A DISSERTATION ON

"ANALYSIS OF SUPPLY WATER IN SUKHRALI VILLAGE USING DIFFERENT PHYSIOCHEMICAL AND MICROBIOLOGICAL PARAMETERS"

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BY

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TO WHOM IT MAY CONCERN

This is to certify that **Ms. BABITA MEHTA** student of M. Sc. Biotechnology, (IV semester), Integral University has completed her four months dissertation work entitled **"ANALYSIS OF SUPLLY WATER SUKHRALI VILLAGE USING DIFFERENT PHYSICOCHEMICAL AND BOLOGICAL PARAMETERS"** successfully. She has completed this work from the FARE Labs Pvt. Ltd., Gurgaon, under the supervision of **MR. SATISH KUMAR SINGH**. The dissertation was compulsory part of her M.Sc. degree.

I wish her good luck and a bright future.

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TRAINING CERTIFICATE

This is to certify that **Babita Mehta,** D/o B.S Metha from, **Intergral University** MSc in Biotechnology has successfully completed her Major Project in **"Analysis of supply water sukhrali village using different physicochemical and biological parameters."** from 17th Jan-2022 to 02 June 2022 at **FARE Labs Pvt. Ltd.** and has been awarded excellent grade on the basis of her performance.

She has accomplished the Major Project successfully. We have found her sincere and devoted during the training.

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DECLARATION

I, **BABITA MEHTA**, certify that the work embodied in the training report **"Analysis of supply water Sukhrali village using different physicochemical and microbiological parameters"** to be submitted to the Master of Science in Biotechnology of Integral University, Lucknow, Uttar Pradesh, India is original and is the result of analysis carried out by me under the supervision of **Mr. Satish Kumar Singh** Head of Environmental Science Department, FARE Labs Pvt. Ltd. for the time period of January, 2022 to June, 2022. The matter embodied in Master of Science thesis has not been submitted for the award of any other degree/ diploma.

I declare that I have faithfully acknowledged and referred to the research workers wherever their works have been cited in the text. I further certify that I have not willfully lifted up some other's work, paragraph, text data, results, etc. reported in journals, books, magazines, reports, dissertations thesis, etc., or available at web sites and included them in this M.Sc. thesis and cited as my own work. I have completed all pre submission requirement as per the University rules.

BABITA MEHTA

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LIST OF ABBREVATIONS

APHA- American Public Health Association

BOD- Biochemical oxygen demand

CFUs- Colony forming units

COD- Chemical oxygen demand

MPN- Most probable number

RFC- Residual free chlorine

SPC- Standard plate count

TDS- Total dissolved solids

TSS- Total suspended solids

WHO- World Health Organization

WQI- Water quality index

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ABSTRACT

Rising population, pollution and climate changes that are directly affecting drinking water quality are important concern in Indian cities. The purpose of the study is to investigate the Water Quality Physicochemical and Microbiological parameters of drinking water supplied to the Sukhrali village. The physicochemical parameters such are pH, TDS, hardness, calcium, alkalinity, chloride, nitrate, sulphate and residual free chlorine with some important microbiological parameters such as standard plate method and most probable number method were analyzed from the sample collected from different locations to check the concentration of these parameters. Regardless the problem of pollution and other mentioned earlier, the water quality of supply drinking water distributed were all under the acceptable and permissible limits passed by WHO and APHA for drinking water. The study defines and conclude that the drinking water quality of water distributed to Sukhrali village by municipal corporation has appropriately undergone water treatment process and then best quality drinking water supplied to the locations. Furthermore, studies are need to be conducted in future to maintain the water quality and prevent it from concentration and microbial growth.

CHAPTER –I

INTRODUCTION

Water is the most crucial component to sustain life, every living being in the universe including microorganism needs water for their growth and evolution. About 70.9% of the Earth's surface is covered with water, mostly in the form of seas and oceans. Small portions of water occur as groundwater (1.7%). Pure liquid water is colorless, odorless and tasteless and consists only of H2O molecules. All biological reactions occur in water and that is crucial for the continuity of life. The importance of water can never be matched; water is the core of sustainable development and is crucial for energy production, socio-economic development, food production, healthy ecosystem and for human survival itself. Water is also at the heart of adaptation to climate change, serving as the crucial link between society and the environment. Water is also a rights issue. As the global population grows, there is an increasing need to balance all of the competing commercial demands on water resources, so that communities have enough for their needs. In particular, women and girls must have access to clean, private sanitation facilities to manage menstruation and maternity in dignity and safety. At the human level, water cannot be seen in isolation from sanitation. Water quality has been reported considerably in the scientific literature. The most approved definition of water quality is "it is the physical, chemical and biological characteristics of water" Nayla Hassan Omer (2019)[i]

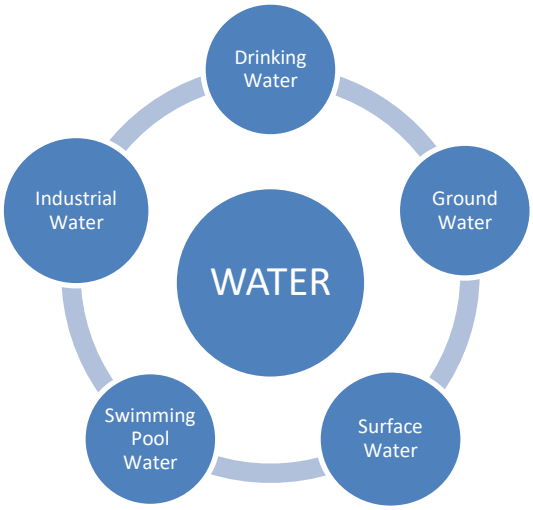


FIGURE1.1: Water

Water being the chief part of ecosystem has a valuable national strength. Water sources may be mostly occurring in the form of rivers, lakes, glaciers, rain water, ground water etc. Apart from the need of water for drinking, water resources play essential role

in various sectors of economy such as agriculture, livestock production, forestry, industrial activities, hydropower generation, fisheries and other creative activities.

The availability of clean and safe water is the dream to a every individual, but the availability and quality of water either it is surface or ground, have been deteriorated and declined due to few important factors like increasing population, urbanization, industrialization that causes numerous health problems. Water quality of any specific area or specific source can be assessed using physical, chemical and biological parameters. The values of these parameters are harmful for human health if they occurred more than defined limits. Therefore, the suitability of water sources for human consumption through drinking, daily uses has been described in terms of Water quality index (WQI), which is one of the most effective ways to describe the quality of water. WQI utilizes the water quality data and helps in the modification of the policies, which are formulated by various environmental monitoring agencies. R Awachat Ankita (2017).[ii]

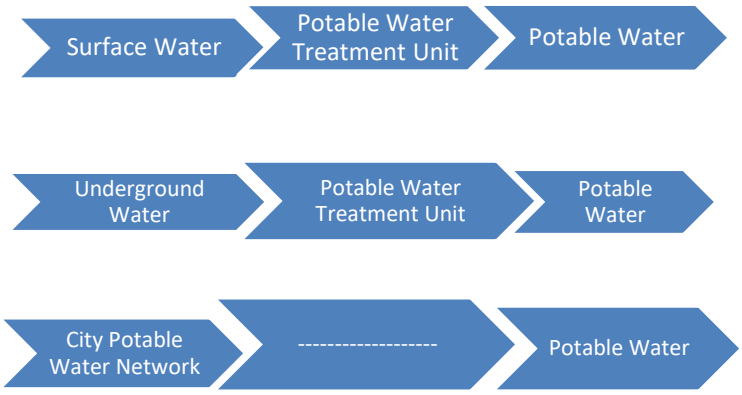


FIGURE1.2: Water Treatment Units

Potable water is the main source of drinking water in the both urban and rural areas. The potable water in its initial stages is not fit for drinking and uses from some sources, proper water supply system plays a crucial role in fulfilling the daily water necessities of the society. And the primary goal to be fulfilled is the proper treatment of water that is to be supplied to a society. A term biological stability is used to define whether the water can be consumed by the consumer or its out of the certain limits. Biological stabilities of drinking water refer to the concept of providing consumers with drinking water of same microbial quality at the water treatment facility. But due to the disturbance in water mains and premise plumbing the uncontrolled growth of microbes or bacteria can occur that can lead to the sanitation (developing of disease by opportunistic pathogens). The scarcity of quantity and quality of drinking water is increasing because of industrialization and population abundance that leads to growth of number of harmful and life-threatening microbes and bacteria. The other factor for the scarcity and

contamination of the water is the inappropriate designing, failing of the water supply systems.

The accessibility of good quality water is significant feature for preventing diseases and improving quality of living. Natural water (groundwater, surface water) contains various forms of impurities that are introduced in the aquatic system by natural calamities such as weathering of rocks and leaching of soils, dissolution of aerosol particles from the atmosphere in the aquatic system. Number of human activities such as mining, processing of metal-based materials, continuous increased used of fertilizers in agricultural revolution could result in continual increase in concentration of metals contamination in fresh water sources. Fecal pollution of drinking water cause contamination of water with disease causing microbes (water borne diseases) that led to human illness globally and death of millions of people. The qualities of water (physical, chemical and biological characters) directly affect the quality life. The quality of water is related to animals as well as plants. Industrial effluents generated by industries and factories which remain untreated causes water pollution and harmful effects.

Water containing excessive number of heavy metals such as Pb, Cr, As, Fe, etc. and other heavy metals from industrial processes are of special concern because this causes death and chronic poising in aquatic life and also to people if consumed without proper water treatment and sanitation by water supply systems. High level of organic matters due to pollutants in the rivers causes increase in the number of parameters such as Biological Oxygen Demand (BOD), Total Dissolved Solids (TDS), Total Suspended Solids (TSS) and fecal coliform. This makes water exceeds permissible limits which becomes unsuitable for drinking, agricultural, and other uses.

