of water from Kerala Water Authority of Ernakulam district were collected and assessment of physico-chemical properties was made to see whether these water sources are satisfying the standards of drinking water. Parameters like pH, electrical conductivity, total dissolved solids, colour, odour, taste, turbidity, total hardness, total alkalinity, biochemical oxygen demand, dissolved oxygen, calcium, chlorides, magnesium, sulphates, iron and nitrates were analysed. The investigation reveals that with the exception of water sample collected from Kerala Water Authority, all the home well waters have water quality problems. Therefore, it indicates that all the samples of home well waters in the present study are undesirable or otherwise unfit for human consumption.

INTRODUCTION

The poorer segments of the population, both in urban and rural areas, generally use well water as a main source of drinking water. It is also noticed that when the public water supply fails, the well water further serves as a source of direct drinking water for even the rich section of population. Studies on water quality properties are therefore necessary to determine the extent of pollution so as to monitor likely danger to the human population. The tremendous organic loads imposed by urban sewage and other wastes constitute a major cause of pollution of natural water bodies (Hynes 1960). In view of the public apprehension of the hazards of water pollution, regular water quality monitoring of water bodies is highly necessary (Renn 1970). The test result allows us to find out whether the water we drink and use for household activities is reliable and safe. In light of this information, the authors have tried to study the quality of well waters collected from various areas of Ernakulam district to see whether these waters are fit for human consumption or not.

MATERIALS AND METHODS

Sample collection: Samples of home well waters and the water supplied by Kerala Water Authority (KWA) through pipeline in Ernakulam district were collected in high grade plastic bottles of one litre capacity. Before collection, the bottles were rinsed with distilled water and then thrice with the well water sample. During collection, care was taken to avoid the trapping of air within the bottle by completely immersing the bottle within the water sample until the bottle is completely filled in with the water sample. The samples were collected from some selected regions of Ernakulan district during the month of March 2010. The location and source of water samples are given in Table 1.

Analysis of water samples: The samples collected were brought to the laboratory and the parameters like pH, electrical conductivity (EC) and total dissolved solids (TDS) were measured immediately after collection. Other physico-chemical parameters like colour, odour, taste, turbidity, total hardness (TH), total alkalinity, biochemical oxygen demand (BOD), dissolved oxygen (DO), calcium, chlorides, magnesium, sulphates, iron and nitrates were analysed within 36 hrs of collection. The standard methods were adopted for the analysis of water samples (APHA 1995).

Comparison with BIS standards: Physico-chemical parameters analysed and measured on water samples were compared with BIS (1998) for drinking water. Each data provided in the Table 2 is an average of three samples collected from each area under study.

RESULTS AND DISCUSSION

The results of water analysis of the collected samples are presented in Table 2. It is clear that with the exception of W4 sample, all the other samples were colourless, whereas W4 was light brown coloured. The excess iron present in water can cause the formation of insoluble hydroxides, which settle out as rust-coloured silt which imparts an objectionable reddish-brown colour and taste to water (Cohen et al. 1960). Regarding the taste, the samples W1, W2, W5 and W6 were tasteless whereas the samples W3 and W4 were slightly salty. There is report that at concentrations above the aesthetic objective, chloride content imparts undesirable tastes to water (WHO 1984). All the six water samples

Table 1: Location and source of water samples collected from Ernakulam District.

Sl.No.	Sample Code	Location	Source
1	W1	Keezhumadu	Home Well
2	W2	Muttom	Home Well
3	W3	Manjummal	Home Well
4	W4	Irumpanam	Home Well
5	W5	Kakkanad	Home Well
6	W6	KWA Water	Pipe Line

analysed were found to be odourless.

With respect to the pH of water samples, a variation from 4.96 to 7.46 was observed. According to BIS (1998), the permissible range of pH is from 6.5 to 8.5. In the present study, the pH of well water samples W1, W2 and W5 was below the permissible limit, whereas of others within the permissible limit. The low pH values of waters may be because of the leaching of organic acids from decaying vegetation or may be because of the presence of dissolved carbon dioxide generated by bacteriological oxidation (Sawyer & McCarty 1967). Water having a pH below 6.5 can cause considerable damage to the water supply system, resulting from complex interactions between pH and other physico-chemical parameters (Tihansky 1974). As the pH is related to a variety of different parameters, it is not possible to determine whether pH has a direct relationship with human health but it is argued that pH has an indirect effect as it can affect water treatment processes (Aramini et al. 2009).

