STUDIES ON THE PHYSICO-CHEMICAL PARAMETERS OF WELL, BORE WELL, LAKE AND POND WATERS IN PALLERI VILLAGE OF VELLORE DISTRICT, TAMILNADU

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Abstract: For the present study, water samples collected in bore well, well, lake and pond waters from Palleri village of Ponnai town of Walaja taluk of Vellore District were analysed for the physico-chemical parameters such as turbidity, EC, TDS, pH The result of the physic-chemical parameters of bore well, well water, lake water and pond waters of Palleri village of Walaja taluk indicated that the fluctuation physic-chemical parameter were found to be either within the desirable limit or within desirable limit as prescribed by WHO (2000). Result of the present study indicated that the contents of calcium (54), Magnesium (15), Nitrate (14), Chloride (69), Fluoride (0.6) and Sulphate (39) were found to be lower than the desirable limit in bore well water of Palleri village. Similarly, the same trend of values were found in well water of Palleri village. Content of TDS (368), Alkalinity (141), Calcium (53). Nitrate (29) and Chloride (55) were found to be lower than the desirable limit in lake water of Palleri village. There was a low content of Magnesium (13), Nitrate (12), Fluorite (0.4) and Phosphate (17) noticed in pond water of Palleri village. It is concluded from this study that there is no harmful effect noticed in the water bodies of Palleri village as evidenced from the result of physico-chemical parameters fell within the permissible limit and thereby it is indicated that it is suitable for drinking and irrigation purposes although low levels of fluoride and inorganic content present in most of the bodies in Palleri village. Although the water is recommended for drinking purpose, the low level of fluoride content indicated a harmful effect for the cause of dental carries and other effect.

Introduction: India is a vast country, where a large number of people live in villages. A large number of villages and cities still do not have adequate and safe drinking water. In order to essential needs of the people, water comes at the second position of air. During the last decade, it has been realized that the time has come to pay more and more attention to the ground water resources and their adequate management by utilizing modern technique (Tiwari,1999). Numerous anthropogenic activities, like disposal of sewage and industrial water, recreational activities, excessive usage of fertilizers to land and use pesticides have threatened environmental health of both surface and ground water. Water pollution has however, threatened to reduce the quantity available in ponds, lakes, rivers and reservoirs due to other human activities (Trivedy and Chandrasekar, 1999).

Rao, *et al*. (1999) reported that due to increasing industrialization, urbanization and other developmental activities most of our water bodies such as ponds, lakes, streams and rivers have become polluted. Environmental effects of chromium (Cr) have been extensively reviewed (NAS, 1974; Steven, *et al.,* 1976; Synder, *et al.,* 1977; Towill, *et al.,* 1978; Taylor and Parr, 1978; Langard and Norseth, 1979; Post and Campbell, 1980; Hatherill, 1981; Ecological Analysts, 1981). Tamil Nadu is situated at the South Eastern Extremity of the Indian peninsula and it is the southernmost state of mainland India. It is located between 8°05 and 13°34 at North Latitude, 76014' and 8021' at East Longitude, Andhra Pradesh in the north, Karnataka in the North-West, Kerala on the West, Bay of Bengal in the east.

Vellore district has become not only the hub of educational institution and also for the tannery industry, chemical industry, sugar mills etc., Vellore water is in an alarming condition as it has been receiving domestic and industrial wastes. Hence, the present study is centered around the water quality assessment in well, bore, pond and lake waters of Arcot town and its surrounded area of Vellore District.

Materials and Method: Description of the Study Area: Sampling site of Palleri village (Fig.1) is 15 km away from tannery industrial areas of Ranipet and Sipcot and located in 12.928303 latitude and 79.332485 longitude. In this village, well, bore well water (Fig.3) are being utilized both for drinking and irrigation purposes. Pond (Fig.4) and lake waters (Fig.3) are also being utilized for irrigation purpose rather than for drinking purpose as these waters are being utilized for cattle drink and human washing. However, it is so necessary for assessing the physico-chemical parameters of the water suitable for drinking and irrigation purposes. The methods followed for the physical parameters such as appearance, odour, turbidity NTU, Total Dissolved Solids and electrical conductivity and chemical parameters such as pH, alkalinity pH, alkalinity total, total hardness CaCo3, calcium, magnesium, sodium, potassium, iron total, manganese, free ammonia,, nitrite, nitrate chloride, fluoride, sulphate, tidy's test were done according to the procedures given in APHA (2000) and their units are represented as mg/l. The water samples were collected for 3 months from January to March, 2013 by using 1 litre of polyethelene bottle.

