

**STUDIES ON THE PHYSICO-CHEMICAL AND  
BACTERIOLOGICAL PARAMETERS OF DRINKING WATER  
SAMPLES FROM THE BORE AND OPEN DRAW WELLS  
OF SELECTED AREAS OF COIMBATORE DISTRICT**

By

**G. SUDHA**

Reg. No. 92PLS12

A THESIS SUBMITTED TO  
THE AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND HIGHER  
EDUCATION FOR WOMEN (DEEMED UNIVERSITY) COIMBATORE-641 043  
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF  
**MASTER OF SCIENCE IN LIFE SCIENCES.**

**APRIL, 1994.**

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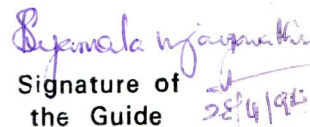
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Dean of the Faculty



Signature of  
the Guide

# Acknowledgement

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## LIST OF ABBREVIATIONS

Fe	= Iron
Mn	= Manganese
Mg	= Magnesium
Ca	= Calcium
Cu	= Copper
H <sub>2</sub> SO <sub>4</sub>	= Sulphuric acid
TDS	= Total Dissolved Solids
I.S.I	= Indian Standards Institute
I.C.M.R.	= Indian Council for Medical Research
W.H.O.	= World Health Organisation
USEPA	= United States Environmental Protection Agency.
EEC	= European Economic Countries.

# Introduction

## INTRODUCTION

"Every thing is originated in the water, and everything is sustained by water".

- Goethe.

Water, the most vital resources for all kinds of life on this planet is also the resource adversely affected both qualitatively and by all kinds of human activities. It is the exploited natural systems, since man ~~stode~~ the earth. It is an essential element to maintain all forms of life and most living organisms cannot survive even for a short period without water.

The major sources of water for domestic, industrial and agricultural purposes are from rain, upland surface water, surface water and ground water.

The major sources of water for domestic, industrial and agricultural purposes are from rain, upland surface water, surface water and ground water.

Rain is the only main sources but, depending on where it occurs and flows along it mainfests itself as upland surface water, surface water and sea water. But, before it touches the ground it is exposed

to dust particulates (i.e. suspended particulate matter SPM), oxides of carbon, Nitrogen and sulphur besides unburnt hydrocarbon arising out of normal fuel burning operations and also other industrial gaseous emissions depending upon locations of operations.

Upland surface water included hill streams, lakes and springs and water from these are generally very soft (due to impervious strata), slightly acidic in nature (Plumbo Solvent), devoid of Iodine and some what exposed to organic and bacterial contamination from surface run offs. The presence of traces of insecticide, and fertilizer residuals cannot be excluded in places proximate to plantations and vegetable cultivation.

Surface water consists of rivers, lakes and tanks impounded reservoirs etc., where the water becomes somewhat moderately hard and mineralised due to flow in different strata. It is also getting exposed to heavy organic contamination due to discharges from sewage treatment plants, agricultural run offs and abuse or misuse.

Ground water includes shallow draw wells and filter point bore wells and also deep bore wells.

The shallow draw wells and filter point bore wells are generally having sub surface water and hence moderately mineralised but, are likely to get exposed to extraneous organic and bacterial contamination arising out of surface run offs from unhygienic insanitary surroundings and due to sewage and percolation through porous strata. Sea water is the receptacle of all wastes including abnoxious wastes containing metallic, organic inorganic and radiological pollutants.

Ground water is extensively use as a source or potable water since,

1. in some areas surface supplies are insufficient, unavailable or require extensive purification, treatment and
2. ground water is almost unstinted source of water and is superior to surface water because of low contamination or free from enteric pathogens.

Though, the defilement of water as a result of human activities is a phenomenon as old as hills, increasing industrialisation, urbanisation, developmental activities and consequent pollution of water has brought a veritable water srosis. The notable references on the above problem are Motwani (1956), David (1956), Saxena et al., (1966), Berma and Shukla (1969). Today most of the rivers

of the world receive millions of litres of sewage, domestic waste, industrial and agricultural effluents.

Most of the water used by humans can be classified as fresh water because the concentration of dissolved constituents is low. The definition of fresh water is not precise, but a value of 1500 g/m<sup>3</sup> total dissolved solids (TDS) is an approximate upper limit. Surface waters tend to be turbid, a property caused by the presence of clay and other light scattering colloidal particles and treatment for turbidity requirements ground waters are often sources of water for individual and small communities.

Wells and springs are the two ground water sources (Fair et al ; 1960) but is available in the form of wells. Technically the wells are of two kinds, shallow and deep. Wells may also be classified on construction into dug wells (unlined kutchha well, masonry pucca well and step wells) and tube wells. Dug wells are generally more than 2 feet in diameter not over 50 feet in depth. Bored and drilled wells are generally used in hard ground and rock may be sunk to the depths measuring hundreds and even thousands. Colour in drinking water may be due to the presence of coloured organic substances, usually humics,

metals such as Iron and Manganese; or highly coloured industrial wastes. The primary importance of colour in drinking water is of aesthetic value.

The National Research Council, Drinking water and health, Washington D.C. States that turbidity in water is caused by the presence of suspended matter, such as clay, silt, colloidal particles (organic particles resulting from decomposition of plants and animal debris and other microscopically important organisms.

Quality criteria for water, Washington D.C. have proposed that TDS in water comprises inorganic salts and small amounts of organic matter such as carbonates, bicarbonates, chlorides and Calcium, Magnesium, sodium, Potassium, nitrates are the principal ions for TDS. TDS in water may originate from natural sources, sewage effluent discharges, urban run offs or industrial waste discharge.

Taste and odour in the assessment of drinking water quality are complementary. Their problems account for the largest single class consumers complaints. Ground water sources for supply normally have fewest taste problems. Inorganic substances like calcium, Potassium,

zinc, Iodine etc exert as unpleasent taste which is objectionable to consumers.

Substances and characteristics affecting the acceptability of water for domestic use is likely to give rise to offtaste and to promote corrosion. The highest desirable level quoted in 7.0 - 8.5 and maximum permissible level quoted is 6.3 - 9.2. In the EEC draft directive for water is given as the guide value with a maximum admissive value of 9.5.

Temperature can affect the palatibility of water supply preferably the temperature of drinking water should be several degree below the ambient temperature and too high a temperature can result in a flat tasting water probably due to the loss of dissolved gases.

Nitrate is the most ubiquitous chemical contaminant in the world's aquifers and the levels of contamination is high and increasing. Increasing degradation of drinking water and eutrophication in coastal waters in the European community are consequences of steadily increasing nitrate levels in surface, ground and coastal waters. (Fried et al; 1991).

The ingestion of nitrate in drinking water has caused methan<sup>e</sup>globinemia in infants (Johnson et al., : 1987). Cases of infantile methan<sup>e</sup>globinemia has not been reported in areas where the drinking water contains less than 10 mg of nitrates per litre. Methanoglobinemia is mostly prevalent where the nitrate - nitrogen levels in drinking water are between 10 and 20 mg/litre.

Traces of fluorides occur in many waters and high concentrations are often associated with under ground sources. The highest natural level reported is 2800 mg/l. Occassionally, fluorides may enter a river as a result of industrial discharg<sup>e</sup>s. In high doses, fluoride is acutely toxic to man and pathological changes include haemorrhagic gastro enteritis, acute toxic nephritis etc. Chronic effects from high exposure in man are primarily related to mottling of teeth and fluorosis in which bone structure is affected.

In most countries the majority of water supplies contain less than 20 mg of sodium per litre. Excessive intake of sodium chloride causes vomiting and elimination of much of the salt. Acute effects may include convulsions, muscular twitching, rigidity, cerebral and pulmonary oedema. (Guide lines for canadian drinking water

quality).

Iron is an essential element in human nutrition (Watt et al, 1963), its presence can give rise to an astrigent taste, discoloration, deposits of rusts can promote growth of "Iron bacteria".

Sulphates are discharged into the aquatic environment in the wastes from different industries. Doses of sulphates between 1.0 - 2.0 gm have a cathartic effects on infants (Mckee et al., 1963).

Phosphates are added to water to prevent corrosion to low levels of addition. As per EEC directive on Quality of water for Human Consumption limits. The maximum permissible limit of phosphates in drinking water is 2mg/l as phosphorous which has no health effect and this level would limit the use phosphates added to water to prevent corrosion to low levels of addition.

#### **Microorganisms:**

The direct infection of town wells by privy paults can be dated back to the 18th century though the cause of infection was not proved for another century. The direct leakage from privies into hand pumped wells in

London during 1854 caused 616 deaths from cholera among the users of the well within 40 days (Parker, 1980).

Craun and McCabe (1973) attributed the high incidence (49.4%) of water borne disease due to unsatisfactory well construction and improper perlocation of wells. In public systems ground water, however, both source contamination, treatment deficiencies and inadequately protected sources were responsible for 95% of the cases of illness.