The values of TDS in different water samples varied from 70 to 1210 mg/L. The desirable and maximum excessive level of TDS in drinking water prescribed by BIS is 500 mg/L and 1000 mg/L respectively. The water samples W1, W2, W5 and W6 have an acceptable value. The water sample W3 has a TDS value greater than the desirable limit but it is within the excessive limit whereas W4 has a TDS value higher than the maximum excessive limit. The most important aspect of TDS with respect to drinking water quality is its effect on taste (Bruvold & Pangborn 1966). The drinking water containing more than 500 mg/L of TDS is not considered desirable (Sastry & Rahee 1988) and it can also cause excessive scaling in water pipes, water heaters, boilers and household appliances (Tihansky 1974). In this respect the present data reveal that water samples collected from Manjummal and Irumpanam are considered to be undesirable and unacceptable respectively. But in areas of acute shortage of water, people are forced to use water having TDS value above the permissible limit and in such cases it should be used only after removing the excess TDS using technologies such as reverse osmosis and electrodialysis (Clark et al. 1977).

The concentration of iron (as Fe) in different water samples varied from 0.25 mg/L to 1.58 mg/L. The highest iron concentration was identified in the sample W4 (1.58 mg/L). This value lies above the maximum excessive limit for consumable water. Other water samples like W1, W3 and W5 also were identified to have iron concentration above the desirable limit but within the excessive limit, whereas W2 and W6 samples have safe concentration. The ingestion of large quantities of iron can result in haemochromatosis, a condition in which normal regulatory mechanisms do not operate effectively, leading to tissue damage as a result of

Table 2: Physico-chemical characteristics of water samples collected from various locations in Ernakulam district for comparison with BIS standards(1998) for drinking water consumption.

Sl. No.	Paramet er	BIS (1998) standards		Water samples					
		DL	EL	W1	W2	W3	W4	W5	W6
1	Colour	Colorless	-	Colorless	Colorless	Colorless	Light coloured	Colorless	Colorless
2	Odour	Agreable	-	Agreable	Agreable	Agreable	Agreable	Agreable	Agreable
3	Turbidity	5	10	2	1	1	2.30	0.90	0.80
4	TDS	500	1000	80	80	720	1210	110	70
5	pH	6.5-8.5	NR	6.24	5.44	7.46	7.02	4.96	7.45
6	TH	300	600	11.76	14.70	118.16	335.20	14.70	11.76
7	Calcium	75	200	2.35	3.52	42.33	78.92	3.52	3.52
8	Magnesium	30	100	1.42	1.42	12.99	35.24	1.42	0.71
9	Iron	0.3	1.0	0.86	0.25	0.38	1.58	0.42	0.27
10	Chlorides	250	1000	19.2	28.80	258.80	371.10	24.9	11.5
11	Sulphates	200	400	6.29	11.72	33.36	89.31	4.91	5.43
12	Nitrates	45	NR	1.89	2.51	1.56	1.32	3.16	1.55
13	EC	-	1400	210	280	1470	1895	320	130
14	Total Alkalinity	200	600	54.90	7.63	146.40	134.20	3.05	61.0
15	BOD	-	5	1.84	2.76	5.16	5.76	4.60	1.84
16	DO	-	-	7.6	7.2	6.4	4.8	7.1	7.7
17	Taste	Tasteless	-	Tasteless	Tasteless	Salty	Salty	Tasteless	Tasteless

Desirable limit (DL); Excessive limit (EL)