Clean water is critical to survival, and its absence can impact the health, food security, and livelihoods of families across the world. Although our planet has sufficient fresh water to achieve a regular and clean water supply for all, bad economics and poor infrastructure can skew supply unfavorably. Drought afflicts some of the world's poorest countries, worsening hunger and malnutrition. SDG 6: Clean Water and Sanitation (2015) said a goal that Floods and other water-related disasters account for 70% of all deaths related to natural disasters. Global goals and national priorities on reliable energy, economic growth, resilient infrastructure, sustainable industrialization, consumption and production, and food security, are all inextricably linked to a sustainable supply of clean water. Hydropower is one of the most crucial and widely-used renewable sources of energy and as of 2011, represented 16% of total electricity production worldwide.

The action and programme from the government has been induced to cope up with the safe and clean drinking water facilities. The overall proportion of Indian households with

access to improved water sources increased from 68% in 1992-93 to 89.9% in 2015-16. However, in 2015-16, 63.3% of rural households and 19.7% of urban households were not using improved sanitation facilities. According to the World Bank, more than 520 million in India were defecating in the open – the highest number in the world. This figure is expected to have reduced significantly given that improving sanitation is a key priority of the government which has introduced several flagship programmes including the Swachh Bharat Abhiyan to clean India, the National Rural Drinking Water Programme, and Namami Gange, which aims at the conservation of the river Ganga. The drinking water quality of the specific location is been checked through this project and the analysis is based on physicochemical and microbiological parameters to test whether the drinking water supplied is safe and clean for drinking purpose and other household purpose or not.

OBJECTIVE:

1. **To analyze the physicochemical parameters of the supply water.**

2. **To assess the microbiological parameters of the supply water.**

3. **To determine whether the water supplied to a community is safe for daily use.**

CHAPTER-II
REVIEW OF LITERATURE

GENERAL

Various technical papers on Assessment of supply water quality have been presented at research level from which I referred many papers for study. These papers are presented below.

This chapter reviews the literature relevant to the objective of the study, status of supply water quality in the area of Sukhrali village as well as information on the development of adsorbent and their use in the removal of pollutants from water. A brief review of the different adsorbents to remove the pollutants has also been included. The most common and wide spread threat associated with water is contamination, either directly or indirectly, by sewage, by other wastes or by human or animal excrement. If such contamination is recent, and if among the contributors, there are carriers of communicable enteric diseases, some of the living casual agents may be present. The drinking water so contaminated or its use in the preparation of certain foods may result in further cases of infection. As we know various sources contribute for the contamination of the water so to overcome with such contaminants, we undergo a series of process to make it fit for use. Public drinking water systems use different water treatment methods to provide safe drinking water for their communities. Public water systems often use a series of water treatment steps that include coagulation, flocculation, sedimentation, filtration, and disinfection. Number of relevant work and study has been conducted to check the physico-chemical parameters of supply water. From the day one entire the world knows the importance of water. Water is the prime necessities of life. 70% of our body is constituent of water. The analysis of various water quality parameter, chlorides, dissolved oxygen, total iron, nitrate, water temperature, pH, total phosphorous, fecal coliform bacteria, and their adverse effect of these parameters in human health was studies by Manoj Kumar et al. (2012). His study revealed that inspite of abundance of water present in the globe there is still shortage of soft water.

2.1 EFFECT OF PHYSICOCHEMICAL PARAMETERS ON WATER:

According to S. A.Manjare et al. (2010) found that there were monthly changes in Physico-chemical Parameters of Tamadalge Water Tank in Kolhapur District, Maharashtra. Monthly changes in physical and chemical parameters such as water temperature, transparency, turbidity, Total Dissolved Solids, pH, Dissolved Oxygen, Free Carbon dioxide, and Total Hardness, Chlorides, Alkalinity, Phosphate and Nitrates, but was noted that all the parameters were within the permissible limits incidating that the tank was not polluted and can be used for Domestic, Irrigation, Pisiculture.

Siyue Li et al. (2011) conducted water quality assessment in the rivers along the water conveyance system of the Middle Route of the South to North Water Transfer Project (China) using multivariate statistical techniques and receptor modeling CA classified the selective 19 rivers into three groups reflecting their varying water pollution levels of moderated pollution, high pollution, and very high pollution. The FA-MLR receptor modeling revealed predominantly anthropogenic inputs to river solutes in Beijing and Tianjin, i.e., 77% of nitrogen and 90% of phosphorus from industry, and 80% of COD Mn from domestics. This study is critical for water allocation and division in the water-receiving areas using the existing rivers for MRSNWTP.

The water quality index for the following parameter pH, Temperature, Total Dissolved Solids (TDS), Turbidity, Nitrate-Nitrogen(NO3-N), Phosphate(PO43-), Biological Oxygen Demand(DO),Dissolved Oxygen(DO)measure at the six different sites (S1-S6) along the river Narmada was found to be excellent to good at season summer and winter and poor to unsuitable for huaman consumption in the season monsoon along the river. The fall in the quality of water in monsoon season and its effect was due to poor sanitation, turbulent flow, soil erosion and high anthropogenic activities Nidhi Gupta et.al(2017) also concluded that during the monsoon season the water quality goes down due to the rainfall and it effects the lives of people adversely due to poor sanitation and suspended particles present in water. Md. Shamimuzzaman et al. (2019) reported 53.75% water was an unsatisfactory for chlorine level along with Total Dissolved Solid (TDS), hardness, iron, and alkalinity based unsatisfactory were 28.75%, 15.0%, 8.75%, and 3.75% respectively. Sixty-one samples were found coliform contaminated that is 76.25% of the total samples and 58.75% sample was carried fecal substances. E. coli and Vibrio was unsatisfactory as 61.25% and13.75% respectively. This study shows the water being supplied in Dhaka city for drinking purpose is not 100% safe for drinking and daily use. The high concentration of sulphate and nitrate in water can cause many problems to human health. The analysis of the parameters is necessary for the consumption of healthy drinking water A.S.Thangai et al.(2019) determined the sulphate and nitrate in the drinking water that has undergone reverse-osmosis. Sulphate levels were measured using the turbidity method at 420 nm and nitrate levels by phenoldisulphonic acid methods at 410 nm. The conclusion he got revealed that the sulphate level to be 3.65 to 5.72 mg/L and nitrate level of 1.15 to 4.62 mg/L that were lower than WHO guidelines for drinking water. The continued use of reverse osmosis as a mechanism to purify water is recommended.

National Rural Drinking Water Programme (NRDWP) was launched in 2009. It aims to provide safe and adequate water for drinking, cooking and other domestic needs to every rural person on a sustainable basis.

2.2 EFFECT OF MICROBIOLOGICAL PARAMETERS ON WATER:

The analysis of water samples from two streams was conducted by Sunday O Eze, et al.(2012), the physicochemical and microbiological analysis was conducted by him in the water samples. It included determination of pH, TSS, TDS, hardness, BOD, COD, heavy metal analysis and microbiological analysis that included bacterial count (MPN/100) coliforms. Conclusion from his study was releaved that water of the two streams, a spring and borehole was fit for drinking, and the microbiological parameters was also under permissible limits. Microbial growth in the drinking water is studied by the flow cytometry method. It was analysed that the growth of the microbes in the drinking water is not suitable for the health, Hannah R. Safford et al. (2018) researched and observed safe and effective water treatment, distrubition and reuse of the water with microbial free water is necessary. The application of flow cytometry method makes it easy for routine water quality assessment.

2.3 EFFECT OF COMBINED PHYSICO-CHEMICAL AND MICROBIOLOGICAL PARAMETERS ON WATER QUALITY:

Several combined or collective study of physico-chemical and microbiological parameters were conducted by the author. The study conducted by H. Derfoufi et al. (2019) in the Wadi Zegzel a mountain stream inside a site of ecological and biological interest (SIBE) in the Northeast of Morocco. The impact of various anthropogenic activities (agricultural, tourism.) was obvious. It is suggested that surveillance of Wadi Zegzel is necessary for the proper management and preservation of this heritage. Normed Principal Component Analysis (PCA) was applied to standardize the data to evaluate correlations between physicochemical variables (T°C, pH, BOD, COD, NH4) and microbiological variables (TC, FC, EC, SF) and their spatiotemporal structure (the spatial effect and the seasonal effect). The upstream Zegzel is characterized by a gradient of mineralization in winter and it’s downstream by a gradient of fecal pollution during the summer. The waters of the Wadi Zegzel are below the limit of Moroccan standards for the quality of surface water and water intended for irrigation. Therefore, they are considered of good quality for agricultural uses.

2.4 IMPACT OF PIPE MATERIAL AND CLIMATE CHANGE ON WATER QUALITY:

Silja Tamminen et al. (2008) reported that quality of potable water has been a major issue in the water industry for the last few decades. The pipe quality determines quality of the water supplied. The deterioration of treated water can be due to physical, chemical or microbiological changes that occur in the water during distribution. In addition, pipe material and decay of a disinfectant agent can affect the quality of the water being distributed. In this study the purpose was to simulate the decay of chlorine in two networks, one made of old cast iron (CI) pipes and another of polyethylene (PE)

pipes. To maintain the chlorine concentrations required by WHO (Cl must be greater than 0.2 mg/l and lesser than 0.5 mg/l) re-chlorination stations were necessary to add into both networks. The performance of both networks before re-chlorination was low due to high initial chlorine concentrations, but after the addition of the re-chlorination stations it was 100% throughout the networks. The performance of the water age was dependent mainly on the tank usage, and the performance of contamination by organic material depended on the coefficient that defines the decay rate of the organic material in the bulk phase.

The climate change somehow has a adverse effect on the water quality. The deterioration of the water bodies such as lakes and rivers are been affected by the change in weather due to global warming ad greenhouse effects. Two points were taken into consideration after knowing about the fact of water deterioration by Ianis Delpla et al. (2009). First study was conducted on the physicochemical and microbiological parameters of the water bodies (rivers, lakes) then the impact of this analysis was realted with the drinking water. The outcome was worsening the climate change was impacting the drinking water quality so severly that was increasing the risk of human health.