Shah and patel (1989) reported the presence of diarrhoea causing enterpathogens in drinking water of rural panchamahols of Gujarat district.

Water borne diseases are caused by pathogenic or harmful bacteria. Bacteria are everywhere on the surface of earth and are in great excess even in natural unpolluted water bodies, However, Water cotaminated with sewage provides an excellent medium for the growth of bacteria. The most important water borne disease causing micro organisms are Salmonella typhi, S.Parathyphi, Shigella dysentriae and Vibrio Cholerae which spread the respective diseases such as typhoid, paratyphoid, dysentery and cholera.

Water borne disease out breaks attracted the attention towards the determination of microbial load in ground water samples. The use of total coliform in the assessment of bacterial pollution of fresh water has received very wide attention. Indicator bacteria are usually present in large numbers than pathogens, and are easier to isolate and much safer to work with it (Mason, 1981).

Bacteriological data from the community water supply study (McCabe et al., 1970) revealed that 9% of 621 well waters contained coliform, 2% faecal coliforms and 83% of wells contained bacteria as determined by standard plate count (APHA, 1971) and 11% of wells had bacterial density greater than 500 organisms/ml.

The bacterial quality of bore well waters supplying the Nuzvid town in raw (Andhrapradesh) and after treatments like boiling, filtering was studied by Somasekara et al., (1988). The temperature 60 °C was appropriate for bacterial killing and about 10mg/l of bleaching powder was effective in reducing coliforms.

In addition to bacterial diseases viruses are known to cause diseases of public health are

known.

The common indicators of microbial pollution are coliform, faecal coliform, E.coli, bacterioides, Clostridium perfringens, Bifidobacterium bifidus. Among these faecal coliforms and E.coli are ideal since they correlate better with faecal contamination in water; relatively easy to test and their survival patterns similar to most of the persistent water borne intestinal pathogens (Gelderich, 1978, Feng and Hartman, 1982).

Several epidemiological studies have evaluated a possibility of a link between drinking water contaminants and cancer in human population. Ecological studies with water chlorination and cancer occurrence in a number of different populations have shown elevated rates with surface of chlorinated water supplies.

viruses of major concern in relation to water borne transmission of infections disease are essentially those that multiply in the intestine and the excreted in large numbers in the faeces of infected individuals. Concentrations as high as  $10^8$  viral units per gm of faeces have been reported. viruses enter the water primarily by way of sewage discharge. Explosive out breaks of viral hepatitis and gastro enteritis resulting from

sewage contamination of water supplies have been well documented epidemiologically (Craunand McCabe, 1973).

Enteric viruses are capable of producing a wide variety of syndromes including rashes, fever gastro enteritis myocarditis, meningitis, respiratory disease and hepatitis. However, when drinking water is contaminated with sewage, two diseases may occur in epidemic proportions - gastro enteritis and infectious hepatitis.

Coimbatore is a city situated in Tamil Nadu. It is often known as "The Manchester of South India". It is a big industrial city with many textile mills. The effluents released by these mills often percolate into the ground water and thus may be a source of pollution due to which many water borne diseases may spread.

The present study has been undertaken to impart a knowledge on the advantages and disadvantages of the presence of dissolved solids and microorganisms in the drinking water especially on the health aspects of the people in the study areas.

The water sample examination may also given an idea of the palatibility colour odour, other chemical and bacteriological parameters which may suit the consumer s acceptability.

# Review of Literature

## REVIEW OF LITERATURE

Wells and springs are the two ground water sources (Fair et al; 1960), but it is generally available in the form of wells.

The quality of ground water in Jaipur city was studied and it was found that except in few cases, alkalinity, hardness, chloride, sulphate and total dissolved solids were present within the limit (Olaniya et al., 1969).

The chloride content of 70 per cent of village in Ajmer district were within the acceptable range and 11 per cent of the villages had chloride levels above 500 mg/l. Dissolved solids in 16% of villages were within the permissible values; and 12% had beyond 2000 mg/l. (Bhargava et al., 1978).

The well water in Udaipur district were free of any chloride and sulphate. About 74 % of the samples contained the concentration less than 1000 mg/l. Sulphate was found less than 200 mg/l in 96% of samples. The distribution of Total dissolved solids (TDS) was not uniform in this district (Gupta, 1981).

It was reported that the water samples collected from Uttarpradesh had 6.2. + 0.4 mg/l potassium. (Handa et al; 1983). Turbidity in excess of the guide line value of 5NTU (Nephelometric turbidity units) is generally objectionable to consumers. (Public Health Service drinking water standards, Rockville) Taste thresholds in distilled water for the major cations of drinking water (calcium, Magnesium, sodium and potassium) have been reported by Campbell et al, 1970.

Turbidity and colour are indirectly related to temperature as the efficiency of coagulation is strongly temperature dependent. The optimum pH for coagulation decreases as temperature increases.

Taylor and coworkers were unable to establish any significant correlation between the incidence of viral hepatitis A and disinfected water pH. The study has been primarily directed towards the effect of pH on disinfection efficiency.

It was revealed from experiments conducted by Brar et al., (1984) that out of 315 well waters from Delhi 60% of the water samples were found to be fit for drinking and 38% were marginal and 3.8 per cent were unfit

even for irrigation.

Weil et al., (1985) have studied on the nitrate content of ground water which irrigated coastal plain soils. This study was conducted to determine the vertical and seasonal patterns of nitrate leaching under such soils.

A survey of trace metals on the ground water of Rourkela was conducted (Pradhan et al; 1986). The concentrations of 10 trace metals (Iron, Magnesium, Zinc, Calcium, Sodium, Potassium, Aluminium, Strontium etc.,) have been determined by analysing 35 samples of ground water collected from 7 deep tube wells located in a study area of about 350 acres. The concentration of the trace metals were determined with an atomic absorption spectro photometer. These concentrations were much below their permissible limits recommended for drinking water.

The ground water quality of Tiruppur where water samples from dug and tube wells near the Noiyyal river in Tiruppur area were analysed for the assessment of chemical quality with reference to Indian standards for drinking water (Ramaswami et al; 1987). It was observed that the water samples from open wells had high

values of pH, alkalinity, chloride, Nitrogen, sulphate, total hardness, Magnesium and sodium when compared to those of tube wells while, low cadmium calcium potassium contents were observed.

Investigations have shown that, Nitrate is the most ubiquitous chemical contaminant in the world's aquifers and the levels of contamination are increasing. Ingestion of nitrate in drinking water has caused methamoglobinaemia in infants under 6 months of age and recently caused the death of a South Dakota infant (Johnson et al ; 1987).

The ground water pollution in and around Ujjain city was conducted (Patel; 1988). The study area, mainly composed of Deccantrap basaltic lava flows, is situated on the bank of river kshipra. The well samples collected near the waste disposal represents ground water pollution in the region. 3 main polluted zones have been demarcated in the study area. (North Western region, Western portion near river kshipra meandering, Eastern side of Hira and Binod Mills). In these regions the degradation in ground water quality is mainly due to disposal of industrial and municipal sewage waste. Presence of thick alluvium in North - Western portion may also attribute the

degradation of ground water quality.

Ozha et al (1988) had studied the nitrate content in ground water of some districts of Rajasthan, Nitrate in high concentrations had been observed in ground waters of Churu and Barmer districts. Eighty per cent water samples of Churu district and 65% Barmer district had nitrate values, above the acceptable limit of 500 mg/l. It was observed that nitrate content increased as the depth of water table increased.

A study on the nitrates in ground water sources in Medchal block of Andhrapradesh has been done (Rao et al; 1989). In this the presence of nitrates in ground water and its relationship and other physico-chemical constituents of waters had been studied in a grid pattern. Nitrate concentration was found to increase with decrease in pH and with increase in hardness, chloride, sulphate and total solids while alkalinity, flouride and water table do not exhibit any significant effect on the nitrate content.

Abbi et al (1988) had investigated on the ground water quality deterioration in Hubli city area samples from 14 open wells and 9 bore wells located in the

vicinity of sewage sources had been analysed for major anions and cations, dissolved oxygen, COD. Many samples had high sodium, Iron, total dissolved solids concentrations of chlorine, Na, Fe, TDS indicates their impact on ground water quality. It was suggested that proper lining of sewage channels and adopting some special purification process will decrease the corrosivity of ground water.

A study regarding the chemical character of ground water in Nagaur district, Rajasthan had been done, chemical analysis on ground water samples showed that flouride and nitrate concentrations increase with an increase in salinity. While high flouride waters on the other hand had relatively high percentage of calcium and magnesium. High bicarbonate content was observed in ground waters rich in flouride, while it was low in nitrate water. High values of phosphorous were observed in association with high flouride and potassium, showing its occurrence due to mineral weathering and local pollution (Gupta, 1988).

