Investigating The Quality of Water Available in The *Palayanoor* Village of The *Sivaganga* District in Tamil Nadu, India

N. MANONMANI[1], C. K. MAHADEVAN[2]

[1] *Department of Chemistry, Sri Meenakshi Government Arts College for Women(A), Madurai, Tamil Nadu, India*

[2] *CSIR Emeritus Scientist, Department of Physics, Bharathidasan University, Tiruchirappalli, Tamil Nadu, India*

Abstract— The present study is focused on the determination of physico-chemical parameters such as colour, odour, pH value (at 25 ºC), total hardness, turbidity, total dissolved solids content, dissolved oxygen content, chemical oxygen demand, biochemical oxygen demand, flouride content, chloride content, magnesium content, residual free chlorine content, sulphate content, total alkalinity content, iron content, cadmium content, mercury content, arsenic content, chromium content and lead content of various water samples collected from different sampling points (Ayyanar pond, Open-wells, Panchayat taps and Bore-wells) in the Palayanoor village of the Sivangai district in Tamil Nadu, India. In order to ensure that the water is safe for drinking and other uses, the above mentioned parameters were analyzed and compared with the standard permissible limits to assess the best designated use of this water for various purposes. Escherichia coli (E. coli) and total coliform study was also made. The results obtained indicate that this water can be used for agricultural purposes, cattle washing, human bathing, etc and proper purification is needed, when used for the drinking purpose.

Indexed Terms-- Bore-well water; Open-well water; Panchayat tap water; Pond water; Physico-chemical characteristics; Water quality analysis.

I. INTRODUCTION

The quality of water (determined by the physical, chemical and biological compositions) is now the concern of experts in all countries of the world; the decision of WHO's 29th Session (May 1976) emphasizes that water delivered to the consumer should meet the high requirements of modern hygiene and should be free from pathogenic micro-organisms and toxic substances [1]. Due to historical, geographical, religious, political, and sociocultural reasons, India has a unique place in the world; however, pollution-causing activities have caused severe changes in aquatic environments over the last few decades [2].

The quality of potable water depends on the water sources like river, pond, well, lake, *etc*.; and the drinking water could be polluted with pathogens, toxic metals, chemical compounds (such as pesticides and herbicides) and other agricultural and industrial wastes [3]. The pollution of drinking water is responsible for large number of mortalities and morbidities due to water borne diseases like typhoid, cholera, diarrhea, dysentery, hepatitis, as well as many protozoan and helminthes infections. Exposure to chemicals in drinking water may lead to a range of chronic diseases (*e.g.*, cancerous and cardiovascular diseases), adverse reproductive outcomes and effects on children's health (*e.g.*, neurodevelopment), among other health effects [4,5]. Therefore, the quality and nature of water require proper assessment before use which can be done by suitable physical and chemical analyses.

Physico-chemical characteristics of water have been analyzed by several researchers considering water samples from different water resources of the world [6-10]. Palayanoor village is a medium size village (849.2 hectares in area) in the Sivangai district of Tamil Nadu, India; the site map of which is shown in Figure 1. As per the Constitution of India and

Panchayath Raaj Act, Palayanoor village is administrated by a Sarpanch (Head of Village) who is an elected representative of the village. Most of this village people are farmers; and they have the water sources (for their consumption) like: Ayyanar pond, Bore-wells, Open-wells and Panchayat taps.