The water being supplied to the houses is not said to be 100% safe for drinking in any case. The strategy formation should be done before the supply of drinking water to every house. A strategy through the study was set by Emily Kumpel et al. (2014) for the distrubution of drinking water through drinking water distrubution system, at different psi 10 and 17 psi and the chlorinated water was passed through the pipes and it was noticed that the continuous pressure and physicochemical parameters were measured and periodic collection of samples for total coliform and E. coli test were conducted throughout the supply cycles. The result concluded was that at the high psi at pressures >17 psi few total coliforms and no E. coli were detected when water was delivered with a chlorine residual.

Gang Liu et al. (2017) driven by the development of water purification technologies and water quality regulations, the use of better source water and/or upgraded water treatment processes to improve drinking water quality have become common practices worldwide. This article reviews the contaminants that develop in the water distribution system and their characteristics, as well as the possible transition effects during the switching of treated water quality by destabilization and the release of pipe material and contaminants into the water and the subsequent risks. The changes in the hydraulic conditions in the pipes (residence time and flow) were among important determinants of the physical, chemical and microbiological quality of water in the distribution network. Hadi Mohammed et al. (2021) revealed that the parameters have significant impact on the quality of water in the pipes.

CHAPTER: III

MATERIAL AND METHODOLOGY

3.1 STUDY AREA:

Gurgoan is the city located in the northern Indian state of Haryana. Gurgaon is the India's second largest information technology hub and third largest financial and banking hub. It is situated near the Delhi-Haryana border, about 30 km southwest of the national capital New Delhi. A report collected by Orlando, A. et al. (2011). This city is dream city for every youngster but on the other hand it's facing a pollution problem. Gurgoan lies on the Sahibi River a tributary of Yamuna which originates from the Aravalli range in Rajasthan and flows through west and South Haryana into Delhi. The main source of water is the river in the city and it is unfortunate that its water is most unsuitable for drinking as well for the daily use purpose. The city is not stable with its socio-economic issues and adversely polluted water and the air. The pollution of water is either by the industrial waste or other sources of waste that knowingly or unknowingly becomes the part of water bodies. Due to tremendous increasing population of the city, it has been more difficult to manage the proper water quality and its supply.

As my project site was Sukhrali village located at latitude 28.4771° N, longitude 77.0600° E. The study was conducted from the month of February to May (spring to early summer). Main focus of my study is to check the quality of drinking water supplied by the municipality system so, I collected the sample from the different location of the village. The water sources were: Public taps, Taps of the houses.

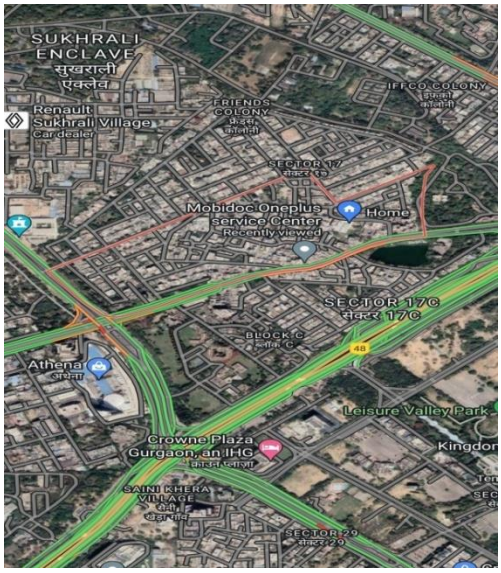


FIGURE 3.1: Satellite image of experimental site (Source– Google)

Environmental quality of the area deteriorates mainly as a result of the increasing industrial activity. The exploding population, increasing industrialization and urbanization causes water pollution. The water pollution by agricultural, municipal and industrial sources has become a major concern for the welfare of mankind.

3.2 EXPERIMENTAL DETAILS:

3.2.1 WATER SAMPLING PROCEDURE:

The water samples were analyzed for the various parameters in the Environmental Science (Water Dpt.) and Microbiology Department of FARELABS PVT LTD Gurgoan. Various physical and chemical parameters including colour, odour, pH, temperature, conductivity, turbidity, total dissolved solids (TDS), hardness, calcium, alkalinity, chloride, nitrate, sulphate, and residual free chlorine have been monitored for the tap water from the location marked. Various microbiological parameters including Standard plate count (SPC) Multiple Tube Dilution Test (MTD) have been conducted for the tap water samples.

Plastics bottles of 1.0 liter holding capacity with air tight caps were used for collection of the samples. Each bottle was previously washed and sanitized, washed with 2% Nitric acid and then rinsed three times with distilled water. This step was conducted to avoid any kind of microbial and other contamination that may affect the testing procedure or protocols. The sample bottles were kept in clean place after the sampling procedure, each bottle was filled leaving no air space, and then sealed to prevent leakage. Each container was marked with the name and sampling location.

3.2.2 SAMPLE HANDLING AND PRESERVATION:

1. Samples should be analyzed as soon as possible, preferably in the field at the time of sampling.
2. High purity water and water not at equilibrium with the atmosphere (ground waters or lake waters collected at depth) are subject to changes when exposed to the atmosphere,

Therefore, the sample containers should be filled completely and kept sealed prior to analysis.

3.2.3 SAMPLING POINTS:

The samples were collected from the different location of the Sukhrali village and are as follows:

1. Location 1: Elegant pg, Sector 17A

2. Location 2: House no. 1419, Sector 17C

3. Location 3: Hanuman mandir, sector 17C

4. Location 4: Near Gurunanak farmhouse, Sector 17

5. Location 5: House no.12/4

6. Location 6: Mata wali gali, kala kaun, sukhrali

7. Location 7: bread pakora building, sukhrali

8. Location 8: Near Iffco chowk, Sector 17

9. Location 9: Sector 17 B

10. Location 10: Block C, Harjan Basti, sukhrali

3.2.4 WATER QUALITY PARAMETERS:

Water quality parameters that were conducted were physical, chemical and biological all these parameters were conducted in all of the samples and the observation or results were then afterwards analyzed.

1. Color of the tap water from every location was conducted and noted.

2. Odor of the tap water from every location was conducted and noted.

3. pH of the tap water from every location was conducted and noted.

4. TDS (Total Dissolved Solids) of the tap water from every location was conducted and noted.

5. Turbidity of the tap water from every location was conducted and noted.

6. Total Hardness and Calcium of the tap water from every location was conducted and noted.

7. Alkalinity and Chloride of the tap water from every location was conducted and noted.

8. RFC (Residual Free Chlorine) of the tap water from every location was conducted and noted.

9. Nitrate of the tap water from every location was conducted and noted.

10. Sulphate of the tap water from every location was conducted and noted.

11. SPC (Single Plate Count) of the tap water from every location was conducted and noted.

12. MPN (Most Probable Number) of the tap water from every location was conducted and noted.

The results of the analyzed parameters of tap water of the different locations of Sukhrali village are compared with the related standards for drinking water prescribed by IS:10500 and IS:1622 from APHA. The drinking water standard is given in the table no.

Table 3.1: DRINKING WATER STANDARDS (IS: 10500)

SI.No	Parameters	Specification	Method of test Ref to	Standard
1.	COLOUR	5 Max.	IS 3025 (P4)	IS10500
2.	ODOUR	Agreeable	IS 3025(P5)	IS10500
3.	Ph	6.5 to 8.5	IS3025(P11)	IS10500
4.	TOTAL DISSOLVED SOLIDS	500 Max.	IS3025(P16)	IS10500
5.	TURBIDITY	1.0 Max.	IS3025(P10)	IS10500
6.	HARDNESS	200 Max.	IS3025(P21)	IS10500
7.	CALCIUM	75 Max.	IS3025(P40)	IS10500
8.	ALKALINITY	200 Max.	IS3025(P23)	IS10500
9.	CHLORIDE	250 Max.	IS3025(P32)	IS10500
10.	RESIDUAL FREE CHLORINE	0.2 Min.	IS3025(P26)	IS10500
11.	NITRATE (as NO3)	45 Max.	IS3025(P34)	IS10500
12.	SULPHATE (as SO4)	200 Max.	IS3025(P24)	IS10500

(Except pH and turbidity other parameters are in mg/l)

3.3 METHODS AND METHODOLOGIES:

3.3.1 METHODOLOGY FOR MEASUREMENT OF pH VALUE: (ELECTROMERIC METHODS):

pH is one of the most common water quality tests performed. pH indicates the sample's acidity, but is actually a measurement of the potential activity of hydrogen ions (H+) in the sample**.** The pH scale is logarithmic, so everyone-unit change in pH actually represents a ten-fold change in acidity**.** There is no legally enforceable standard for drinking water pH levels because pH is considered an aesthetic water quality. However, the U.S. Environmental Protection Agency (EPA) recommends a pH between 6.5 and 8.5 for drinking water. Since metals dissolve readily in acidic water, dissolved metals may be present in drinking water with a low pH level. Metals such as iron, manganese, copper, and lead can leach into drinking water from pipes or the local aquifer.
pH value is the logarithm of reciprocal of hydrogen ion activity in moles per liter. In water solution, variations in pH value from 7 are mainly due to hydrolysis of salts of strong bases and weak acids or vice versa. Dissolved gases such as carbon dioxide, hydrogen sulphide and ammonia also affect pH value of water. The overall pH value range of natural water is generally between 6 and 8. In case of alkaline thermal spring waters pH value may be more than 9 while for acidic thermal spring waters the pH may be 4 or even less than 4. Industrial wastes may be strongly acidic or basic and their effect on pH value of receiving water depends on the buffering capacity of water. The pH value obtained in the laboratory may not be the same as that of water at the time of collection of samples due to loss-or absorption of gases, reactions with sediments, hydrolysis and oxidation or reduction taking place within the sample bottle. pH value should preferably be determined at the time of collection of samples. The pH value may be determined either electrometrically or calorimetrically. The electrometric method is more accurate but requires special apparatus. The calorimetric method is simple and requires less expensive apparatus, and is sufficiently accurate for general work. It is, however, subject to interference by color, turbidity, high saline content, free chlorine and various oxidants and reductants.