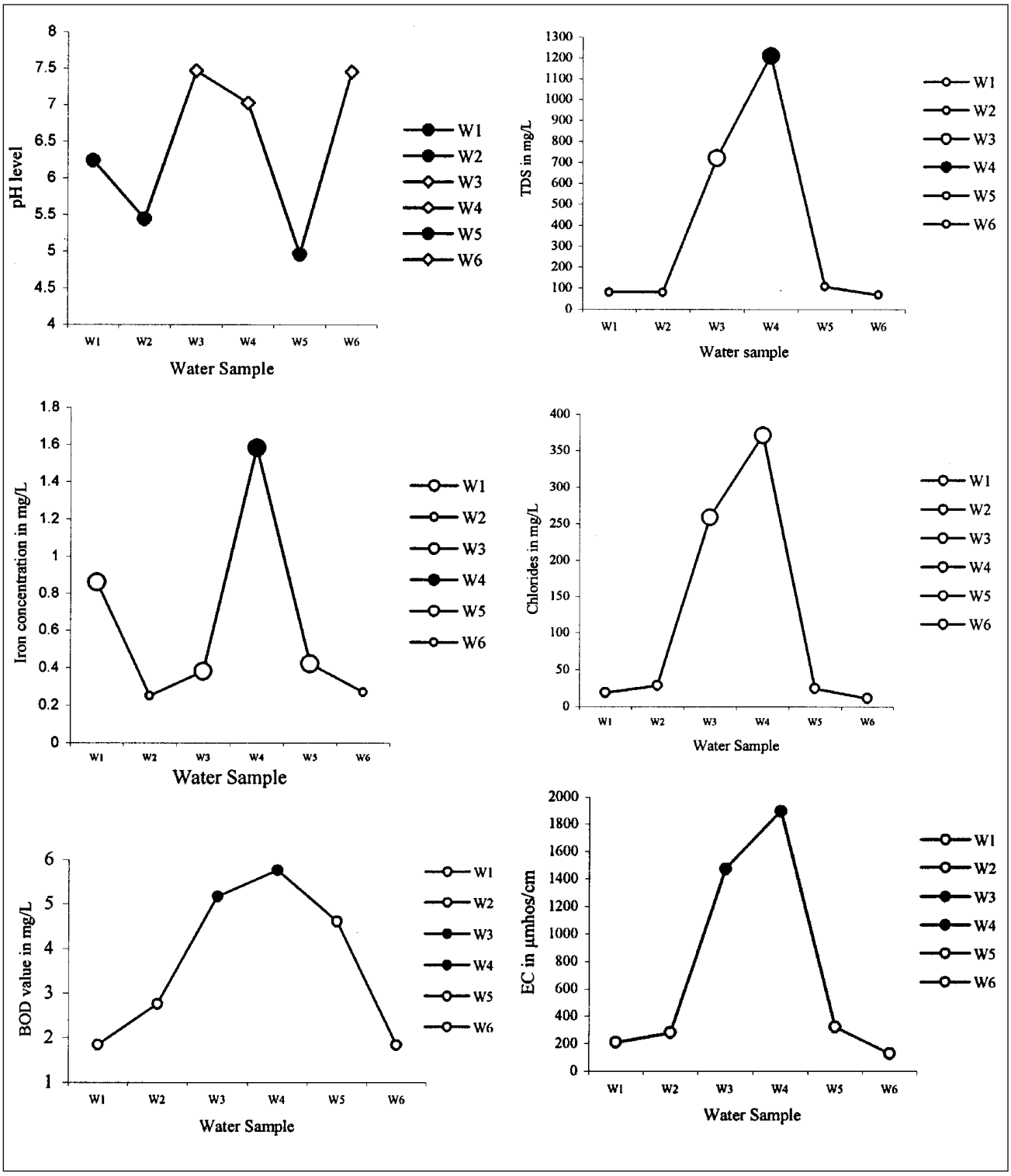

Fig. 1: Comparative evaluation of various physico-chemical parameters of different water samples collected from various regions of Ernalulam district of Kerala. Small White spot represent desirable limit (DL). Small Black spot represent undesirable level. Large White spot represent above the desirable level but within the Excessive Limit. Large Black spot represent above the Excessive Limit (EL)

the accumulation of iron (Dillman et al. 1987). In addition to this, when the iron concentration in the domestic water supplies exceeds 0.3 mg/L, it becomes objectionable for a number of reasons, which are indirectly related to health (Cohen et al. 1960).