Fig 1. Showing The Collection of Water Samples from the Lake Water of Palleri Village

Fig 2. Showing The Collection of Water Samples from the Pond Water of Palleri Village

Results and Discussion: For the present study, water samples collected in bore well, well, lake and pond waters from Palleri village of Ponnai town of Walaja taluk of Vellore District were analysed for the physico-chemical parameters such as turbidity, EC, TDS, pH, total alkalinity, total hardness, Ca, Mg, Fe,NH_3, NO_3, Cl, F, So_4, PO_4 and Tidy's test content using standard methods as given by APHA (2000) and their results are depicted in table 1. The acceptable limit mentioned in the text represents the standard for drinking water quality according to WHO (1984). Since the Palleri village is 15 km away from Sipcot tannery industrial area and there is a chance of getting the water polluted due to the tannery effluents mixing in Palar and Ponnai river, it is very essential to see the physico-chemical parameters of bore well, well, lake and pond waters of Palleri village suitable for drinking and irrigation purposes.

Appearance of bore and well waters was clear and colourless and appearance of lake and pond water was yellowish in colour. Colour or appearance may result from the presence of natural metallic ions like Iron and Manganese, human and peat material, plankton, Weeds and Industrial waste. The colour is usually the first contaminant to be recognized in wastewaters that affects the aesthetics, water transparency and gas solubility of water bodies (Yuxing and Jian 1999). The odour of bore well, well, lake and pond waters was none in Palleri village, respectively.

Table 1. Result of Physico-Chemical Parameters of the Well Water, Bore Well Water, Lake Water & Pond Water Samples Collected from Palleri Village

S.No.	Parameters	Acceptable Limit WHO (1984)		Palleri (Bore well water)	Palleri (Well water)	Palleri (Lake)	Palleri (pond)
	Physical Examinations						
1.	Appearance	A	B	C & C	C & C	Yellowish	Yellowish
2.	Odour	Unobjectionable		None	None	None	None
3.	Turbidity NTU	1	10	0	0	18±1.0	17±1.0
4.	Total Dissolved Solids mg/l	500	2000	469±2.0	425±2.0	368±1.0	675±1.50
5.	Electrical Conductivity (Mic mho/cm)	-	-	670±1.00	607±2.00	525±2.00	964±2.00
	Chemical Examinations						
6.	pH	6.5-8.5	6.5-9.2	6.92±0.10	7.19±0.10	7.12±0.10	7.33±0.10
7.	Alkalintiy pH as $CaCO_3$ mg/l	-	-	0	0	0	0
8.	Alkalintiy Total as $CaCO_3$ mg/l	200	600	188±2.0	172±1.0	144±1.0	288±1.0

9.	Total Hardness as $CaCO_3$ mg/l	200	600	198±1.0	180±1.50	190±1.0	304±2.50
10.	Calcium as Ca mg/l	75	200	54±0.9	49±1.0	53±0.5	100±1.00
11.	Magnesium as Mg mg/l	30	150	15±0.09	14±0.05	14±0.05	13±0.08
12.	Sodium as Na	-	-	-	-	-	-
13.	Potassium as K	-	-	-	-	-	-
14.	Iron Total as Fe mg/l	0.1	1.0	0.00	0.00	0.81±0.05	1.03±0.01
15.	Manganesium as Mn	30	150	0.00	0.00	0.00	0.00
16.	Free ammonia as NH_3 mg/l	-	-	0.00	0.00	0.68±0.01	0.61±0.01
17.	Nitrite as NO_2 mg/l	-	-	0.00	0.00	0.09±0.001	0.07±0.001
18.	Nitrate as NO_3 mg/l	45	100	14±1.0	10±1.0	29±0.9	12±0.8
19.	Chloride as Cl mg/l	200	1000	69±1.0	72±1.0	55±0.09	105±1.0
20.	Fluoride as F mg/l	1.0	1.5	0.6±0.001	0.6±0.02	0.4±0.01	0.4±0.01
21.	Sulphate as SO_4 mg/l	200	400	39±0.0	49±0.0	41±0.8	70±0.0
22.	Phosphate as PO_4 mg/l	-	-	0.00	0.00	0.35±0.05	0.15±0.01
23.	Tidy's Test	-	-	0.1±0.00	0.1±0.00	0.4±0.00	0.4±0.00
24.	RC	-	0.2	--	-	-	-
25.	BACTERIOLOGICAL EXAMINATION (M.F Technique)			-	-	-	-
26.	Fecal Coliform (100M)	0	0	--	-	-	-