PRINCIPLE:
The pH value is determined by measurement of the electromotive force of a cell consisting of an indicator electrode (an electrode responsive to hydrogen ions such as a glass electrode) immersed in the test solution and a reference electrode (usually mercury/calomel electrode), Contact between the test solution and the reference electrode is usually achieved by means of a liquid junction, which forms part of the reference electrode. The electromotive force is measured with a pH meter, that is, a high impedance voltmeter calibrated in terms of pH. Several types of electrodes have been suggested for electrometric determination of pH value. Although the hydrogen gas

electrode is recognized as primary standard the glass: electrode in combination with calomel electrode is generally used with reference potential provided by saturated calomel electrode. The glass electrode system is based on the fact that a change, of 1 pH unit produces an electrical change of 59.1 mV at 25°C. The active element of a glass electrode is a membrane of a special glass. The membrane forms a partition between two liquids of differing hydrogen ion concentration and a potential is produced between the two sides of the membrane which is proportional to the difference in pH between the liquids.

APPARATUS:

1. pH meter - With glass and reference electrode (saturated calomel), preferably with temperature compensation.
2. Thermometer - With least Count Of 0.5°C.

SAMPLE HANDLING AND PRESERVATION:

1. Samples should be analyzed as soon as possible, preferably in the field at the time of sampling.
2. High purity waters and waters not at equilibrium with the atmosphere (ground waters or lake waters collected at depth) are subject to changes when exposed to the atmosphere,

Therefore, the sample containers should be filled completely and kept sealed prior to analysis.

FIGURE 3.3.1 a:pH meter

FIGURE 3.3.1 b:pH standards

PROCEDURE:

a) After required warm-tip period, standardize the instrument with a buffer solution of pH near that of the sample and check electrode against at least one additional buffer of different pH value.

b) Measure the temperature of the water and if temperature compensation is available in the instruments adjust it accordingly.

c) Rinse and gently wipe the electrodes with solution. If field measurements are being made, the electrodes may be immersed directly in the sample stream to an adequate depth and moved in a manner to ensure sufficient sample movement across the electrode sensing element as indicated by drift free readings (< 0.1 pH unit).

d) If necessary, immerse them into the sample beaker or sample stream and stir at a constant rate to provide homogeneity and suspension of solids. Rate of stirring should minimize the air transfer rate at the air-water interface of the sample.

e) Note and record sample pH and temperature. However, if there is a continuous drift, take a second reading with the fresh aliquot of sample without stirring and report it as the pH value.

3.3.2METHODOLOGY FOR MEASUREMENT OF TOTAL DISSOLVED SOLIDS:

Water TDS concentrations can be determined using a digital meter.

Total Dissolved Solids (TDS) is a measure of the dissolved combined content of all inorganic and organic substances present in a liquid in molecular, ionized, or micro-granular (colloidal sol) suspended form. TDS concentrations are often reported in parts per million (ppm). Water TDS concentrations can be determined using a digital meter.

FIGURE 3.3.2a: Conductivity meter FIGURE 3.3.2b

3.3.3 METHODOLOGY FOR MEASUREMENT OF TURBIDITY:

PRINCIPLE:

It is based on comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions.

APPARATUS:

1. Sample Tubes - The sample tubes should be of clear and colorless glass.
2. Turbidity meter- The turbidity meter shall consist of a nephelometer with a light source for illuminating the sample and one or more photo electric detectors with a readout device to indicate the intensity of light scattered at right angles to the path of the incident light. The turbidity meter should be so designed that little stray light reaches the detector in the absence of turbidity and should be free from significant drift after a short warm-up period.

FIGURE 3.3.3a: Turbidity meter **FIGURE 3.3.3b**

PROCEDURE:

Turbidity meter Calibration-Follow the manufacturer's operating instructions.

1) Measure the standards on turbidity meter covering the range of interest. If the instrument is already calibrated in standard turbidity units, this procedure will check the accuracy of calibration.
2) Turbidity less than 40 units - Shake the sample to disperse the solids.
3) Wait until air bubbles disappear.
4) Pour sample into turbidity meter tube and read turbidity directly from the instrument scale or from calibration curve.

3.3.4METHODOLOGY FOR MEASUREMENT OF HARDNESS:

3.3.4.1EDTA METHOD (ETHYLENEDAIMINE TETRAACETIC ACID):

Hardness in water is due to the presence of dissolved salts of calcium and magnesium. It is unfit for drinking, bathing, washing and it also forms scales in boilers. Hence it is necessary to estimate the amount of hardness producing substances present in the water sample. Once it is estimated, the amount of chemicals required for the treatment of water can be calculated. The estimation of hardness is based on complexometric titration. Hardness of water is determined by titrating with a standard solution of ethylene diamine tetra acetic acid (EDTA) which is a complexing agent. Since EDTA is insoluble in water, the disodium salt of EDTA is taken for this experiment. EDTA can form four or six coordination bonds with a metal ion. Two type of hardness is present in water first is temporary hardness and second is permanent hardness. Temporary hardness is due to the presence of bicarbonates of calcium and magnesium ions. It can be easily removed by boiling. Permanent hardness is due to the presence of chlorides and sulphates of calcium and magnesium ions. This type of hardness cannot be removed by boiling.

PRINCIPLE:

This method depends on ability of ethylenediamine tetraacetic acid (C10 H16 O8 N2) or its disodium salt to form stable complexes with calcium and magnesium ions. When the dye eriochrome black T (EBT) (C2OH13.N3O7S) is added to a solution containing calcium and magnesium ions at pH 10.0 a wine-red complex is formed. This solution is titrated with standard solution of disodium salt of EDTA, which extracts calcium and magnesium from the dye complex and the dye is changed back to its original blue color. Eriochrome black T is used to indicate the end-point for the titration of calcium and magnesium together.

REAGENTS:

1. Buffer solution- Dissolve 16.9 g ammonium chloride (NH4Cl) in 143 ml concentrated ammonium hydroxide (NH4OH), add 1.25 g of magnesium salt of EDTA and dilute to 250 ml with distilled water. Store the solution in a polyethylene bottle tightly stoppered to prevent loss of ammonia or pick-up of carbon dioxide for no longer than1 month. Dilute 10 ml of the solution to 100 ml with distilled water and check that the pH value is 10.0.

2. Standard calcium solution- 1.00 ml = 1.00 mg calcium carbonate (CaCO3). Dry analytical grade calcium carbonate (CaCO3) in an oven at 180°C for 1 hour. Weigh 1.000 g, suspend it in distilled water and add 1:1 hydrochloric acid AR quality, drop wise slowly to dissolve the solid. Use minimum amount of acid. Boil for a few minutes, cool, add a few drops of methyl red indicator and adjust to orange color with 3N ammonium hydroxide or 1 : 1 hydrochloric acid. Dilute to 1 000 ml with distilled water.

3. Eriochrome black T indicator solution- Dissolve 0.40 g eriochrome black T and 4.5 g hydroxylamine hydrochloride (NH2OH HCl) in 100 ml 95 percent ethanol. This indicator is stable for more than 2 months. Alternatively, dissolve 0.5 g eriochrome black T in 100 ml triethanolamine or 2-methoxyethanol or mixed 0.5 g EBT dye and 100 g sodium chloride in a pestle and mortar. Store in a tightly stoppered bottle. All indicator formulations tend to deteriorate especially when exposed to moisture. If the end point color change is not sharp enough it is either due to the presence of some interfering ions or due to deterioration of the indicator. In the latter case, addition of inhibitor sodium cyanide or sodium sulphide (NaCN or Na2S) does not sharpen the end point color change.

i. Hydroxylamine hydrochloride solution — Dissolve 45 g hydroxylamine hydrochloride (NH2OH.HCl) in demineralised water and dilute to 1 liter, or dissolve 4.5 g hydroxylamine hydrochloride in 100 ml of 95 percent ethanol or isopropanol.

ii. Potassium ferrocyanide crystals

iii. Sodium sulphide inhibitor — Dissolve 5.0 g sodium sulphide (Na2S.9H2O) or 3.7 g Na2S.5H2O in 100 ml distilled water. Tightly stopper so as to avoid excessive contact with air.

iv. Sodium cyanide solution — Dissolve 2.5 g sodium cyanide (NaCN) in demineralized water and dilute to 100 ml. As sodium cyanide is extremely poisonous, it should be handled with care. The solution should not be made acidic and should be flushed down the drain with large amounts of water when it is to be disposed of.

v. Standard EDTA solution — Dissolve 3.723 g EDTA (Na2H2C10H12O N2.2 H2O) which has been dried overnight in a sulphuric acid desiccator, in demineralized water and dilute to 1000 ml. The reagent is stable for several weeks and large volume is usually prepared. Check the reagent by titrating 25 ml of standard calcium solution. Store in polyethylene bottles.

PROCEDURE:

1. Standardization — Pipette 25.0 ml of standard calcium solution in a porcelain basin and adjust the volume to 50 ml with distilled water. Add 1 ml buffer solution.
2. Add 1 to 2 drops of indicator.
3. Titrate slowly with continuous stirring until the reddish tinge disappears, adding last few drops at 3 to 5 second interval. At the end point the color is sky blue.

CALCULATION:

$$\text{Total Hardness as CaCO3 (mg/ l)} = 100(V1 - V2) \div V3 \times CF$$

Where: -

V1= volume in ml of the EDTA standard solution used in the titration for the sample,
V2= volume in ml of the EDTA solution used in the titration for blank,
V3 = volume in ml of the sample taken for the test,
CF = X1/X2 = correction factor for standardization of EDTA,
X1 = volume in ml of standard calcium solution taken for standardization, and
X2 = volume of ml of EDTA solution used in the titration.