Harish Chandra et al., (1989) had done evaluation of drinking water quality during Mahakumbh mela, ie., between January - February (1989). 85 water sample from tube wells and hand pumps were analysed for physico-chemical and bacteriological parameters to assess their

potability for humans. The values of various parameters were ranged between desirable and maximum permissible limit. No bacterial contamination was detected in any water samples which had free residual chlorine of 0.2 mg/l or above. A high level of cadmium was found in some of the drinking water samples from the city and the mela area. At the mela area, all the hand pump water samples had 9 times cadmium than the permissible limit.

Water quality of reservoirs and temple tanks in Tirupati and Tirumala had been assessed by (Naidu et al., 1990). It was found that the temperature ranged between  $27^{\circ}\text{C}$  -  $37^{\circ}\text{C}$ ; pH of the waters between 7.0 and 7.6; Hardness was in the range of 20 - 122 ppm for waters from reservoirs and 79 - 99 ppm in the case of tanks which is below the permissible limit of 250 ppm.

The concentration of fluorine in the irrigation waters ranged from 0.4 to 2.6 mg/l. 50% of the samples exceeded the critical limit of 1 mg/l for drinking purposes. Long term use may affect the consumers. The nitrate concentration ranged from 0.2 to 8.6 mg/l and its presence is useful for crop growth.

(Gnanambal et al., 1989)

All the chemical parameters except total hardness were found to be below the desirable limits in the well waters of Thivakudi village, Thiruchirapalli and in Sembattu village a satellite town of Tiruchirapalli. It was found that ground waters are not suitable for the purpose of drinking, irrigation and industrialization (Vijayaram et al, 1989).

Ground water samples from 305 working tube wells in 65 villages of sangrur block (district Sangrur) were analysed for their chemical composition and to assess their suitability for irrigation purposes. Based on electrical conductivity (EC) and residual sodium carbonate (RSC) the samples were grouped into different categories for preparing water quality map of the district. Electrical conductivity ranged from 500-2835 mhos/cm. Sodium was the most dominant cation and value ranged from 0.6 - 21.7 mg/l. (Benbi et al., 1991).

A study of the ground water quality in coastal regions of South Madras had been done by (Chowdhary et al. Demand and for fresh ground water is on a tremendous increase due to population growth, advanced agricultural practices and industrial usages. The sodium and chlorides were the dominant ions in the ground water. Over 150

samples were analysed. There were few locations where the ground water were not suitable even for irrigation purposes. The major contaminant sources identified in this area were brine water estuaries, liquid and solid wastes. The pH varied between 6.4 and 8.7. The electrical conductivity ranged between 70 and 5000 mhos/cm.

Abdul Wahid Isaraili, (1992) investigated the occurrence of heavy metals in river Ganga and sediments observed that the calcium concentrations in sediments were found considerably higher than those obtained from river water. The higher concentrations of heavy metals in sediments may be due to on going physico-chemical reactions in aquatic system, which usually precipitate these metals. The amount of organic matter in sediments varied from 0.62 to 0.89 %. Metals like Cr, Cu, Mn and Ni have interacted with organic matter, aqueous phase and settle down resulting in high concentration in sediments. Finer particles of silt and clay have large surface area and have tendency to absorb and accumulate metal ions through adsorption.

#### Micro organisms:

Extensive bacteriological surveys on ground water quality in United States showed that 9 to 85% of the samples examined contained coliforms and 2 to 75% of these same waters were positive for faecal coliforms. These

studies indicate that the microbial quality of ground water cannot be taken for granted especially in rural areas.

Bacteriological data from the community water supply study (McCabe et al; 1970) revealed that 9% of the 621 well waters contained coliform, 2% faecal coliforms and 83% of wells contained bacteria as determined by standard plate count (APHA, 1971) and 11% of wells had bacterial density greater than 500 organisms/ml.

It has been attributed that the high incidence (49.4%) of water borne disease is primarily due to unsatisfactory well construction and improper location of wells. In public systems using ground water, however, both source contamination treatment deficiencies and inadequately protected sources were responsible for 95% of the cases of illness (Craun and McCabe, 1973).

The direct infection of town wells by privy paults can be dated back to the 18th century through the cause of infection was not proved for nearly another century. The direct leakage from privies into the hand pump wells in London during 1854 caused 616 deaths from cholera among the users of the well within 40 days (Parker, 1980).

Anuja singh and Wadh wani (1987) have studied fungi in relation to physico chmical factors of tube well waters, which are the source of drinking water in Trans-Gomti area of Lucknow. The presence of fungi in relation to abiotic factors is sought only 6 fungi, three species of Aspergillus, one each of Cephalosporium, Pencillium and Tricho derma were isolated.

The common indicators of microbial pollution are faecal coliform, E. coli, faecal streptococcus, clostridium perfringens, Bacterioides, Lactobacillus, correlate better with faecal contamination in water, relatively easy to test and their survival patterns are similar to most of the persistent water-borne intestinal pathogens (Geldreich, (1978) Feng and Hartman (1982).

Somasekara Rao et al., (1988) studied the bacterial quality of bore well waters supplying the Nuzvid town of Andhrapradesh, in raw and after treatments like boiling, filtering. The temperature 60 c was appropriate for bacterial killing and about 10 mg/l of bleaching powder was effective in reducing coliforms.

Bacterio logical analysis of 44 hard pump water samples from gastroenterites affected areas

showed that 30 (68.2%) hand pump were with 10 coliforms 100 ml and or 0.1 faecal coliforms 100 ml (WHO guide lines).

Coliform cantamination has also been observed in a parallel study by Baveha et al, 1989.

# Materials and Methods

## MATERIALS AND METHODS

The drinking water samples for the present study were collected from the bore and open draw wells of selected areas of Coimbatore district before noon (between 9 a.m. and 12 noon). The areas selected are:

- a) Kamakshinagar Sellappanpalayam - Bore well (Fig.1)
- b) Goundampalayam near Railway gate - Bore well (Fig.2)
- c) Vinayakar Koil Thottan, Sangapur open draw well (Fig.3)

The samples were collected for the analyses of physical (colour, turbidity and odour), chemical (Total solids pH, Alkalinity, Total hardness, oxygen absorbed in 4 hours, Ammonical nitrogen, Albuminoid nitrogen, Nitrate nitrogen, Chloride, Fluoride, Manganese Iron sulphate, phosphate, Nitrite nitrogen and Electrical conductivity and Bacteriological parameters (Total colonies per ml on agar at 37 °C, MPN coliform bacteria per 100 ml, nature of coliform bacteria isolated).

The water samples to be tested were drawn in a white jerry can (2.5 litres) The polythene

jerry can was cleaned and rinsed with water properly. Water is drawn into the jerry can leaving some air space. The mouth of the can with water samples was closed tightly to avoid any leakage in transit. For bacteriological analyses samples were collected in sterilized glass containers.

#### **Preservation of water samples**

The water samples collected for physico chemical analyses were preserved at room temperature, samples for bacteriological tests were preserved at 4 °C by keeping the bottles in a bucket full of ice.

The Analyses were carried out based on "Standard methods of American Public Health Association" (1980)".

#### **PHYSICAL TESTS:**

##### **Colour:**

Permenant colour standards were used to observe the colour of the samples. Turbidity of the samples were measured by using jackson candle turbidity weter and odour by normal sniffing at room temperature.

**CHEMICAL TESTS:**

Temperature of the drinking water samples were measured by using the thermometer at the sampling area pH of the samples were determined by pH meter.

**ESTIMATION OF TOTAL SOLIDS (T.S.)**

A known volume (25ml) of the sample was taken in a pre weighed silica crucible and was evaporated to dryness, using a water bath. After complete evaporation the final weight of the crucible was taken. The total solids present in the sample was calculated by using the formula.

$$\text{T.S. mg/l} = \frac{(\text{Final} - \text{Initial}) \text{ weight of crucible} \times 1000}{\text{Volume of the sample}}$$

Volume of the sample

**ESTIMATION OF ALKALINITY:**

Alkalinity of water is its acid neutralising capacity. It is the sum of all the titrable bases. The measured value may vary significantly with the end point of the pH used.

**REAGENTS:**

i) Sulphuric acid (N) : 28 ml of cone -  $H_2SO_4$  was taken in a 1000 ml volumetric flask and made upto the mark with  $CO_2$  free distilled water.

ii) Sulphuric acid (0.02N) :

20 ml of  $1N H_2SO_4$  was made up to 1000 ml with  $CO_2$  distilled water.  $10\text{ ml of } 0.02\text{ N } H_2SO_4 = 1.0\text{ mg } CaCO_3$

iii) Phenolphthalein indicator:

500 mg of phenolphthalein was dissolved in 50 ml of 50% ethylalcohol

iv) Methyl orange indicator.