In the present study, in order to understand the quality of water for drinking and other purposes in the above village, we have selected the above mentioned (and available) four water sources by getting samples from them at different places and analyzed physico-chemically. The results obtained are reported and discussed herein.
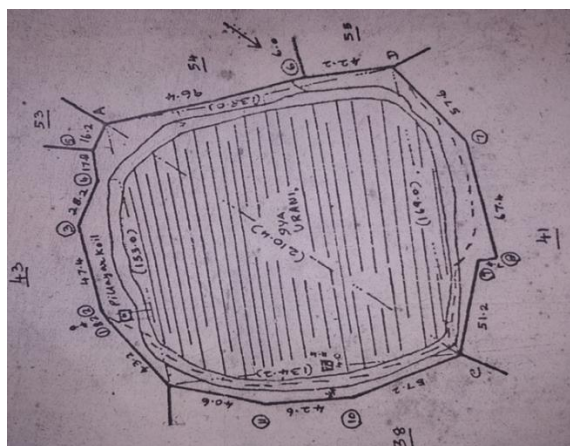

Figure 1: Site map of Palayanoor village in the Sivagangai district of Tamil Nadu

II.   EXPERIMENTAL METHODS

• *Sample Collection*
Water samples were collected in glass bottles having well fitted stoppers. For the physico-chemical analyses, the bottles should have a water holding capacity of about 1 litre; and, for the bacteriological examinations, bottles with smaller holding capacity is sufficient. The bottles were thoroughly cleaned, and filled thrice with water and emptied before collecting the sample. After collecting the sample the stopper in the bottle was well secured and the bottles containing samples of water were labeled stating the source, date and time of collection. Ayyanar pond, Bore-wells, Open-wells and Panchayat taps available in the Palayanoor village were the water sources considered for the present study. In each source, sample was collected from five to six places

and mixed together to form the single sample; the single samples were considered for the study after filtering by means of a piece of cloth (to avoid the minute floating materials, if present). Further, the samples were collected in January 2021.

• *Physico-chemical Analysis*
The physico-chemical parameters such as colour (the true colour of water from which the turbidity has been removed), odour (a quality factor affecting acceptability of drinking water), pH value (the measure of acidity, H^+ ion concentration, at 25 ºC), total hardness (the measure of calcium and magnesium presence), turbidity (the reduction of transparency), total dissolved solids (TDS) content (the measure of particulate solids presence at 105 ºC), dissolved oxygen content (the measure of oxygen presence), chemical oxygen demand (COD), biochemical oxygen demand (BOD), flouride content (the measure of fluoride presence), chloride content (the measure of chloride presence), magnesium content (the measure of magnesium presence), residual free chlorine content (the measure of residual free chlorine), sulphate content (the measure of sulphate presence), total alkalinity (the quantitative capacity to react with a strong acid to a designated pH), iron content (the measure of iron presence), cadmium content (the measure of cadmium presence), mercury content (the measure of mercury presence), arsenic content (the measure of arsenic presence), chromium content (the measure of chromium presence) and lead content (the measure of lead presence) were determined for all the four water samples considered in the present study by applying the available standard techniques [11-13].

III.   RESULTS OBTAINED

The results obtained in the present study are provided in Table 1 along with the measurement details (the parameters tested/analyzed with the instrument/method used) and the maximum acceptance limit (the prescribed guideline values [14]). The water samples collected from Open-wells, Ayyanar pond, Panchayat taps and Bore-wells (in the Palayanoor village) are represented herein as Sample I, Sample II, Sample III and Sample IV, respectively.

The colour and odour of all the four samples considered is found to be acceptable and agreeable as

with the guideline prescription. The pH observed for Sample I is slightly more (by 0.3) than the acceptable limit (8.5); and the turbidity observed for Sample II is slightly more (by 0.15) than the acceptable limit (1.0). The cadmium and mercury contents in all the four samples are observed to be very much higher than the acceptable limits (see Table 1); so, purification is required for all the samples in this regard. The biological parameters like E. coli and total coliform have been determined, and thereby, the coliform growth is found to be present in all the four samples considered (see Table 1); however, this coliform growth is considered to be unwanted and is required to be removed before consuming the water.