FIGURE 3.3.4.1a: Titration hardness

FIGURE3.3.4.1b: Hardness Automated burette

3.3.5 METHODOLOGY FOR MEASUREMENT OF CALCIUM:

PRINCIPLE:

Calcium can be determined by EDTA titration in solution of 0.1 M sodium hydroxide (pH 12-13) against murexide. Just like during determination of magnesium all metals other than alkali metals can interfere and should be removed prior to titration. Magnesium in that high pH precipitates as $Mg(OH)_2$ and is not complexed by EDTA, thus its presence can be ignored. Note, that if the amount of magnesium is huge, calcium can coprecipitate with $Mg(OH)_2$. Presence of ammonium salts is undesired, as they lower pH and make end point less sharp. To get rid of ammonia, solution can be heated after NaOH was added.

Reaction taking place during titration is:

$$Ca^{2+} + EDTA^{4-} \rightarrow CaEDTA^{2-}$$

APPRATUS:

To perform titration, we will need titrant - 0.01 M EDTA solution and 1M Sodium Hydroxide solution. We will also need indicator - either in the form of solution, or ground with NaCl - 100 mg of indicator plus 20 g of analytical grade NaCl.

PROCEDURE:

Procedure to follow is mostly identical with the one used for the EDTA standardization.

1) Transfer calcium solution to Erlenmeyer flask.

2) Dilute to about 100 mL with distilled water.

3) Add 10 mL of 1 M sodium hydroxide solution.

4) Add a pinch of murexide ground with sodium chloride (100 mg of indicator plus 20 g of analytical grade NaCl).

5) Titrate with EDTA solution till the color changes to violet.

FIGURE 3.3.5a:Calcium Automated burette

FIGURE 3.3.5b :Calcium Titration

3.3.6 METHODOLOGY FOR MEASUREMENT OF ALKALINITY:

Alkalinity of water is its acid-neutralizing capacity. It is the sum of all the titratable bases. The measured value may vary significantly with the end-point pH used. Alkalinity is a measure of an aggregate property of water and can be interpreted in terms of specific substances only when the chemical composition of the sample is known. Alkalinity is significant in many uses and treatments of natural waters and wastewaters. Because

the alkalinity of many surface waters is primarily a function of carbonate, bicarbonate, and hydroxide content, it is taken as an indication of the concentration of these constituents. The measured values also may include contributions from borates, phosphates, silicates, or other bases if these are present. Alkalinity in excess of alkaline earth metal concentrations is significant in determining the suitability of water for irrigation. Alkalinity measurements are used in the interpretation and control of water and wastewater treatment processes. Raw domestic wastewater has an alkalinity less than, or only slightly greater than, that of the water supply. Properly operating anaerobic digesters typically have supernatant alkalinities in the range of 2000 to 4000 mg calcium carbonate (CaCO3)/L.

PRINCIPLE:

Hydroxyl ions present in a sample as a result of dissociation or hydrolysis of solutes react with additions of standard acid. Alkalinity thus depends on the end-point pH used. For methods of determining inflection points from titration curves and the rationale for titrating to fixed pH end points. For samples of low alkalinity (less than 20 mg $CaCO_3$/L) use an extrapolation technique based on the near proportionality of concentration of hydrogen ions to excess of titrant beyond the equivalence point. The amount of standard acid required to reduce pH exactly 0.30 pH unit is measured carefully. Because this change in pH corresponds to an exact doubling of the hydrogen ion concentration, a simple extrapolation can be made to the equivalence point

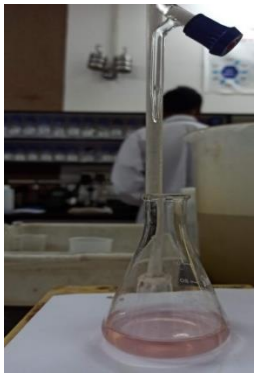


FIGURE 3.3.6a: Titration for alkalinity

PROCEDURE:

1) Take 25 or 50ml sample in a conical flask and add 2-3 drops of phenolphthalein indicator.

2) If pink color develops titrate with 0.02N H_2SO_4 till disappears or pH is 8.3. Note the amount of H_2SO_4 used.

3) Add 2-3 drops of methyl orange to the same flask, and continue titration till yellow color changes to orange. Note the amount of H_2SO_4 used.

4) In case pink color does not appear after addition of phenolphthalein continue as above.
5) Alternatively, perform potentiometric titration to preselected pH using appropriate volume of sample and titration assembly. Titrate to the end point ph without recording intermediate pH. As the end point is approached make smaller additions of acid and be sure that pH equilibrium is reached before adding more titrant. The following pH values are suggested as equivalence points for corresponding alkalinity as mgCaCO3/L.

Table 3.2: END POINT pH VALUES

Alkalinity range and Nature of sample	End point pH Total Alkalinity	End point pH Phenolphthalein Alkalinity
Alkalinity, mgCaCO3/L:		
30	4.9	8.3
150	4.6	8.3
500	4.3	8.3
Silicates, phosphates known or suspended	4.5	8.3
Industrial waste or complex system	4.5	8.3
Routine or automated analyses	4.5	8.3

CALCULATIONS:

Calculate total (T), Phenolphthalein (P) alkalinity as follows:

P-alkalinity, as mgCaCO3/L = A × 1000ml/L sample
T-alkalinity, as mgCaCO3/L = B × 1000ml/L sample

In case H2SO4 is not 0.02N apply the following formula:

Alkalinity, as mg CaCO3/L = A/B×N×50000/ml of sample

Where,
A = ml of H2SO4 required to bring the ph to 8.3
B = ml of H2SO4 required to bring the ph to 8.3

3.3.7 METHODOLOGY FOR MEASUREMENT OF CHLORIDE:

Chloride is the form of chloride (Cl-) ion, is one of the major inorganic anions in water and wastewater. The salty taste produce by the chloride concentration is variable and dependent on the chemical composition of water. Some waters containing 250mgCl-/L may have a detectable salty taste may be absent sodium. On the other hand, the typical salty taste may be absent in waters containing as much as 1000mg/L when the predominant cations are calcium and magnesium.

A high chloride content may harm metallic pipes and structures, as well as growing plants.

3.3.7.1 ARGENTOMETRIC METHOD:

PRINCIPLE:

In a netural or slightly alkaline solution, potassium chromate can indicate the endpoint of the silver nitrate titration of chloride. Silver chloride is precipitated quantitatively before red silver chromate is formed.

APPARATUS:

Erlenmeyer flask - 250 ml capacity.
Micro burette - 50 ml.

REAGENT:

a) Potassium chromate indicator solution: Dissolve 50g K_2CrO_4 in a little distilled water. Add $AgNO_3$ solution until a definite red precipitate is formed. Let Stand 12h, filter, and dilute to 1L with distilled water.
b) Standard silver nitrate titrant 0.0141M (0.0141N): Dissolve 2.395g $AgNO_3$ in distilled water and dilute to 1000ml. store in brown bottle.
c) Standard sodium chloride solution0.0141N: Dissolve 824.0mg NaCl in distilled water and dilute to 1000ml.

PROCEDURE:

a) Sample preparation: Use a 100-ml sample or a suitable portion dilution to100 ml. if the sample is highly colored, add 3ml Al (OH)3 suspension, mix, let settle, and filter.
If sulfide, sulfite, or thiosulfate is present, add 1ml H_2O_2 and stir for 1 min.
b) Titration: Directly titrate samples in the ph range 7 to 10. Adjust sample 7 to 10 with H_2SO_4 or NaOH if it is not in this range. For adjustment, preferably use a ph meter with a non-chloride-type reference electrode. (Only if available) Treat a separate portion with required acid or alkali and continue analysis. Add 1 ml K_2Cro_4 indicator solution. Titrate

with standard AgNO3 titrate to a pinkish yellow endpoint. Be consistent in endpoint recognition.

Standardize AgN03 titrate and establish reagent blank value by the titration method. A blank 0.2 to 0.3 ml is usual.

CALCULATION:

mg Cl-/L =(A-B) × N× 35450/ ml sample

Where:

A = ml titration for sample,
B = ml titration for blank, and
N = normality of AgNO3.

3.3.7.2POTENTIOMETRIC METHOD:

PRINCIPLE:

Chloride is determined by potentiometric titration with silver nitrate solution with a glass and silver- silver chloride electrode system. During titration an electronic voltmeter is used to detect the change in potential between the two electrodes. The endpoint of the titration is that instrument reading at which the greatest change in voltage has occurred for a small and constant increment of silver nitrate added.

APPARATUS:

a) Glass and Silver-Silver Chloride Electrodes: Prepare in the laboratory or purchase a silver electrode coated with AgCl for use with specified instruments.
b) Electronic Voltmeter: To measure potential difference between electrodes.
c) Mechanical stirrer, with plastic- coated or glass impeller.

REAGENTS:

a) Standard Sodium Chloride Solution, 0.0141M (0.0141N)
b) Standard Silver Nitrate titrant, (0.0141M) (0.0141N)
c) Nitric Acid (HNO3) conc.

PROCEDURE:

a) Standardization:

1) Place 10ml standard NaCl solution in a 250 ml beaker,
dilute to about 100ml, add 2.0ml concentrated HNO_3. Immerse stirrer and electrodes.

2) Add standard $AgNO_3$ titrant.

3) Differential titration curve displayed on the screen of titrator.

b) Sample Analysis:

1) Pipette 100ml sample, or a portion containing not more than 10mg Cl^-, into a 250ml beaker.

2) Add 2 ml HNO_3 according to the sample volume.

3) Complete determination through auto titrator. The reading displays on the screen with a curve.