Note:

1. A CPHEEO Std – Desirable Limit: B.CPHEEO/BIS Std – Permissible limit in the absence of alternative source.
2. Results of Chemical Examination expressed in mg/l except pH
3. C & C – Clear & Colourless

Turbidity content was nil in bore and well waters. Whereas, it was 18 and 17 in lake and pond waters of Palleri village, respectively. This increase of turbidity content in the water may cause lack of primary productivity, reduction of O_2 and increase of CO_2 and thereby reduction of biomass including fish and other aquatic organisms will occur (Akan, et al., 2009).

Total dissolved solids (TDS) content was in a range of 469, 425, 368, 675 in bore well, well, lake and pond waters of Palleri village, respectively. The result indicated that there is no harmful effect due to the presence of total dissolved content ranged between 368-675. Total dissolved solids is one of the important measures of water quality. Waters with high solid contents are of inferior palatability and may induce an unfavourable physiological reaction in the transient consumer. The desirable limit of TDS is 500 (WHO, 1984). Hike level of TDS may cause harmful effects in irrigation and drinking purposes. For most of the natural water, the main contributors for Total dissolved solids are calcium, magnesium, sodium, potassium, chloride, sulphates and bicarbonates. TDS reflect the increasing extent of industrial and domestic discharge in aquatic habitats (Welcomme, 1985).

High value of TDS was found to affect survival and growth of fish (Dicketson and Vingard, 1999). High levels of TDS in the effluent renders it unsuitable for irrigation and drinking purpose. According to Manivasakam (1984) high amount of TDS recorded in tannery effluent could be attributed to processes like soaking, liming, dehairing, defleshing and deliming.

Electrical conductivity content was found to be around 670 in bore well water, 607 in well water, 368 in lake water and 675 in pond water of Palleri village, respectively. The Electrical conductivity is a useful tool to evaluate the purity of water. It is the property of water caused by the presence of various ionic species. The acceptable limit of Electrical Conductivity is 600 (WHO, 1984). It is significantly noticed that the Electrical Conductivity content was likely to be increased only in the canal water carrying the sludge of tannery effluent discharge. The high level of conductivity may be due to the presence of inorganic substances and salts which show good conductivity (Robinson and Stokes, 1959). The electrical conductivity is a useful parameter of water quality for indicating salinity hazards.

Among the physical parameters of water compared in four different water bodies like bore well, well water, lake and pond water of Palleri village, their levels are assumed to be within the desirable limit as prescribed by WHO (1984) and thereby it is clearly indicated that there is no harmful effect due to presence of these parameters in the water bodies and thereby it is so healthy for drinking and irrigation purposes. It is suggested from this study that the water bodies should be kept in a sustainable manner from free of

intrusion of industrial waste into the water bodies by direct or indirect means.

The desirable and acceptable limit of pH is 6.5-8.5. In the present study, the pH levels were found to be within the acceptable range of 6.93-7.23. The pH value of water is an important indication of its quality and it is dependent on the carbon dioxide, carbonate and bicarbonate equilibrium. The discharge of waste water into water bodies may cause a drop or increase their pH affecting size and activities of microbial populations there in. Other workers also reported acidic (Pathe, et al., 1995; Dikshit and Shukla, 1989; Mbuthia, et al., 1989; Saravanan, et al., 1999) and alkaline tannery waste waters (Shukla and Shukla, 1994; Kadam, 1990; Sastry, 1986; Sakthivel and Sampath, 1990). The factors like photosynthesis, exposure to air, disposal of industrial wastes and domestic sewage affect pH (Saxena, 1987). WHO (1984) prescribed beyond pH 8.5, the water can affect the mucous membrane.