Table 1: Parameters tested/analyzed with the instrument/method used and the results obtained along with the maximum acceptance limit prescribed

Sr. No.	Parameter (with unit) - Instrument/Method	Results obtained for				Maximum acceptance limit of IS:10500:2012
		Sample I	Sample II	Sample III	Sample IV	
1	Calcium content (mg/L) - EDTA Titrimetric method	17	48	168	171	75
2	Chlorides(mg/L)- Argentometric method	28	30	657	730	250
3	Colour(Hazen)- Vision method	<1.0	<1.0	<1.0	<1.0	5.0
4	Magnesium(mg/L)- EDTA Titrimetric method	14	7.0	20	159	30
5	Odour- Wide mouth glass stoppered bottle	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
6	pH value at 25 ºC- pH meter	8.8	6.7	7.5	7.5	6.5-8.5
7	Residual free chlorine(mg/L)	<0.1	<0.1	<0.1	<0.1	0.2
8	Sulphates (mg/L)- Spectrophotometer	11	14	309	347	200
9	Total alkalinity(mg/L)- Titrimetric method	275	180	518	554	200
10	TDSat 105 ºC(mg/L)- Gravimetric method	365	349	2630	2872	500
11	Total hardness (mg/L)- Titrimetric method (complexometric)	102	148	1273	1083	200
12	Turbidity (NTU)- Nephlometric turbidity unit Turbidity meter	<0.5	115.7	<0.5	<0.5	1.0
13	Iron (mg/L)- 1,10Phenanthroline	0.01	0.01	0.01	0.01	0.3

14	Cadmium(mg/L) - Atomic absorption method	0.01	0.01	0.01	0.01	0.003
15	Mercury (mg/L)- Atomic absorption method	0.01	0.01	0.01	0.01	0.001
16	Arsenic(mg/L)- Atomic absorption method	0.01	0.01	0.01	0.01	0.01
17	Chromium(mg/L) - Atomic absorption method	0.01	0.01	0.01	0.01	0.05
18	Lead (mg/L) -Atomic absorption method	0.01	0.01	0.01	0.01	0.01
19	Dissolved oxygen(mg/L)- Titrimetric Winkler method	6.7	5.9	7.3	6.2	6.5-8 mg/litre
20	COD (mg/L)- Refluxed method	5.01	26	<1.0	<1.0	20 mg/l
21	Fluoride(mg/L)- Zirconium Alizarin methods	<0.01	<0.1	<0.1	<0.1	1.0
22	BOD at 27°Cfor 3days- Incubation method	<1.0	2.5	<1.0	<1.0	3-5 mg/l
23	Escherichia coli(MPN/100ML)	900	1600	500	500	Absent
24	Total coliform(MPN /100ML)	1600	1600	900	900	Absent

IV. DISCUSSION

Sample I (Water from Open-wells)
Calcium, chlorides, magnesium, residual free chlorine, sulphates, TDS, total hardness, iron, arsenic, chromium, lead, dissolved oxygen, COD, fluoride, *etc.* are found to be within the standard limits; and pH, total alkalinity, cadmium, mercury, *etc.* are beyond the limits. The BOD is found to be less than the range prescribed; and the micro biological parameters such as E. coli and total coliform growth is very high. From this, it can be understood that this water cannot be used (as it is) for the drinking purpose, as per IS: 10500 [14]. So, in order to use this as drinking water, it has to be purified to reduce the pH, total alkalinity, cadmium and mercury contents, and coliform growth.

Sample II (Water from Ayyanar Pond)
Calcium, chlorides, magnesium, residual free chlorine, total alkalinity, sulphates, TDS, total hardness, iron, arsenic, chromium, lead, dissolved oxygen, COD, fluoride, *etc.* are found to be within the standard limits; and turbidity, cadmium, mercury, *etc.* are beyond the limits. The micro biological parameters such as E. coli and total coliform growth is very high. So, it can be understood that this water cannot be used (as it is) for the drinking purpose, as per IS: 10500 [14]. So, for it to be used as drinking water, it has to be purified to reduce turbidity, cadmium and mercury contents, and coliform growth.