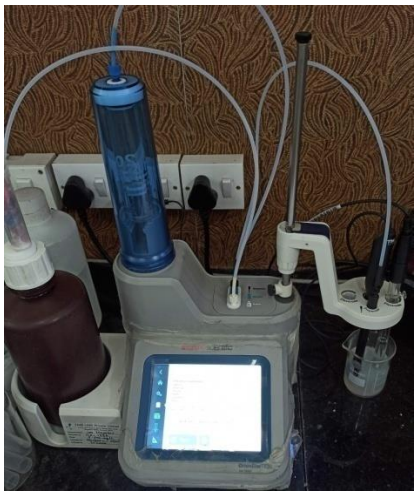


FIGURE3.3.7a: Chloride by Auto titrator

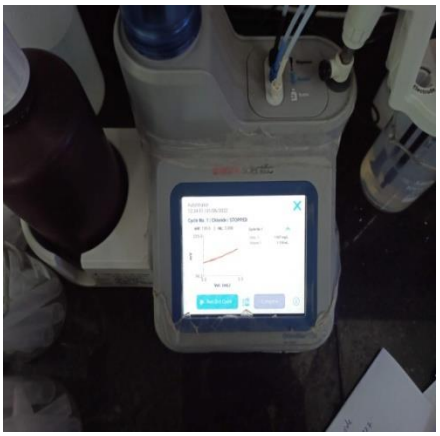


FIGURE3.3.7. b: Chloride graph

3.3.8 METHODOLOGY FOR THE MEASURMENT OF RESIDUAL FREE CHLORINE:

Chlorination of water and wastewater serves primarily to destroy or deactivate disease-producing micro-organisms. The other benefit is the overall improvement in water quality. Chlorination may produce adverse effects. Taste and odor characteristics of phenols and other organic compounds present in water may be intensified. Potentially carcinogenic chloro-organic compounds, such as chloroform may be formed. Combined chlorine formed on chlorination of ammonia or amine bearing waters adversely affects some aquatic life" To fulfill the primary purpose of chlorination and to minimize any adverse effects, it is essential that proper test methods be used with a fore knowledge

of limitations of analytical determination. This method supersedes 45 of IS: 3025-1934 'Methods of sampling and test (physical and chemical) for water used in industry'.

3.3.8.1 CHLORINE METHOD: Using DPD Tablet Reagents:

PRINCIPLE:

DPD indicator is specific for free available chlorine at a controlled pH. Subsequent addition of a small amount of potassium iodide immediately causes monochloramine to produce a color. Further addition of excess potassium iodide causes a rapid response from dichloramine. Interference from copper and dissolved oxygen is prevented by the use of EDTA, which is incorporated in the tablet reagents.

APPARATUS:

Lovibond Comparator 2000+ or Nessleriser 2150
Lovibond Daylight 2000 Lighting Unit Discs, glasswares.

REAGENTS:

Table 3.3: CHLORINE TABLETS

Determination	DPD Tablets, Comparator Black Printed	DPD Tablets, Nessleriser
Free Chlorine	DPD No.1	DPD No.1
Free & Combined Chlorine	DPD No.1 & No.3	DPD No.1 & No.3
Free Chlorine, Monochloramine & Dichloramine	DPD No 1, No.2 & No.3	DPD No 1, No.2 & No.3
Total Residual Chlorine	DPD No.4	DPD No.4

Different tablets use for the analysis of the chlorine.

PROCEDURE:

A) For Free Chlorine:

1. Place a 13.5mm./10ml. moulded cell, containing the sample, in the left-hand compartment of the Comparator.
2. Rinse out another cell with sample and leave a few drops in the bottom.
3. Add to this cell a DPD No.1 tablet and crush with a clean stirring rod.
4. Make up the volume to 10ml. with sample, mix well and place the cell in the right-hand compartment of the Comparator.
5. Hold the Comparator against a source of white light such as the Lovibond Daylight 2000 Unit or failing this North daylight and rotate the disc until a color match is obtained.

Match at once. The value displayed in the window is the free chlorine concentration in mg./l.((Reading 1)

B) For Free, Total and Combined Chlorine:

1. Determine free chlorine as described above.
2. After recording the disc reading, add a DPD No.3 tablet to the colored liquid in the right-hand cell and mix to dissolve. Allow to stand for two minutes.
3. Rotate the disc and match the colors again. (Reading 2) This reading gives the total residual chlorine in mg./l.
4. The combined chlorine concentration = (Reading2 – Reading 1)

C) For Total Residual Chlorine Only:

1. Place a 13.5mm. /10ml. moulded cell, containing the sample, in the left-hand compartment of the Comparator.
2. Rinse out another cell with sample and leave a few drops in the bottom.
3. Add to this cell one DPD No.1 tablet and one DPD No.3 tablet (or one DPD No.4 tablet, which is these two combined) and crush with a clean stirring rod.
4. Add the water sample up to the 10ml. mark, mix rapidly to dissolve the remains of the tablet(s) and place the cell in the right-hand compartment of the Comparator.
5. After two minutes match the colors and record the reading as total residual chlorine.

D) For Complete Differentiation:

1 Place a 13.5mm./10ml. moulded cell, containing only sample, in the left-hand compartment of the Comparator.
2 Rinse out another cell with sample and leave a few drops in the bottom.
3 Add to this cell a DPD No.1 tablet and crush with a clean stirring rod.
4 Add sample to the 10ml mark. Mix well and place the cell in the right-hand compartment of the comparator. Match the colors immediately (Reading 1). This reading is the free chlorine concentration in mg. /l.
5 Next, add to the right-hand cell a DPD No.2 tablet, mix vigorously to dissolve and match at once (Reading 2). The monochloramine concentration = (Reading2 – Reading1).
6 Finally, add one DPD No.3 tablet, mix vigorously and allow to stand for two minutes. Match against the disc (Reading 3). The dichloramine concentration = (Reading3 – Reading2)

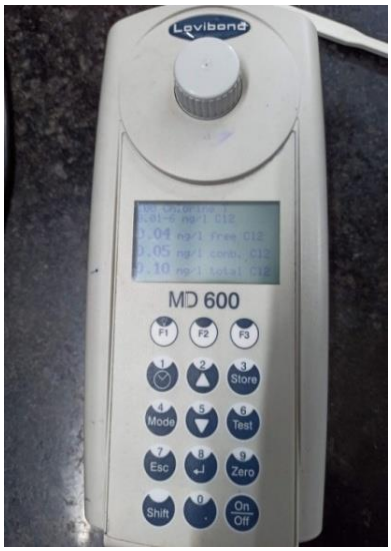


FIGURE3.3.8.1a:RFC by Lovibond

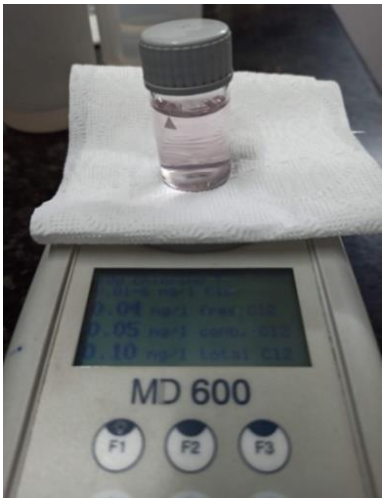


FIGURE 3.3.8.1b

3.3.9 METHODOLOGY FOR THE DETERMINATION OF NITRATE:

Nitrate (NO3-) determination can be difficult because of the high probability that interfering constituents will be present in various matrices. Nitrate is the most highly oxidized form of nitrogen compounds commonly present in natural waters. Significant sources of nitrate are chemical fertilizers, decayed vegetables and animal matter, domestic effluents, sewage washout. Depending on the situation, these sources can contaminate streams, rivers, lakes and ground water. Unpolluted natural water contains minute amounts of nitrate. Excessive concentration in drinking water is considered hazardous for infants because of its reduction to nitrate in intestinal track causing methemoglobinemia. In surface water, nitrate is a nutrient taken by plants and converted into cell protein. The growth stimulation of plants, especially of algae may cause objectionable eutrophication.

3.3.9.1 UV SPECTROPHOTOMETER METHOD:

The method is useful for the water free from organic contaminations and is most suitable for drinking. Measurement of the ultraviolet absorption at 220nm enables rapid determination of nitrate. The nitrate calibration curve follows Beer's law up to 11mg/LN.

Beer's law: The concentration of a solute is directly proportional to the absorbance of the solution.

Acidification with 1N hydrochloric acid is designed to present interference from hydroxide or concentrations up to 1,000mg/L as CaCO3. Chloride has no effect on the determination. Minimum detectable concentration is 40µg/L NO3-N.

PRINCIPLE:

Nitrate is determined by measuring the absorbance at 220nm in sample containing 1ml of hydrochloric acid (1N) in 100ml sample. The concentration is calculated from graph from standard nitrate solution in range 1-11mg/L as N.

APPARATUS:

a) Spectrophotometer, for use at 220nm and 275nm with matched silica cells of 1cm or longer light path.

b) Filter: One of the following is required.

i. Membrane filter: 0.45µm membrane filter, and appropriate filter assemble.
ii. Paper: Acid-washed, ash less hard-finish filter paper sufficiently retentive for fine precipitates.

c) Nessler tube, 50 ml

REAGENTS AND STANDARDS:

a) Redistilled water: use redistilled water for the preparation of all solutions and dilutions.

b) Stock nitrate solution: Dissolve 721.8mg anhydrous potassium nitrate and dilute to 1000ml with distilled water. 1ml=100µg N = 443µg NO3-.

c) Standard nitrate solution: Dilute 100ml stock nitrate solution to 1000ml with distilled water. 1ml = 10µg NO3N = 44.3µg NO3.

d) Hydrochloric acid solution: HCl, 1N.

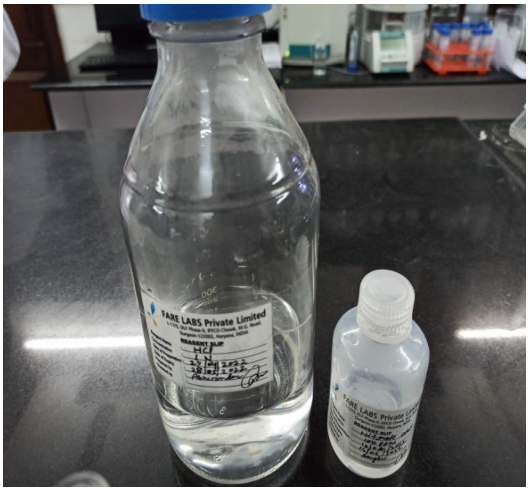


FIGURE3.3.9.1a: Nitrate Standard and HCl (1N) used for Nitrate detection.