**PROCEDURE:****A. PHENOLPHTHALEIN ALKALINITY:**

50 ml of the sample was taken in a 250 ml conical flask and phenolphthalein indicator solution was added. If no pink colour appeared there was no phenolphthalein alkalinity. If pink colour appeared then titrated with 0.02 N sulphuric acid the solution became colourless.

**Calculation:**

Phenolphthalein alkalinity (as  $\text{CaCO}_3$ ) mg/l =

$\frac{\text{ml } 0.02\text{N } \text{H}_2\text{SO}_4 \text{ for phenolphthalein endpoint} \times 1 \times 1000}{\text{ml sample taken for titration}}$

---

ml sample taken for titration

**B. METHYL ORANGE ALKALINITY:**

To 50. ml of the sample, 3 drops of methyl orange indicator was added the sample was then titrated against 0.02 N sulphuric acid until light pink colour has appeared.

**Calculation:**

Methyl orange alkalinity (as  $\text{CaCO}_3$ ) mg/l:

$\frac{\text{ml } 0.02\text{N } \text{H}_2\text{SO}_4 \text{ to methyl orange alkalinity end point} \times 1000}{\text{ml sample taken for titration}}$

---

ml sample taken for titration

**ESTIMATION OF TOTAL HARDNESS:****PRINCIPLE:**

Calcium and Magnesium ions react with EDTA to form soluble complexes and the completing of reaction is indicated by the colour change of a suitable indicator such as Erichrome black T. **REAGENTS:**

## 1. Calcium standard solution:

1 gm of calcium carbonate was dissolved with 50ml of distilled water. To this solution 20.5 ml N HCl was added and made up to 1000 ml with distilled water.

## 2. Standard/EDTA titrant (0.02N):

3.728 gm disodium salt of EDTA was dissolved with 1000 ml of distilled water. 1.0 ml of 0.02N EDTA 1.0 mg CaCo<sub>3</sub>.

## 3. Ammonia - Ammonium chloride buffer:

16.9 gms of Ammonium chloride was dissolved in 143 ml conc. Ammonia solution. To this 1.25 gm Magnesium salt of EDTA was added and diluted to 250 ml with distilled water.

## 4. Sodium sulphide inhibitor:

5.0 gm of Na<sub>2</sub>S · 9H<sub>2</sub>O was dissolved in 100 ml distilled water.

5. Erichrome black T indicator:

0.5 gm of the dye and 100 gm of sodium chloride were mixed together and prepared as a dry powder.

**PROCEDURE:**

50 ml of the sample was taken in a conical flask and 1 ml of buffer solution was added. The sample was then titrated against standard EDTA solution until a reddish tinge appeared and the last few drops were added within 3-5 seconds. The end point was the appearance of blue colour. The whole titration should be completed within 5 minutes after the addition of buffer.

**Calculations:**

$$\text{Hardness of CaCO}_3 \text{ mg/l} = \frac{\text{ml EDTA titrant} \times E \times 1000}{\text{ml sample taken for titration}}$$

where:

E is  $\frac{\text{CaCO}_3}{3}$  equivalent to 1.0 ml EDTA.

Hardness is classified into 2 types namely:

1. Carbonate hardness and
2. Non - carbonate hardness

The carbonate hardness is due to bicarbonates and carbonates of sodium and magnesium whole. Non-carbonate hardness is due to sulphates, chlorides and nitrates of calcium and magnesium where,  
Calcium hardness = Alkalinity (carbonate + bicarbonate)  
Non - carbonate hardness = Total hardness - Alkalinity

Then 1 gm Ammonium per sulphate was added on boiling. The solutions were transferred to Nessler tube and measured photometrically by using spectrophotometer. A calibration curve was prepared and the Magnesium equivalent to the observed optical density was found out from the calibration curve.

The following elements in the drinking water samples have been estimated by the following methods: Chloride as chlorine has been estimated by using MOHRS methods (Argentometric method) Ammonical nitrogen has been estimated by using Direct Nesslerisation method and Albuminoid nitrogen by Nesslerisation method.

Oxygen absorbed in 4 hours has been estimated by Tidy's test. The presence of Nitrate nitrogen has been found out by using phenol disulphonic acid method.

The presence of fluoride as fluorine (SPADNS method) and Iron as Fe ( $\alpha$  -  $\alpha$  bipyridyl method) were also estimated.

#### QUALITATIVE TESTS:

The presence of Nitrite nitrogen has been determined by using Diazotisation method and the presence of sulphate by Gravimetric method. The presence of phosphates has been done by using Ammonium Molybdate method.

Electrical conductivity has been measured by using Electrical conductivity meter.

#### BACTERIOLOGICAL TESTS:

The bacteriological tests was done by the following methods.

##### 1. Total count or Agar plate count test:

Bacteria are cultivated on specially prepared medium of agar for different dilutions of sample of water with sterilised water. The diluted sample is placed in an incubator for 24 hours at 37 C. The bacterial colonies

which are formed are then counted and the results are computed for 1 C.C.

2. E.coli test was also conducted in three parts:

a) Presumptive test b) confirmed test c) completed test.

Isolation of coliform bacteria has been done by the following tests.

a) Methyl Red (M.R) Test (b) Voges - Pros Kauer (V.P) Test  
c) Growth in citrate test d) Indole test and (e) lactose fermentation at 44<sup>o</sup> C test.

Tables on different parameters comparing the water samples with standards were also prepared.

Fig.1 : Water sample collected from borewell at Kamakshinagar, Sellappanpalayam.



Fig.2 : Water sample collected from borewell at Goundampalayam, Railway gate.



Fig.3 : Water sample collected from an open draw well at Vinayakar Kovil thottam, Sangapur.



## Results and Discussion

## RESULTS AND DISCUSSION

The results of drinking water samples collected from the selected areas of Coimbatore for the physico-chemical and bacteriological analyses were tabulated in Table I, II and III each with three columns indicating sample I, II and III.

Sample I-water sample collected from the borewell, of Kamakshinagar, Sellampampalayam Sample II, the water sample collected from borewell, Goundampalayam and sample III water collected from open draw well, Vinayakar Koil thottam, Sangapur.

The results of physical characters (Colour, turbidity, odour) of water are presented in Table I.

The results of chemical examination comprising various parameters are summarised in Table -2. Bacteriological analysis relating the colony counts are shown in figs. 4, 5 and 6 MPN of coliform bacteria and the nature of bacteria are showed in Table 3.

Table 4 indicates the recommended guide line values of drinking water by ISI, I.C.M.R. and W.H.O.

**PHYSICAL TESTS:****A. colour**

Colour is the psycho - physiological and psycho - physical aspect.

Colour in drinking water may be due to the presence of coloured organic substances usually humics, metals such as Iron and Managanese or highly coloured industrial coasts. Sample I in the present study is slightly yellowish and this is attributed to the iron content (0.35 mg/l) of the water. Samples II and III are colourless and clear. Brown et al., (1974) have studied the comparative toxicities of trace metals and their humate complexes with reference to human health.

Tripathy and Adhikari (1990) made a preliminary study on river Nandira (Orissa) on the colour effect due to industrial effects.

**TURBIDITY:**

As stated by National Research Council, drinking water and health, Washington.D.C. turbidity in water is caused by the presence of suspended matters such as clay, silt, colliodal particles, plankton and other Microscopic

organisms. Turbidity in the sample I had shown value of 6 JTU which is slightly higher than the recommended sample II had shown a value of 3 JTU sample III 2 JTU which may be desirable since the value falls below the desirable level of ISI. Excessive turbidity can protect micro organisms from effects of disinfection, stimulate the growth of bacteria in the water and itself exert a significant chlorine demand, it is vitally important in producing safe drinking water, using chlorine as disinfectant that turbidity should be kept low preferably below 1 NTU. A turbidity in excess of the guideline value of 5 NTU is generally objectionable to the consumers (public health service drinking water standards, Rockville., 1962)

#### Turbidity :

The turbidity of water is related to or effects many other indicators of drinking water quality, the suspended particulate matter in potable water supply renders the water unattractive to the consumer (Atkins and Tomlinson 1963). Consumption of highly turbid, chlorinated water may be a dangerous health risk (Dennis , 1959 and Simsons, 1975).

The presence of turbidity can have a significant effect on the microbiological quality of drinking water.

**ODOUR :**

Odour of drinking water is the sensation that is due to the presence of substances having an appreciable vapour pressure that stimulate the human nasal and sinus cavities. All the three samples tested showed an unobjectionable smell to the consumers. Odour problems may occur due to an increased loading of dangerous pathogens, chemical contaminants etc., to the drinking water. Ground water tends to have fewer odour problems (Burtschell., 1959).