Alkalinity is a total measure of substances in water that they have acid neutralizing ability. Alkalinity is not a pollutant. The content of total alkalinity as $caco_3$ was 188 in bore well, 172 in well water, 144 in lake water and 288 in pond water of Palleri village. These ranges were within the permissible limit of 200-600. Alkalinity is important for fish and aquatic life because it protects or buffers against pH changes (keep the pH fairly constant) and makes water less vulnerable to acid rain. High alkalinity values are indicative of the eutrophic nature of the water body. Total alkalinity values of water are important in calculating the dose of alum and biocides in water (Trivedy and Goel, 1986). The permissible limit of total hardness as $caco_3$ is between 200-600. Total Hardness as $caco_3$ content was 188, 172, 190, 304 in bore well, well, lake and pond waters in Palleri village, respectively.

Total hardness content was assumed to be optimum with slight reduction in value in bore well, well and lake water except in the pond water as its value was so optimum in the permissible limit. These parameters indicated that there is no harmful effect due to its presence in the water. Hardness is advantageous in certain conditions. It prevents the corrosion in the pipes by forming a thin layer of scales and reduces the entry of heavy metals from the pipes to the water (Praharaj, et al., 2002). The harness of water is an important consideration in determining the suitability of water for domestic and industrial uses. Hard water will precipitate soap and leathering does not take place satisfactory. Calcium content was 54, 49, 53 and 100 in bore well, well, lake and pond waters of Palleri village, respectively. Among these four water samples analyzed, values of bore well, well and lake waters were found below the desirable limits as its value was in a range of 49-54, but, the pond water of Palleri village was seemed to be within the permissible limit.

The presence of bicarbonates of calcium and magnesium indicate temporary hardness, which can be removed by boiling. Hard water is generally believed to have no harmful effect on human being. Cardiovascular diseases were reported to continue more to the areas of soft waters than to those having hard water (Crawford, 1972). Maximum value of hardness is observed in winter and minimum in summer (Pandhe, et al., 1995).

Vijayaram, et al. (1989) found that the concentrations of total hardness, chlorides, calcium, magnesium and sulphates were 2 to 20 times higher in the ground water of Tiruchirappalli city, Tamil Nadu due to the presence of tanneries. Calcium is most important cation in the study of water quality. Hardness of water as calcium carbonate is an important measure of pollutant. Calcium is one of the nutrients required by the organism and at low concentration calcium has no hazardous effect on human health calcium is an essential constituent of human being. The low content of calcium is drinking water may cause rickets and defective teeth; it is essential for nervous system, cardiac function and in coagulation of blood. Being an important contributor to hardness in water it reduces the utility of water for domestic use (Purohit and Saxena, 1990).

The acceptable limit of magnesium is 30-150. The magnesium content recorded 15, 14, 14 and 13 in bore well, well, lake and pond water were seemed to be below the desirable limit. Geologically, Magnesium rich minerals are associated with basic and ultra basic rocks and ultramafic rocks of igneous and metamorphic percentage. When Magnesium is present above 200mg/l, it may produce gastrointestinal irritation. Magnesium is moderately toxic element if its concentration in drinking water is high. Calcium and Magnesium are of great neurochemical importance. Symptoms of cathartic and diuretic action are observed if excess of these ions are consumed (Brian and Berry, 1997). They are also the source of the hardness.

The same trend could be noticed from the tannery effluent in Nagpur by Srinivas, et al. (1984) and reported that the presence of Calcium, Magnesium and bicarbonates in excess makes water unfit for irrigation since its application increase problems of soil salinity and its permeability detrimental to crop plants. Iron content in bore and well water was found to be nil and its content in lake and pond waters was recorded to be 0.81 and 1.03, respectively. Among the lake and pond waters compared, pond water value was slightly to be higher up to 1.03. This fluctuation may be due to the presence of inorganic load in the water at various levels. Generally, surface water contains < 1mg/l of Fe. Some ground water contains

much higher level of Fe. The iron value > 2mg/l imparts bitter astringent taste to the water (Maiti, 2002). Concentration of Fe above the safe limit could lead to liver, lung, kidney, brain, heart, muscle and respiratory disorders (Loak, et al., 2002).