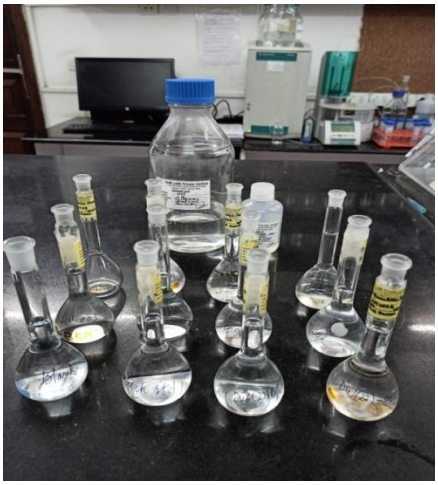


FIGURE3.3.9.1a:Sample preperation for Nitrate detection.

PROCEDURE:

Read the absorbance or transmittance against redistilled water set at zero absorbance or 100% transmittance. Use a wavelength of 220nm to obtain the nitrate reading and, if necessary, a wavelength of 275nm to obtain interference due to dissolved organic matter.

CALCULATION:

For correction for dissolved organic matter, subtract 2 times the reading at 275nm from the reading at 220nm to obtain the absorbance due to nitrate. Convert this absorbance value into equivalent nitrate by reading value from a standard calibration curve.

Nitrate N, mg/L = mg nitrate –N/ ml of sample

NO_3, mg/L =Nitrate N mg/L× 4.43

NOTE:

Interferences presents in the form of dissolved organic matter, nitrite, hexavalent chromium and surfactants are removed by adding 1ml (1N) HCL solution in the 50ml clear filtered solution.

3.3.10 METHODOLOGY FOR THE DETERMINATION OF SUPLHATE:

Sulphate ions usually occur in natural water. Many sulphate compounds are readily soluble in water. Most of them originate from the oxidation of sulphate ores, the solution of gypsum and anhydrite, the presence of shales, particularly those rich in organic compounds, and the existence of industrial wastes. Atmospheric sulphur dioxide formed by the combustion of fossil fuels and emitted by the metallurgical roasting processes may also contribute to the sulphate compounds of water. Sulphur trioxide (SO_3)

produces by the photolytic oxidation of sulphur dioxide comes with water vapours to form sulphuric acid which is precipitated as acid rain or snow. Sulphur- bearing minerals are common in most sedimentary rocks. In the weathering process gypsum (calcium sulphate) is dissolved and sulphide minerals are partly oxidized, giving rise to a soluble of soluble that is carried away by water. In humid region, sulphate is readily leached from the zone of weathering by infiltrating waters and surface run off but in semiarid and arid regions the soluble salts may accumulate within a few ten of feet of land surface. Where this occurs, sulphate concentration in the shallow ground water exceeds 5000mg/L and gradually decreases with depth.

Ingestion of water containing high concentration of sulphate can have a laxative effect, which is enhanced when sulphate is consumed in combination with magnesium. Water containing magnesium sulphate at levels about 1000mg/L acts as a purgative in human adults. Taste threshold concentrations for the most prevalent suplhate salts are 200-500mg/L for sodium sulphate, 250-900mg/L for calcium sulphate, and 400-600mg/L for magnesium sulphate. Essentially on the basis of above values, which are also allied to the cathartic effect of sulphate, a guidelines value of 4000mg/L is proposed. Sulphate cause scaling in water supplies, and problem of odor and corrosion in wastewater treatment due to its reduction to H2S.

SO4 2-+organic matter ---S 2-+H2O+CO2 (1a) (in the presence of anaerobic bacteria)

S 2-+ H ---HS- (1b)

HS- + H+ ---H2S (1c)

PRINCIPLE:

Sulphate ion is precipitated in hydrochloric acid medium with barium chloride in such a manner as to form barium sulphate crystals of uniform size. The absorbance of barium sulphate suspension is measured by a nephlometer or transmission photometer (turbidity meter) and the sulphate ion concentration is determined by comparison of the reading with a standard curve.

The turbidity metric method depends on the fact that barium sulfate formed following barium chloride addition to a sample tends to precipitate in a colloidal form and this tendency is enhanced in the presence of an acidic buffer (consists of magnesium chloride, potassium nitrate, sodium acetate, and acetic acid). These precipitates need to be separated through filtration (using a filter) before sample is analyzed for sulfate concentration. This is a very rapid method and can be used for samples with sulfate concentration greater than 10 mg/L (samples can be diluted and then it can be analyzed).

Ba2+ + SO4 2- ---BaSO4 (precipitate; poorly soluble)

APPARATUS:

Turbidity meter or spectrophotometer - for use at 420 nm.

Usual laboratory glass apparatus.

REAGENTS AND STANDARDS:

a) Dry Barium Chloride (BaCl2) crystals

b) Stock Sulphate solution (100 mg/l) - Dissolve 0.1479 g of anhydrous sodium sulphate (Na2S04) in distilled water and dilute to one liter.

c) Standard sulphate solution - Dissolve 0.1479 g of anhydrous sodium sulfate in distilled water to make the volume 1 L. This solution contains 100 mg sulfate/L (i.e., 1 mL=100µg SO4 2-). Prepare standards of various strengths (preferably from 0.0 to 40.0mg/L at the intervals of 5 mg/L by diluting this stock solution). Above 40 mg/L accuracy decreases and BaSO4 suspensions lose stability.

d) Buffer Solution A: Dissolve 30 g magnesium chloride (MgCl2.6H2O), 5 g sodium acetate (CH3COONa.3H2O), 1.0 g potassium nitrate (KNO3), and 20 mL acetic acid (CH3COOH; 99%) in 500 mL distilled water and make up to 1000 mL.

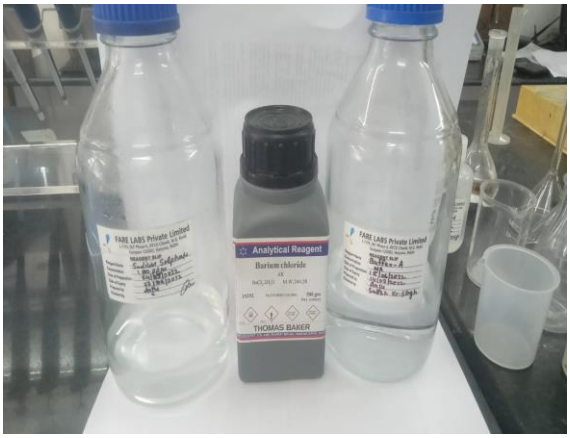


FIGURE3.3.10a: Sulphate standard, Buffer A, BaCl2 for Sulphate detection.

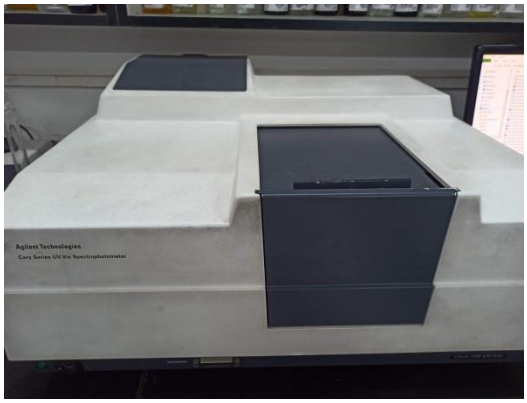


FIGURE3.3.10.1b:Suplhate detection by Sepectrophotometer.

PROCEDURE:

1. Filter the sample though filter paper (Whatman No. 1) and take 50 mL of filtrate in an Erlenmeyer flask.
2. Add 20 mL buffer solution and mix in stirring apparatus. While stirring, add 0.15 g of barium chloride to the sample and stir the sample with the help of magnetic stirrer for about an hour. 3. Measure the absorbance against a distilled water blank (DO NOT ADD BARIUM CHLORIDE TO IT.) at 420 nm using spectrophotometer. Absorbance for the blank sample is taken to correct for sample color and turbidity.
4) Process the standard solution of different strengths in similar way and record the absorbance for each solution. Plot a standard sulfate calibration curve on a graph paper from these absorbance values putting strengths (mg/L) on X-axis and absorbance @ 420 nm on Y-axis. Fit a best-fit linear model to the data. Express equation as: Absorbance value= A+B× Sulfate concentration (in mg/L) (3)
5. Using the standard sulfate calibration curve (a linear-model; Equation 3), find out sulfate concentration in the given unknown sample in mg/L. Sulfate concentration (mg SO4 2-/L) = (1000×mg SO4 2-)/(mL sample).

CALCULATION:

Read the sulphate concentration of sample directly from the calibration curve.

3.3.11METHODS FOR THE DETERMINATION OF MICROBIOLOGICAL PARAMETERS:

3.3.11.1 STANDARD PLATE COUNT:

General - Standard plate count (which is an empirical method) serves to indicate the efficiency of certain processes in water treatment, particularly coagulation, filtration and disinfection and the cleanliness of the mains, reservoirs, etc. It provides an estimate of the general hygienic quality of water, which is important where large scale preparation of food and drink is concerned. Low counts are of importance for avoiding food spoilage, while rising plate counts give the earliest sign of pollution. The standard plate count method is a direct measurement of the viable aerobic and facultative anerobic bacteria in a water environment capable of growth on the selected plating medium. The procedure does not allow the more fastidious aerobes or obligate anaerobes to develop. Also, the bacteria of possible importance in water such as Crino-thrix, sphaerotilus and actinomycetes will not develop within the incubation period specified for potable water. Since an aggregate of cells will appear as one colony on the growth medium. The number of types of bacteria that develop are influenced by the time and comparative temperature of incubation, the pH of the medium, the level of the oxygen, the presence of specific nutrients on the growth medium competition among cells for nutrients, antibiosis, mediation, etc.