Sample III (Water from Panchayat Taps)
Magnesium, pH, residual free chlorine, iron, arsenic, chromium, lead, dissolved oxygen, COD, fluoride, *etc.* are found to be within the standard limits; and calcium, chlorides, total alkalinity, TDS, total hardness, cadmium, mercury, *etc.* are beyond the limits. The BOD is found to be less than the range prescribed; and the micro biological parameters such as E. coli and total coliform growth is high. This shows that this

water cannot be used (as it is) for the drinking purpose, as per IS: 10500 [14]. So, to be used as drinking water, this has to be purified to reduce calcium, chlorides, sulphates, TDS, total hardness, cadmium and mercury contents, total alkalinity, pH and coliform growth.

Sample IV (Water from Bore-wells)
The pH, residual free chlorine, iron, arsenic, chromium, lead, dissolved oxygen, COD, fluoride, BOD, *etc.* are found to be within the standard limits; the calcium, chlorides, magnesium, sulphates, total alkalinity, TDS, total hardness, cadmium, mercury, *etc.* are beyond the limits; and the micro biological parameters such as E. coli and total coliform growth is high. It can be understood that this water cannot be used for the drinking purpose, as per IS: 10500 [14]. So, this water has to be purified (for it to be used as drinking water) by reducing the calcium, chlorides, magnesium, sulphates, cadmium and mercury contents, TDS, total alkalinity, total hardness and coliform growth.

It is required to stop pollutants from contaminating nearby water bodies to avoid or prevent pollution of water sources. Prevention of pollution can be done by treatments like biological filters, sand filters and chemical additives and related processes; moreover, these techniques are economical and cost effective. Further, prevention is more economical than cleaning up water pollution that has already occurred; in addition, safe drinking water is the basic human right, and it is a component of effective policy for the health protection (WHO 2012 [13]).

There is some similarity observed in the case of water samples collected from Bore-wells (Sample IV) and Panchayat taps (Sample III). Chlorides, total hardness, TDS, total alkalinity, sulphates, calcium, etc. are found to be very much higher than the acceptable limits in the case of both samples (Sample III and Sample IV); also, magnesium is found to be very much higher than the acceptable limit in the case of Sample IV.

In general, all the four water sources are found to be polluted, and purification is required if it is used for the drinking purpose. However, water sources like Bore-wells (Sample IV) and Panchayat taps (Sample III) require more attention; as these sources are normally used for the drinking purpose by the people of Palayanoor village. Total hardness is normally formed when water percolates through deposits of calcium and magnesium containing minerals; presence of hardness may not affect the human health seriously, but it may reduce the actions of soaps while taking bath and washing clothes. Presence (in high amount) of chlorides salts may cause corrosion in the walls of the water storage tanks; also, it causes hyperchloremia (leading to kidney failure, high level of blood sodium, diabetes insipidus, diarrhea, vomiting, respiratory losses, *etc.*).

The presence of chlorides in high amount can be reduced/removed by using the reverse osmosis, distillation, de-ionization, *etc.* techniques. Presence of soluble compounds can be reduced by converting them into insoluble particulates, and separated; sedimentation/infiltration is normally used for softening the water as well as for removing soluble metals and dissolved natural organic matter from the polluted water.

CONCLUSION

Water samples collected from Open-wells and Ayyanar pond are found to have less impurities/unwanted items than the other two sources (Panchayat taps and Bore-wells) have; this means that the water used for the drinking purpose by the Palayanoor village people, at present (from Panchayat taps and Bore-wells), has more impurities/unwanted items. For drinking purpose, the water from Panchayat taps and Bore-wells must have to be purified to reduce the unwanted items present in them, and for the people to have a healthy living. As per the results obtained in the present study, all the four water sources available in the Palayanoor village have to be purified for healthy living; and water from these sources (as available without purification) can be used for agricultural purpose, cattle washing, human bathing, *etc*. As per the current water quality standards, the water available (from the four sources considered) in the village is unfit for human consumption and can be noted as polluted water.

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