**CHEMICAL TESTS :****(A) Total Dissolved Solids (TDS):**

Environmental protection agency in the Quality criteria for water states that TDS in water comprises inorganic salts and small amounts of organic matter. The principal ions contributing to TDS are carbonate, bicarbonate, chloride, sulphate, Nitrate, Sodium, Potassium, Calcium and Magnesium. Bruvold etal., (1967) have rated the palatibility of drinking water according to TDS level by using the following scales.

Excellent : less than 300 mg/litre.  
Good : between 300 and 600 mg/litre.  
Fair : between 600 and 900 mg/litre.  
Poor : between 900 and 1200 mg/litre.  
Unacceptable : greater than 1200 mg/litre.

The sample II had a value of (1640 mg/l) and sample III of (2225 mg/l) as a rule are unacceptable to the consumer because they exceed the recommended guideline value i.e., 500 mg/l specified by ISI, ICMR & WHO. Sample I had shown a value of (600 mg/l) and can be regarded as good. Rainwater and Thatcher (1960), have suggested that waters in contact with granite, siliceous sand, well leached soil or other relatively insoluble material have TDS levels of less than 30 mg/litre. There is no evidence of deleterious physiological reactions occurring in persons consuming drinking water supplies that have TDS levels in excess of 1000 mg/litre (Rainwater, 1960, Durfor, 1972 Ongerth, 1974). The results of certain epidemiological studies would appear to suggest that TDS in drinking water may even have beneficial health effects. Water with low TDS may also be unacceptable because of its flat, insipid taste. Hardness is a measure of the capacity of water to react with

soap. In fresh water the major contributing factors for hardness are ions which are from lime stones, including chalk in water. The polyvalent metallic ions such as strontium, Iron, Ba and Mn also contribute to the hardness as stated by Environmental protection Agency in Quality Criteria for water.

Hardness is divided into carbonate (temporary) and non-carbonate (Permanent). Carbonate hardness refers to the amount of carbonates and bicarbonates in solution which are responsible for the deposition of scales in kettles and can be removed or precipitated by boiling. Non carbonate hardness is caused by the association of the hardness causing cations with sulphate, Fluoride or nitrates and cannot be removed by boiling.

Sources of water containing upto 100 mg of calcium /litre are fairly common and that containing over 200 mg of calcium /lit are rare. Here in our study sample I contains 176 mg/l, sample II-220 mg/l, and sample III 500 mg/l of calcium. Sample III predominates in calcium hardness.

Water containing levels of magnesium at concentration upto 10 mg/l are common and water sources rarely, contain more than 100 mg of magnesium/lit.

In table 2, sample-I shows a concentration of 152 mg/l, sample-II 300 mg/l, and sample III 400 mg/l of magnesium. All the three samples show a high degree of magnesium concentration.

Although hardness is caused by cations, it may also be discussed in terms of carbonate and non-carbonate (anions) hardness. In our analysis the carbonate concentration in sample-I as 328 mg/l, sample-II 520 mg/l, sample II 475 mg/l were obtained.

The temporary hardness due to carbonates in the samples exceed the guide line values.

Hardness may range from less than 10 mg/l over 500 mg/l (Marier et al., 1979) As per Guidelines Canadian drinking water quality (1975) it was stated that water sources may have a hardness of less than 50 mg/l, values above 500 mg/l are relatively in most countries.

As per the results obtained in Table 2, for the total hardness as calcium carbonate the concentration values are 328 mg/l, 520 mg/l, 900 mg/l for the sample - I, II and III respectively. It is evident from the above result that the

hardness of water is very high when compared, with the recommended guide line values (300 mg/lit) especially in sample II, III.

The degree of hardness of drinking water in the present study can be classified in terms of its equivalent calcium carbonate as follows:-

Soft	= 0.60 mg/l
Medium hard	= 60 - 120 mg/l
Hard	= 120 - 180 mg/l.
Very hard	= 180 mg/l and above.

Ground water is rich in carbonic acid and dissolved potential towards soil or rocks that contain appreciable amounts of the minerals calcite, gypsum, dolomite and consequently hardness levels upto several thousand milligrams/lit can result (Sawyer , 1967 and De Ful Vio, 1975).

Guide line values are not proposed for calcium or Magnesium in water as a guide line value is proposed for total hardness based on aesthetic considerations.

Harish chandra et al., (1991) while evaluating drinking water quality from tubewells and hand pumps during Mahakumbhmela, held at Allahabad found that the total hardness values had ranged between desirable and maximum permissible units.

A probable correlation was observed between total hardness and nitrate in its higher values in a study conducted on nitrates in ground waters of some districts of Rajasthan by Ozhaet al., (1993).

There is no evidence of adverse health effects specifically attributable to high levels of calcium or magnesium in drinking water. Apart from the domestic disadvantage resulting from the use of water possessing a high degree of hardness another possible disadvantage may arise from the association of magnesium with the sulphate ion resulting in a water possessing laxative properties.

Since, 1957 a number of studies in various parts of the world have demanstrated that there is a highly statistically significant negative association between water hard ness and cardio vascular disease (Amuris et al., 1975)

As per the guide lines for Canadian drinking water quality the results of several studies have suggested that a variety of other diseases like nervous system defects, anencephaly, perinatal mortality and various types of cancer are correlated with hardness of water but, there is still considerable doubt about their significance.

In areas with very hard water house hold pipes can become choked with deposition of scales (Coleman., 1976). Hard water also deposits incrustations on kitchen utensils as well as increasing soap consumption.

The drinking water samples of selected areas with a very hard nature is considered a nuisance and an economic burden to the consumer and turned unacceptable to the community as a whole.

The anions like hydroxide, bicarbonates and carbonates have a significant influence and so to a lesser degree do phosphates, silicates, and borates, molecular species of weak acids also contribute if present.

#### ALKALINITY:

The buffering capacity of water is termed as alkalinity

which is produced by anions or molecular species of weak acids mainly hydroxide, bicarbonates and carbonates.

Alkalinity is closely linked to hardness . It is expressed in terms of an equivalent quantity to calcium carbonate. According to Thomas (1953) the alkalinity of surface water is due to the presence of carbonates or bicarbonates. The alkalinity value is usually close to the hardness value.

As per the results obtained from Table 2, it is reported that phenolphthalein alkalinity in the samples was nil and using methylorange as an indicator showed values of 330 mg/l, 520 mg/l and 475 ng/l in samples I II and III respectively. All the three samples analysed showed a high value of alkalinity to the desirable unit and below the maximum permissible limit of ICMR. Hence the taste of the water becomes unpleasant.

pH :

The acidity or alkalinity of water is measured in terms of its pH value or the H-ion concentration. The desirable maximum permissible of pH in water is between 6.5 and 8.5. The maximum permissible as per ICMR is from 6.5 to 9.2. In

our present study of samples I, II and III showed a pH values of 7.4, 7.5, 7.6 respectively. The above investigation on pH proves to be within the permissible limit. Taylor and co-workers (1966) were unable to establish any significant correlation between the incidence of viral hepatitis-A and finished water pH.

A direct relationship between the human health and the pH of drinking water is impossible to ascertain because pH is so closely associated with other aspects of water quality. The quality of water analysed from some wells in Saudi Arabia showed a pH range 5.9 to 8.8 and with a mean value of 7.4 which was reported by Nabil Alaael-din et al., 1993.

#### **IRON :**

It is an essential element in human nutrition (Watt and Merrill, 1963). It occurs in water mainly in the divalent (Ferrous) and trivalent states (Ferric) (Environmental Protection Agency). From the results obtained it was noted from Table (2) that in the sample I, iron as ferrous was found to be about 0.10 mg/litre and the total iron content was about 0.35 mg/litre, while sample II and sample III were without any iron content. Concentrations of iron in drinking water are normally less than 0.3 mg/l. The presence of iron

in sample I gives a slight yellowish colour to the water sample.

Concentrations of iron greater than 1 mg/l have been reported to occur in ground water (Dart, 1974). The presence of iron in drinking water supplies is objectionable for a number of reasons unrelated to health. (Dart, 1974 and Watt, 1963, Moore, 1973). Under the pH conditions existing in drinking water supplies, ferrous salts are unstable and precipitate as insoluble ferric hydroxide which settle out as a result coloured silt. Such water often tastes unpalatable.

#### **MANGANESE :**

The results obtained from the three samples tested showed no occurrence of manganese. It was reported that in Japan, a manganese concentration of 0.75 mg/l (Suzuki, 1970) and 0.005 mg/l (Shroeder et al., 1966) from drinking water had no adverse effect on the health of its consumers. The presence of manganese in drinking water supplies may be objectionable for a number of reasons unrelated to health. At concentration exceeding 0.15 mg/l of manganese imparts an undesirable taste to beverages (Griffin and Wolfe., 1960) and growth of certain nuisance organisms is also supported

by manganese which may cause taste, odour and turbidity in the distributed water.