A considerable variation was observed in the values of electrical conductivity. The EC value varied from 130 to 1895 µmhos/cm. With reference to the BIS, the maximum permissible limit is 1400 µmhos/cm. The water sample with the least EC value was noticed in W6, whereas the maximum in W4. With the exception of water samples W3 and W4, all the samples have an EC value within the permissible limit. The higher EC values of samples W3 and W4 may be due to higher concentration of TDS and ionized substances present (Aramini et al. 2009). It clearly indicates that sample W3 and W4 are unfit for human consumption. Arutchelvan et al. (2004) found significant linear relationship between EC-TDS. The present investigation is also in support of these findings. Similarly, it is also reported that a high positive correlation exists between EC and chloride contents of water (Govindaradjane et al. 2007).

Chloride content of water is another important parameter to be considered to know the quality of water as its higher concentrations can impart undesirable taste to water and may cause corrosion in the distribution system (McConnell 1972). An aesthetic objective of 250 mg/L has been established as maximum desirable limit and 1000 mg/L as maximum excessive limit for chloride in drinking water (BIS 1998). The study shows that water samples W3 and W4 have chloride values above the desirable limit but within the excessive limit. The chloride content of all the other water samples was under desirable limit. As chloride is highly soluble in water, it is not easily removable; a removal of 87 % has been reported using granular activated carbon adsorption and reverse osmosis (Regumathan et al. 1983).

The BOD value ranged from 1.84 to 5.76 mg/L. As per BIS, the maximum permissible limit is 5 mg/L. The study shows that the BOD value for water samples W3 and W4 was higher than the permissible limit. Higher BOD values of water samples W3 and W4 clearly indicate pollution and may be attributed to the percolation of wastewaters loaded with biodegradable compounds (Pitchammal et al. 2009).

It is important to consider the DO content of drinking water because oxygen imparts a good taste to water and is an absolute requirement for the metabolism of aerobic organisms in water bodies. Decrease in DO can favour anaerobic decomposition of organic wastes (Sallae 1974). In the present study, dissolved oxygen value of water samples ranged from 4.8 to 7.7 mg/L. Water sample W4 exhibited the least DO content, whereas the maximum in W6.

The turbidity values of water samples ranged between 0.80 and 2.30 NTU and were within the desirable limit. The WHO (1984) establishes that the turbidity of drinking water should not be more than 5 NTU, and should ideally be below 1 NTU. In this respect the water samples W1 and W4 were slightly turbid. In case where drinking water is turbid, it is essential to eliminate the turbidity for effectively disinfect it for drinking purposes.

The total hardness of water samples varied from 11.76 to 335.20 mg/L. Water sample W4 exhibited a hardness level above the desirable limit but within excessive limit. All other water samples exhibited a value within the desirable limit. Hard water causes incrustation in distribution systems and excessive soap consumption (Coleman 1976).

The values of calcium and magnesium in water samples varied from 2.35 to 78.92 mg/L and 0.71 to 35.24 mg/L respectively. The water sample W4 has the maximum value in both the cases and it was greater than the desirable limit but within the excessive limit. All other water samples have acceptable value. Venkata et al. (2006) reported high positive correlation between TDS-Mg, TH-Ca and TH-Mg. The present study also supports this observation as there is a positive correlation between the values of magnesium, calcium, TDS and total hardness in sample W4. With respect to sulphate and nitrate concentration and total alkalinity, all the water samples W1, W2, W3, W4, W5 and W6 analysed were well within the desirable limits of BIS.

CONCLUSION

The present investigation indicates that all the home well waters W1, W2, W3, W4 and W5 tested for the 17 parameters have at least one or two water quality problems with reference to the BIS (1998). In water sample W2, the pH value alone deviates from the BIS whereas in water samples W1 and W5 both pH and iron concentration are not agreeable. In the case of water samples W3 and W4 several parameters were found to be varying with respect to BIS. Only the KWA water is satisfying all the parameters considered here for the study. Therefore, it is recommended that waters from these wells are to be used for drinking purpose only after pretreatment like filtering, boiling, reverse osmosis, electrodialysis, etc.

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