Free ammonia content was nil in bore well and well waters and this content was noticed to be 0.068 in lake and 0.61 in pond waters. Wetzel (1983) stated that ammonia is generated by heterotrophic microbes as a primary end product of decomposition of organic matter either directly from proteins or from the organic compounds. The nitrite content was nil in bore well and well waters and this content was noticed to be 0.09 in lake and 0.07 in pond waters. Nitrite content has no exception from deviation of ammonia content as this level content was also present in lake and pond waters. The Nitrate (NO_3) content was 14 in bore well water, 10 in well water, 29 in lake water and 12 in pond water and these values were found to be lower than the desirable limit as these values were found to be fluctuated in a range of 10-29. Among the water bodies nitrate contents were found be lower in bore and well waters.

Nitrite poisoning causes fish mortality resulting in converting hemoglobin to methemoglobin as indicated by Boyd (1990). The acceptable limit of NO_3 is 45-100. In excessive amounts it contributes to the illness of infant methemoglobinemia and to prevent this disorder a limit of 10mg dm^3 of nitrate nitrogen is imposed on drinking water (Agarwal, 2005). Nitrate represents the end product of oxidation of nitrogenous matter and its concentration is a presence of nitrification activities under progress in water (Singh, 2002). Nitrate is a prime plant nutrient and rising in its concentration might be expected to increase the eutrophication of waters (Goher, 2002). Nitrate is one of the several inorganic pollutants contributed by nitrogenous fertilizers, human and animal wastes and industrial effluents through the biochemical activities of micro organisms (Agarwal, 2005).

Chloride content was seemed to be low in all the water bodies. Among these four water bodies, chloride content was just high in pond water upto 105. It is generally noticed that chloride content was very low in all the waters of Palleri village. High level is not known to be injurious to fresh water organism. The acceptable limit of chloride is 200-1000. Chloride becomes more toxic when they combined with other toxic substances such as cyanides, phenols and ammonia (Anonymous, 1976). The pollution from the industrial effluent will be a source of chloride concentration in the industrial area. High chlorides indicate organic pollution particularly from domestic sewage. Discharge of industrial effluents in surface water bodies, presence of sodium and calcium, chloride in natural water and higher salinity are responsible for higher concentration of chloride in the area. Higher concentration of chloride is association with increased level of pollution (Umavathi, et al., 2007).

Fluoride content was noticed to be 0.6 in both the bore well and well waters and 0.4 in both the lake and pond water of Palleri village. The result indicated that low level of fluoride content may cause dental fluorosis. The recommended permissible limit of fluoride is 1.0-1.5. The low concentration of fluoride below 0.5 mg/l causes dental caries and when present in higher concentration it causes dental and skeletal fluorosis, mottling of teeth etc. (Agarwal, 2005; Prajapati and Raol, 2006). In the present study the fluoride content was very poor only in lake and pond waters of Palleri village compared to the bore well and well waters of Palleri village as the fluoride content varies around 0.6 mg/l.

Gujarat is one of the most worst affected state amongst the 15 states of India reported as endemic for fluorosis (Jain, et al., 2000). Fluoride is often referred to as two-edged sword fluoride is very much essential for healthy growth of teeth. However, levels higher than 1.5 mg/l causes dental and skeletal fluorosis, decalcification, mineralization of tendencies, digestive and nervous disorders (Udhayakumar, et al., 2006).

Permissible limit of sulphate (SO_4) is 200-400. Sulphate content was 39 in bore well, 49 in well, 41 in lake and 70 in pond water and these levels were found to be very lower than the permissible limit. Presence of sulphate content in high salt water, sewage effluent, ceramic industry, etc., has been discussed in detail by many investigators (Saxena, 1987; Kaur, et al., 1996; Srinivas, et al., 2002). High concentration of sulphate in the tanneries is also as a result of many auxiliary chemicals containing sodium sulphate as a byproduct of the manufacturer or chrome tanning powders containing high levels of sodium sulphate (Bosmic, et al., 2000).

Phosphate content was seemed to be nil in both bore well and well waters and this content was 0.35 in lake water and 0.15 in pond water. Generally, high content of PO_4 in the water may be attributed to the inlet of sewage and the detergents are the contribute factors for phosphates. The excessive phosphate concentration evokes an algal bloom in the water. Since, nitrate, nitrite and phosphate are nutrients for plankton growth, the water is rich in algal contents.