### **Nitrate-Nitrogen :**

Nitrates are widely distributed in substantial quantities in soil, in most waters and in plants, including vegetables. Nitrates are products of bacterial oxidation of organic nitrogen (Guidelines for Canadian drinking water quality, 1978).

Concentrations in water are expressed as mg/l for nitrate-nitrogen (Nitrate-N) and nitrite-nitrogen (Nitrite-N). As indicated in Table-2, sample-II with a concentration of 40 mg/l and sample-III with concentration of 35 mg/l are considered to be quite high to the recommended guide line values of 10 mg/l (USEPA) whereas sample-I with a concentration of 5mg/l fits within the permissible limit.

It was stated by National Research council 1977, Washington D-C in drinking water and health that the levels of nitrates with polluted waters are almost invariably very much higher than the levels of nitrites.

A report by the International Standard Committee on water quality and treatment on nitrates in water supplies (1974) revealed that the levels of nitrate in the range of 20 to over 200 mg/l of Nitrate-nitrogen~~mg/l~~ is a rarity. But, most of the higher levels of nitrates are found in ground water. It is also stated that none of the conventional water treatment and disinfection practices modified the levels of nitrates to any appreciable extent.

It has been well documented both in the guide lines for Canadian drinking water quality (1980) and USEPA. Health effects of nitrates in water (1977) that in some countries water (1977) that in some countries water supplies containing high levels of nitrates have been responsible for cases of infantile methaemoglobinaemia and death. It is also stated in the report by the International Standing Committee on water quality and treatment (1974) that excessive levels of nitrates in water used for the reconstitution of baby food may be responsible for methaemoglobinaemia in infants. A large number of studies have been carried out on the levels of nitrate in water giving rise to meth haemoglobinaemia. Cases of infantile meth haemoglobinaemia have not been reported in areas where the drinking water consistently contains less than 10 mg of nitrate-nitrogen/litre. (Guidelines for Canadian drinking

water quality). Although tests on animals have shown that are a number of nitroso amines, which are carcinogenic, there is no direct evidence of their carcinogenicity in man (WHO, National Research Council, Washington D.C., IARC).

From our study point it is revealed that high concentration of nitrate-nitrogen of water samples II and III proved to be unsuitable for drinking and other domestic purposes.

Nitrate-nitrogen was found to be in traces by Tripathy et al., (1990) in the preliminary studies conducted on river Nandira.

A study conducted on the nitrate contamination of ground water by Weil et al., has shown that Nitrate-nitrogen in the ground water samples were negligible each being  $<0.1$  mg/l in most cases.

**Albuminoid Nitrogen :**

The tests conducted on all the three samples showed very meagre amount of albuminoid nitrogen ie., sample I had a value of 0.01 mg/l, sample II 0.03 mg/l and sample III 0.02 mg/l.

**Ammoniacal nitrogen :**

No traces of ammoniacal nitrogen was found in all the three samples tested.

Tripathy and Adhikari (1990) conducted a preliminary study on the water pollution of river Nandira at eight different sites taking the parameter of Ammoniacal nitrogen. The results showed a value between 445-620 mg/l in 4 sites and two with traces and other 2 were not determined. Sample II 0.44 mg/l and sample III a value of 0.16 mg/l.

**CHLORIDES :**

It is generally present at low concentrations in natural surface water. An average intake of chloride from drinking water is approximately 100mg/day (PeptyJohn, 1972, Zoteman, 1976).

Chloride occurrence in the samples tested had shown a value of 22 mg/l; 360 mg/l and 580 mg/l for samples I, II and III respectively.

The values obtained in samples II and III are above the guide line values (250 mg/l) recommended by WHO and ISI. Chloride is the most abundant anion in human body and contributes significantly along with its associated cations, to the osmotic activity of the extra cellular fluid. It was reported that the taste of coffee particularly is affected if it is brewed with water having a chloride concentration of 400 mg/l as sodium chloride or 530 mg/l (Lockhard, 1955) as calcium chloride.

The ground water samples collected from dug wells and tube wells near Noiyyal river (Tiruppur) for the chemical quality showed a high range of chloride content (Ramaswami and Rajaguru., 1991) than the recommended guide line value.

#### **FLOURIDE :**

Flourine is a fairly common element representing about 0.3 gm/kg of the earth's crust. Traces of flourides occur in many waters and higher concentrations are often associated with under ground sources. As per WHO guide lines the highest natural level reported is 280 mg/l and

most waters contain below 1 mg/l of Flouride. In Table 2 it was observed that the concentration of Flouride was indicated as 0.7, 0.3 and 0.5 mg/l for the tested samples I, II and III. These values fall below the recommended guide line limit of ICMR and ISI.

Gupta (1991) has observed a very high Fluoride content while analysing the chemical characteristics of ground water samples in Nagaur district, Rajasthan which may be due to low hardness and very low solubility of calcium fluoride.

The low fluoride content in our ground water samples studied may due to high hardness content in them.

O<sub>3</sub>ha etal (1993) also observed a high flouride level in ground waters of some districts of Rajasthan.

Singh and Wadhvani (1987) have reported the fungal growth in tube wells has no direct effect on the presence of flouride to act as a limiting factor.

At high doses, Flouride can interfere with the metabolism of carbohydrates, lipids, proteins, Vitamins, enzymes and minerals (WHO).

The presence of flouride in drinking water in excess of 1.0 mg/l gives rise to dental flourosis (mottling of varying degrees of severity in children). When present in high concentrations fluorides may eventually cause endemic cumulative fluorosis with resultant skeletal damage in children and adults (ICMR). Fluorine as reported by Underwood (1977), in small doses may improve fertility & growth rate in some animal species.

Consumption of fluoride in high doses causes acute toxicity in man. Pathological changes include acute nephritis, haemorrhagic gastic enteritis and various degrees of injury to the liver and heart muscle.

#### **DISSOLVED OXYGEN :**

The primary effect of dissolved oxygen is on oxidation-reduction reactions, involving Iron, Manganese, Copper and compounds that contain nitrogen and sulphur. Depletion of oxygen in drinking water is often associated with other problems. Under anaerobic conditions microbial reduction of nitrate to nitrite and also sulphate to sulphide occurs, often giving rise to odour problems (Ridgway et al., 1979).

In our study it is observed that sample-I had shown a value of 0.28 mg/l.

It is difficult to recommend a guide line value, however, as other constituents in the water influence the acceptable level, (WHO).

In a study on the impact of habitation of hydrobiology of lake Pichola (Sanjeev Majoo., 1991) has shown that the values ranged from 2.6 ppm (Sept, Station-2) to 8.2 ppm (Nov, Station-1). The values for dissolved oxygen showed an increasing trend from September to November.

In a study undertaken by Tripathy et al., (1990) on river Nandira at 8 different sites the dissolved oxygen values were found between nil and 14.0 mg/l.

#### **QUALITATIVE TESTS :**

Tests on Nitrite nitrogen, Sulphate and Phosphates obtained were reported in Table(2) as traces in all the three samples. These appears to cause no adverse effect on human beings.

The studies conducted on the Ground water quality deterioration in Hubli City area (Hegde et al., 1992) was found to have the sulphate contents within the permissible levels.

Phosphate is not commonly observed in ground waters. Phosphates in low concentration is not considered to be harmful to drinking water but, it has considerable environmental significance as it effects eutrophic nature of water, promotes algal and fungal growth. Maximum tolerance level of phosphates in the water is 0.15-0.13 mg/l as per USEPA standards. A correlation study of phosphate related to other elements in ground water in Nagaur District, Rajasthan was studied by Gupta (1991).

Water quality in terms of phosphate has been accessed in two temple tanks in Tirupati and Tirumala by Naidu et al., (1990) one of which showed a higher concentration due to the usage of soap by the pilgrims.

**ELECTRICAL CONDUCTIVITY :**

Electrical conductivity is a measure of a water's capacity to convey electric current. It is directly proportional to the dissolved mineral content.

It is an useful determination in order to see if the quality of the water has suffered an exceptional rapid change. It is the reciprocal of mega ohms per cm<sup>3</sup> at 20 C.

Irrigation waters are classified according to electrical conductivity data as follows;

Conductivity	Classification
in micro mhos/cm	
250	excellent
250-750	good
750-2000	permissible
2000-3000	doubtful
3000	unsuitable

In our study it was observed that sample I showed an electrical conductivity of 1000 mega ohms/cm which is permissible, sample II has shown a value of 2000 mega ohms/cm which is doubtful and 3000 mega ohms/cm which is unsuitable for drinking water purposes.

In a study by Harish chandra et al., (1991) during the Maha Kumbh mela held at Allahabad electrical conductivity was observed to be 665 - 1723 micro mhos/cm in pipe supply (mela area) and in hand pump (382 - 1542 micro mhos/cm) and in city area 605 - 1314 and 462 - 1545 micro mhos / cm respectively. Electrical conductivity observed in chemical character of ground water in Nagaur dist, Rajasthan (Gupta, 1991) was between 3160 and 6440 micro mhos/cm.

Microscopic<sup>al</sup> Examination :

An observation was made on the water samples microscopically.

All the three samples were presented with plant fibres which may be due to the presence of decomposed vegetation and sand grains and amorphous matters were also observed. The occurrence of them may be due to sand deposition from nearby areas & other dust particles.

BACTERIOLOGICAL TESTS:

The most common and wide spread danger associated with drinking water is contamination, either directly or indirectly, by sewage, by other ways or by human or by animal excrement. The drinking of water so contaminated or its use in the preparation of certain foods may result in further cases of infection.

Bore well water is actually supposed to be 99% bacteriologically free. But, in urban areas its contamination is possible because of the drains and sewers.

Bacteriological analysis by way of colony counts are recorded in Table 3. Colony bacterial content of water

which do not represent the total number of microorganisms present in water but, simply those that are able to form visible colonies in nutrient media under specified culture conditions. They are of little value in detecting the presence of faecal pollution, although a sudden increase in the colony count from the ground water source may be an early sign of pollution of the aquifer (Muller, 1977).

In the bacteriological examination conducted in our study, sample II has a colony count of 3000/ml (fig,5) which is very high when compared to sample I with 150 colonies/ml (fig,4) and sample III 220 colonies/ml (fig,6). Hence the microbiological quality of sample II is very poor which contains numerous micro organisms including faecal origin.

The analysed water samples are mainly contaminated with coliform bacteria, the term coliform organisms (total coliforms) refers to Gram - ve rod shaped bacteria capable growth in the presence of bile salts or other surface active agents with similar growth inhibiting properties and are able to ferment lactose at either 35 °c or 37 °c with the production of acid, gas and aldehyde within 24 to 48 hours. They are oxidase negative and non-spore forming. These are recognised as suitable microbial indicators of drinking

water quality coliform include Escherischia coli, citrobacteri, Enterobacter and Klebisella species.

Faecal coliform organisms that ferment lactose and other suitable substrates such as mannitol at  $44^{\circ}\text{C}$  or  $44.5^{\circ}\text{C}$  are regarded as presumptive E.coli. E.coli is specifically of faecal origin being always present in the faeces of man, animals and birds in large numbers and rarely found in water or soil that has been subject to faecal pollution.

The most probable number of coliform bacteria in sample II is more than 1800/100 ml and sample III is with 1800/100 ml and sample I no coliform bacteria were observed.

From the above results it is worth while to note that sample II with a high number of coliform bacteria proves to be unsuitable for drinking as well as for other domestic uses.

The presumptive E.coli found in the samples II and III is considered to provide sufficient information to assess the faecal nature of pollution.

Deener and Kerri (1969) reported that regrowth of faecal coliform organisms in the distribution systems is unlikely unless sufficient bacterial nutrients are present. Bio-chemical oxygen demand (BOD) greater than 14 mg/l, water temperature is above 13°C and there is not free chlorine residual.

Coliform bacteria are derived not only from the faeces of warm blooded animals but, also from vegetation and soil (Geldreich et al., 1974, Papavassiliou et al., 1967). Under certain conditions coliform organisms may also persist as nutrients derived from non metallic construction materials. For these reasons the presence of small numbers of coliform organisms (1 to 10 organisms/100 ml) particularly in untreated ground water may be of limited sanitary significance provided faecal coliform organisms are absent.

Hence, from the above study it is clear that though a number of viable colonies on agar at 37°C is 150/ml, sample I does not contain any coliform organisms indicators of faecal contamination whereas sample II with 3000 /ml and with more than 1800 coliform bacteria / 100 ml with E.coli including faecal coliforms is an indicator of that drinking water sample contamination. General hygienic quality of

sample III is also poor due to contamination of water by E.coli. Pathak et al., 1993 in a bacteriological analysis of 44 hand pump water samples from gastroenteritis affected areas showed that 30 (68.2%) hand pumps were contaminated with 10 coliforms 100ml and or 0.1 faecal coliforms 100 ml (WHO guide lines, 1982). Coliform contamination has also been observed in a parallel study by Baveja et al., 1989.

Studies on the water quality on Nandankanran lake (Chatterjee, 1992) has shown that the presence of total coliform, faecal coliform and distribution of phyto planktons in the lake have shown that the lake was contaminated with organic wastes.

TABLE - 1

RESULTS OF PHYSICAL TESTS

SAMPLE - I = Water sample collected from bore well water, Kamakshinagar, Sellampanpalayam.

SAMPLE - II = Borewell water collected from Goundampalayam, Railway gate.

SAMPLE - III = Water collected from open draw well Vinayakar koil thottam, Sanganur.

S.NO.	PARAMETERS	SAMPLE-I	SAMPLE-II	SAMPLE -III
1.	Colour	Slightly yellowish	Colourless	Colourless
2.	Turbidity (JTU)	6	3	2
3.	Odour	None	None	None

TABLE - 2

## RESULTS OF CHEMICAL TESTS

S.NO.	PARAMETERS	SAMPLE-I	SAMPLE-II	SAMPLE - III
1.	TOTAL DISSOLVED SOLIDS	600	1640	2225
2.	TOTAL HARDNESS AS CaCO <sub>3</sub>	328	520	900
3.	CALCIUM HARDNESS AS CaCO <sub>3</sub>	176	220	500
4.	MAGNESIUM HARDNESS AS CaCO <sub>3</sub>	152	300	400
5.	CARBONATE HARDNESS AS CaCO <sub>3</sub>	328	520	475
6.	NON-CARBONATE HARDNESS AS CaCO <sub>3</sub>	0	0	425
7.	ALKALINITY AS CaCO <sub>3</sub>			
	(a) Phenolphthalein	0	0	0
	(b) Methyl orange	330	520	475
8.	pH	7.4	7.5	7.4
9.	IRON AS Fe			
	Ferrous	0.10	0	0
	Total	0.35	0	0
10.	MANGANESE as Mn	0	0	0
11.	NITRATE NITROGEN	5.0	40	35
12.	AMMONIACAL NITROGEN	0	0	0
13.	ALBUMINOID NITROGEN	0.01	0.03	0.01

14. CHLORIDE AS CHLORINE	22	300	580
15. FLUORIDE AS FLUORINE	0.7	0.3	0.5
16. DISSOLVED OXYGEN	0.28	0.44	0.16
17. ELECTRICAL CONDUCTIVITY	1000	2000	3000
18. QUALITATIVE TESTS			
NITRITE NITROGEN	TRACE	TRACE	TRACE
SULPHATE	TRACE	TRACE	TRACE
PHOSPHATE	TRACE	TRACE	TRACE
19. MICROSCOPICAL EXAMINATIONS	Plant fibres Sand grains Amorphous matter	Plant fibres Sand grains Amorphous matter	Sand grains Amorphous matter

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All the calculations are in mg/l except pH and Electrical conductivity.

TABLE - 3

## RESULTS OF BACTERIOLOGICAL PARAMETERS.

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S.NO.	PARAMETERS	SAMPLE-I	SAMPLE-II	SAMPLE-III
1.	Total colonies per ml on agarat 37° C	150	3000	220
2.	MPN of coliform bacteria per 100 ml.	0	> 1800	1800
3.	Nature of coliform bacteria isolated	-	E.Coil-I	E.Coil-I

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TABLE-4

STANDARDS OF PHYSICAL, CHEMICAL AND BACTERIOLOGICAL QUALITY  
FOR WATER.

S.NO	SUBSTANCE OR CHARAC- TERISTIC	PRESCRIBED BY ISI (Max. permissible level)	PRESCRIBED BY I.C.M.R. (Highest desirable level)	PRESCRIBED BY WHO
1.	Colour	10	5 units	15 units
2.	Turbidity	10 NTU (Nephe- - lometric turbidity unit)	5 JTU (Jackson Turbidity unit)	5 NTU
3.	Odour	Unobjectionable	Unobjectionable	-
4.	Total Dissolved solids, mg/l	500	500	1000
5.	Total Hardness (as CaCO <sub>3</sub> ) mg/l.	300	300	500
6.	Alkalinity, mg/l.	200	---	---
7.	pH	6.5 to 8.5	7.0 to 8.5	6.5 to 8.5
8.	Iron (as Fe), mg/l	0.3	0.1	0.5
9.	Manganese (as Mn) mg/l	0.1	0.1	0.1

10. Nitrate Nitrogen, mg/l	---	---	10
11. Nitrite Nitrogen, mg/l	---	---	1.0
12. Chlorides (as Cl), mg/l	250	200	250
13. Fluorides (as F), mg/l	0.6 to 1.2	1.0	1.5

The presence of F, in drinking water in excess of 1.0 mg/l, gives rise to dental fluorosis (mottling of varying degrees of severity in children) when present in high concentrations F, may eventually cause endemic cumulative fluorosis with resultant skeletal damage in children and adults.