The tidy's content was 0.1 in both the bore well and well waters and 0.4 in both the lake and pond water of Palleri village. Tidy's test is useful for testing organic pollution. The pollution may be due to sewage or industrial waste. When the organic load is high, the dissolved oxygen level in water decreased and affects the aquatic life.

Sinha and Gaurav Kumar Rastogi (2007) studied the physic-chemical characteristics of underground drinking water at Maradabad industrial area in India. Their result indicated that the drinking water was found to be highly contaminated with reference to most of the parameters. Their study suggested that people dependent on this water are prone to health hazards of contaminated drinking water and some effective measures are urgently needed for water quality management.

In a report of Government of Tamil Nadu it is stated that a water system head-work has to be virtually abandoned due to the high pollution level by tannery effluents. The water quality in and around Vaniyambadi, Ambur, Walajapet and Dindugal leave much to be desired. The need for tackling the tannery effluents on a serious footing has been raised from time to time (Tamil Nadu Leather Corporation, 1986).

According to Dhulasi Birundha and Saradha (1993), the sewage of a tannery discharged after treatment of one ton hide is equivalent to public sewage of little town inhabited with 5000 people. The effect that leather tanning industry has on the open water bodies is very greater often quite detrimental. The presence of sodium sulphate, chromium and some tanning agents remove oxygen from water, give it an unpleasant odour and completely stop the self purification process in water bodies by killing the biota. The tanning industry is a potential polluting industry of considerable importance. It is realized that the untreated waste waters when allowed to stagnate as is being done in most cases now, give rise to odour nuisance unsightly appearance besides creating ground water and surface water pollution.

Ramaswamy and Sridharan (1998) studied the groundwater quality of Tamil Nadu in the premises of tanneries and observed that the total hardness, chlorides, calcium and magnesium were 3 to 28 times higher than the drinking water permissible limit prescribed by WHO (1993). The tannery effluent contains high concentration of metallic ions like chromium, potassium, sodium and magnesium and organic pollutants like oil, grease, tannin and lignin (Manonmani, et al., 1991).

Khwaja, et al., (2001) discussed about the influence of wasted on the physic-chemical characteristics of the Ganga water and sediments vis-a-vis tannery at Kanpur (India) and revealed that in-crease values of parameters. Such as BOD, COD, Chlorine and total solids could be due to the domestic wastes. Just as much as to the tannery wastes. However, chromium originate from the tanneries. Sponza (2003) stated that the waste water (industrial effluents) causes said and ground water pollution besides causing a number of adverse effect on agricultural produce, animals and health of people living in the neighbouring areas, since it contains waste chemicals and toxic heavy metals. An enormous increase in pollution due to discharge of effluents from industrial units into rivers and lakes is a matter of great concern in developing countries, developed countries. Which have water pollution problem due to industrial proliferation and modernization agricultural technologies, are now on the ways of combating the problems. Through improved waste water treatment technique. But developing countries with lack of technical known how, weak implementation of environmental policies and with limited financial resources are still facing problems.

The result of the physic-chemical parameters of bore well, well water, lake water and pond waters of Palleri village of Walaja taluk indicated that the fluctuation physic-chemical parameter were found to be either within the desirable limit or within desirable limit as prescribed by WHO (2000). It is concluded from this result that there is no harmful effect due to the presence of physic-chemical parameters within the permissible limit and thereby it is indicated that it is suitable for drinking and irrigation purposes although low levels of fluoride and inorganic content present in most of the bodies in Palleri village.

It is significantly noticed that the contents of calcium (54), Magnesium (15), Nitrate (14), Chloride (69), Fluoride (0.6) and Sulphate (39) were found to be lower than the desirable limit in bore well water of Palleri village. Similarly, the same trend of values were found in well water of Palleri village. Content of TDS (368), Alkalinity (141), Calcium (53). Nitrate (29) and Chloride (55) were found to be lower than the desirable limit in lake water of Palleri village. There was a low content of Magnesium (13), Nitrate (12), Fluorite (0.4) and Phosphate (17) noticed in pond water of Palleri village. It is concluded from this study that although the water is recommended highly for drinking purpose the low level of fluoride content indicated a harmful effect for the cause of dental carries and other effect.

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