14. Dissolved oxygen	no guide line values have been prescribed.		
15. Electrical conductivity	no guide line values have been prescribed.		
16. Sulphate- (as SO <sub>4</sub> ), mg/l	150	200	400
17. Phosphates, mg/l	---	---	---
18. Coliforms	absent		

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Fig.4 : Total Plate count heterotrophic bacteria in water sample I.

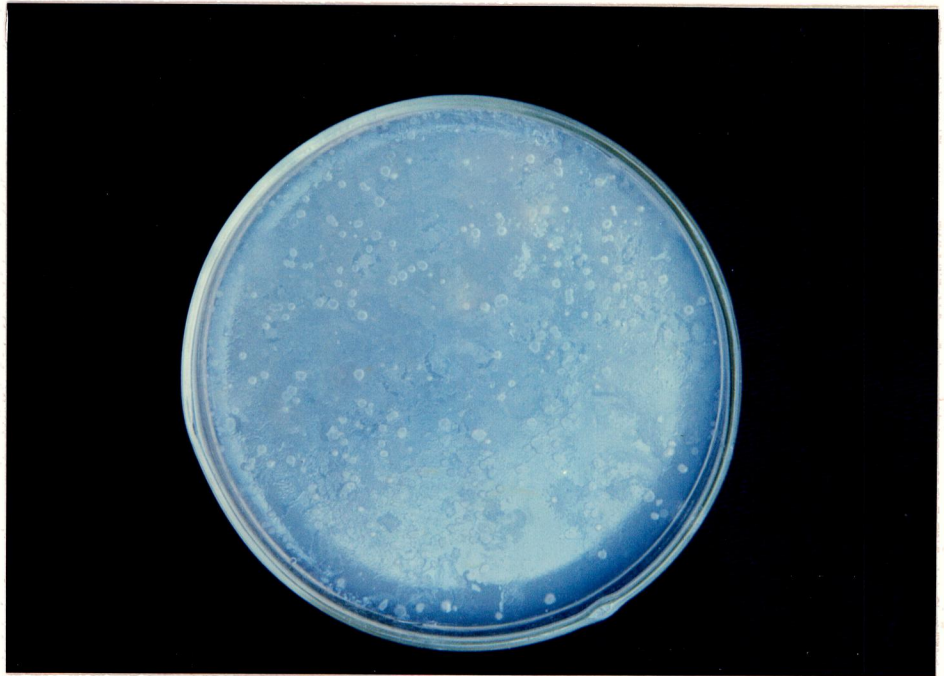
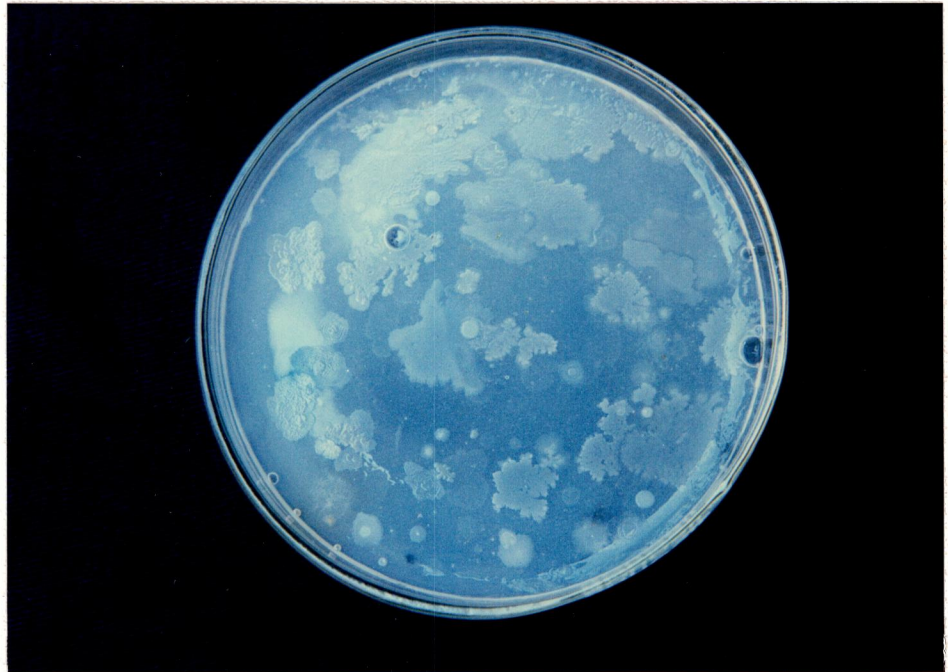


Fig.5 : Total Plate count heterotrophic bacteria in water sample II.



Fig.6 : Total Plate count heterotrophic bacteria in water sample III.



## Summary and Conclusion

## SUMMARY AND CONCLUSION

PHYSICAL EXAMINATION : In the physical analysis carried out for the three selected samples following results were observed. Sample II and III were colourless and clear without any odour and with a turbidity level below the recommended guide line values whereas sample I had a slight yellowish colour due to the presence of Iron and was slightly turbid.

The three samples collected were examined for chemical aspects and the results obtained were discussed as follows :

(a) The total dissolved solids present in the sample II and III were very much higher than the recommended guideline values. Sample I was slightly more when compared with the guideline values. .

(b) As far as total hardness is concerned all the three samples were considered to be very hardd. Sample III specifically had very high concentration of calcium carbonate for its total hardness.

(c) Alkalinity of the Sample III using methyl orange indicator is very high when compared to samples II and I. Phenolphthalein alkalinity is not seen in all the three water samples which have been tested.

(d) pH of all the samples I, II and III tested were between the maximum permissible limits as per I.C.M.R.

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(e) The presence of Iron content was indicated in sample I and that was absent in sample II and III.

(f) There was no traces of manganese found in three samples tested.

(g) The presence of nitrate-nitrogen in sample II and III exceed very much the recommended guide line value as quoted by USEPA. Sample I has a concentration which fits with the recommended guide line value.

(h) Ammoniacal nitrogen was absent in all the three samples tested a very meagre amount of albuminoid nitrogen was found in all the three samples.

(i) The chloride content was higher in sample II and III and is lesser in sample I.

(j) The flouride values in all the three samples were below the ICMR and ISI limits.

(k) The level of dissolved oxygen in the samples studied were low which may be due to the microbial respiration. (l) Electrical conductivity in samples I, II and III were very much higher than the recommended guide line values.

(m) The qualitative tests conducted for nitrite-nitrogen, sulphate and phosphate showed an occurrence of all in traces only.

Microscopical examination of all the three samples showed the presence of plant fibres, amorphous matter and sand grains in samples I and II whereas in sample III only said grams and amorphous matter were seen.

The bacteriological examination conducted for sample I showed a number of viable colonies without any coliform organism - indicators of faecal contamination. Sample II contained numerous micro organisms including faecal coliforms of faecal origin sample III also had a number of colonies with numerous micro organisms especially Escherischia coli.

Therefore, from the above investigations it is clearly evident that the water samples collected from the bore well at Goundampalayam near Railway gate and the open draw well at Vinayakar Kovil Thottam, sang areas though colour less and clear were with an excess amount of TDS which may render the water undesirable for drinking. The degree of total hardness which is very high in these samples makes the water unacceptable by the consumers since these samples may deposit more calcium carbonate on the kitchen ware and leads to more soap consumption. As stated by the guidelines for Canadian drinking water quality, there was no firm evidence that

water hardness cause ill effects in man.

The presence of nitrate nitrogen in the above said samples was very high. This may cause infantile methaemoglobinaemia in having association with water sources that are microbiologically contaminated. Hence, these samples are said to be unsuitable for drinking and other domestic purposes.

Regarding the presence of micro organisms they exceed the limit in the sample II which with faecal coliforms of faecal origin is said to be highly contaminated and hence unfit for drinking. The general hygienic quality of the samples is also said to be very poor.

Judged by the results of chemical examination the water samples (I) collected from the borewell at kamakshi magar, sellampanpalayam is regarded as of acceptable quality for drinking.

It is also important to give some worth while suggestions in keeping the water suitable for potability to the consumers.

Certain epidemiological studies suggest that TDS in drinking water may even have beneficial health effects, its removal by conventional water treatment from water is not necessary.

Consumers can make periodic water quality (taste, odour) in their homes sanitary survey on the hygienic quality can also be done.

Bacteriological examination for the identification of pathogens and there by the level of contamination in the drinking water to find out the microbiological quality of water in the laboratories can be done and suitable steps should be taken to disinfect the water by using certain disinfectory agents like chlorine.

Therefore,

"Water which is 'life - saver' when pure, could become 'life - taker' when impure".

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