In solid medium counting of organisrns depends on the fact that living cells will proceed to multiply and in time will produce sufficient progeny to form a colony visible to naked eye. Since bacteria occur in water as single cells, pairs, groups, chains or even dense clumps, not every individual living cell will develop into a separate colony on incubation. Therefore, number of colonies appearing on a plate does not necessarily represent the total number of organisms present in test volume. The results are expressed as number of colonies per ml.

FIGURE 3.3.11.1a: Sterilized Petri plates in LAF for SPC

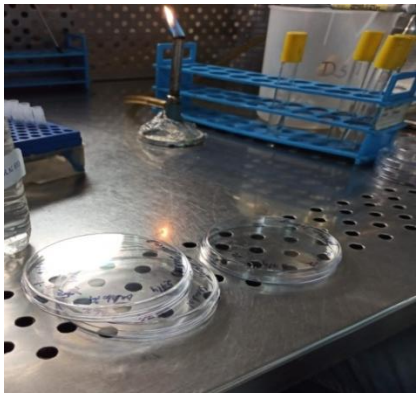


FIGURE3.3.11.1b: Labelling of petri plates.

MEDIUM AND REAGENTS:

a) Nutrient agar - Dissolve 1 g glucose, 5·0 g of peptone and 3.0 g of beef extract in 1000 ml of distilled water. Adjust the pH to 7'2, distribute in required quantity and add 1.5 percent agar powder. Sterilize at 15 ± 0.5 psi gauge pressure, 120°C temperature approximately for 15 minutes in the autoclave.

b) Distilled water:

a) Buffered dilution water - To prepare stock phosphate buffer solution, dissolve 34 g of potassium dihydrogen phosphate in 500 ml of distilled water, adjust pH to 7.2 with sodium hydroxide solution (1 N) and dilute to 1 litre with distilled water. Add 1.25 ml of stock phosphate buffer solution to 1 litre of distilled water, dispense in amounts that will provide 18 ± 0.4 ml or 9 ± 0.2 ml in 150 X 25 mm or 150 X 18 mm test tubes

respectively. Sterilize in autoclave at 15 ± 0.5 psi gauge pressure, 120°C temperature approximately for 15 minutes.

b) Quarter strength ringer's solution - Dissolve 9.0 g of sodium chloride, 0·42 g of potassium chloride, 0·48 g of calcium chloride and 0.20 g of sodium bicarbonate in 1 litre of water. This solution is known as Ringer's solution. Dilute 500 ml of this solution to 2 litre to obtain quarter strength Ringer's solution. Dispense in amounts that will provide 18 ± 0·4 ml or 9 ±0.2 ml in 150 X 25 mm or 150 X 18 mm test tubes respectively. Sterilize in autoclave at 15 ± 0·5 psi gauge pressure, 120°C temperature approximately for 15 minutes.

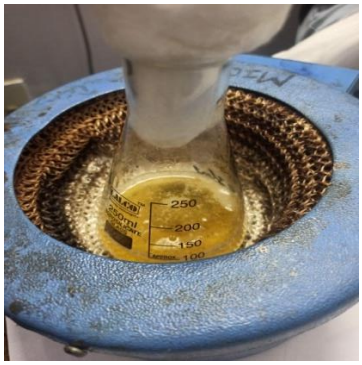


FIGURE3.3.11.1c: Media in Heating Mantle

FIGURE3.3.11.1d

PROCEDURE:

a) Preparation and dilution: Shake the samples about 25 times. Withdraw required portion with a sterile pipette and introduce into the Petri dish or dilution tube.

b) Plating - Place 0.1 ml, or 1·0 ml of other suitable dilution to be used for plating in the Petri dish first. Then add to the Petri dish 10 to 15 ml of melted nutrient agar medium at a temperature of 43 to 45°C (tolerable to the skin). The nutrient agar and the sample shall be thoroughly mixed over the bottom of the Petri dish by tilting and rotating the dish several times, Allow the plate to solidify and place immediately in the incubator in an inverted position.

c) Incubation - Incubate the plates at 37°C for 24 hours.

d) Counting - In preparing plates, plant such amounts of water for dilution which will give from 30 to 300 colonies on a plate. Always have two or more plates for each dilution. Report the result as the average of all plates falling within limits. It is not desirable to plant more than 1·0 ml in a plate. If the colonies are more than 300 or less than 30 from 1 ml sample, disregard it. In practice, counts less than 30 occur when chlorinated water samples are plated. When the number of colonies is more than 300 in a plate, report the count at C TNC ' (too numerous to count). Counting shall be done with an approved counting aid, such as colony counter, record the number of colonies to the nearest 5 units per ml and report the temperature of incubations.

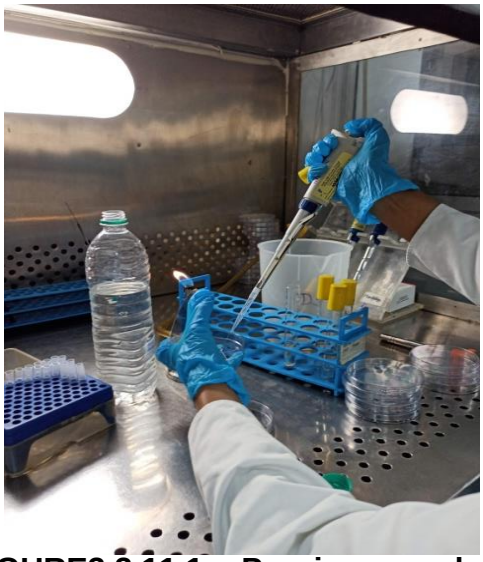


FIGURE3.3.11.1e: Pouring samples

FIGURE3.3.11.1f:Sample Mixing

FIGURE3.3.11.1g: Pouring of Nutrient agar in plate

3.3.11.2 MULTIPLE TUDE DILUTION OR MOST PROBABLE NO.(MPN):

General: The standard test for the estimation of number of the coliform groups may be carried out either by the multiple tube dilution test (presumptive test, confirmed test, or completed test) or by the membrane filter technique. The coliform group includes all aerobic and facultative anaerobic gram negative, non-spore forming rod shaped bacteria which ferment lactose with gas formation within 48 hours at 37°C.

The presumptive, confirmed and completed tests are presented as total independent procedures. In using these procedures, the worker must know what is to be the stage at which the test is to be ended, and details of the procedure throughout. Thus, if the worker knows that the test will be ended at the confirmed test, he will stop at the confirmed test stage only. The most satisfactory information is obtained when the largest portion examined shows no gas in all or a majority of the tubes. The MPN value for a given sample is obtained by the use of MPN tables. Standard practice in water

analysis is to plant five tubes for each dilution and a minimum three different dilutions are employed.

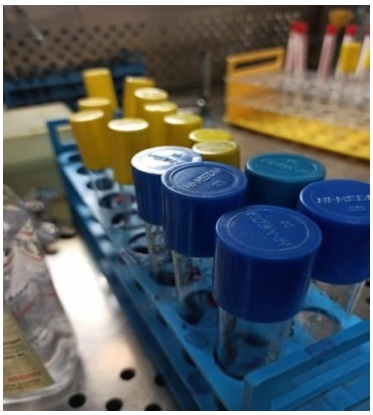


FIGURE3.3.11.2a: Double strength and Single strength media containing tubes.

FIGURE3.3.11.2b:Sterilization by autoclave

MEDIA AND REAGENTS:

a) Dilution water

b) MacConkey broth - This is used as a presumptive medium for the enumeration of coliform bacteria in water samples. Its composition is an as under:

Peptone	20 g
Lactose	10 g
Sodium chloride	5 g
Bile salt	5 g
Distilled water	1000 ml

In place of bile salt which is a commercial product sodium taurocholate or sodium tauroglycocholate may be used. Dissolve all the ingredients and adjust the pH to 7.4.

After adjusting the pH) add 1 ml of 1 percent alcoholic solution of bromocresol purple or 5 ml of 1 percent aqueous solution of neutral red. This will be the single strength medium. Distribute 10 ml of the medium into 150 X 15 mm test lubes and add a Durham's tube (25 X 5 mm) in an inverted position. Plug the tubes with non-absorbent cotton and sterilize at 115°C for 10 minutes in the autoclave. This medium is used for 1 ml and the decimal dilutions of the water sample. For 10 ml and larger aliquots a double strength medium is used. For the double strength medium add the above ingredients in double the quantities in 1000ml of distilled water. This medium is dispensed into 10 ml quantity, in 150 X 18 mm test tubes added with Durham's tube and sterilized.

c) Brilliant Green bile lactose broth (BGB) -This medium is used as a confirmatory test for coliforms as well as for faecal coliforms. Its composition is as under:

Peptone	10 g
Lactose	10 g
Bile salt	20 g
Distilled water	1000 ml

Dissolve all the ingredients and adjust the pH to 7.4. Add 1 33 ml of 1 percent aqueous solution of brilliant green indicator. Distribute 4 ml quantities into 150 X 12 mm test tubes and add a Durham's tube to each. After plugging with non-absorbent cotton, sterilize at 15 ± 0·5 psi gauge pressure, 120°0 temperature approximately for 15 minutes in the autoclave.

d) Peptone water- This is used for indole test or for preparing a liquid culture of an organism. Its composition is as follows:

Peptone	10 g
Sodium chloride	5 g
Distilled water	1000 ml

Dissolve all the ingredients. Adjust the pH to 7.4. Dispense 4 ml medium into 100 X 12 mm tubes and plug with non-absorbent cotton. Sterilize in the autoclave at 15 ± 0·5 psi gauge pressure, 120°C temperature approximately for 15 minutes.

e) Mac Conkey agar - The medium is used for the completed test or for IMViC classification of coliforms. Its composition is as under:

Peptone	20 g
Lactose	10 g
Sodium chloride	5 g
Bile salt	5 g
Distilled water	1000 ml

Dissolve all the ingredients and adjust the pH to 7·4. Add 10 ml of 1 percent aqueous solution of neutral red indicator and 15 g of agar. Steam the medium for 15 to 30

minutes 10 that agar is dissolved properly and sterilize in autoclave at 15 ± 0.5 psi gauge pressure, 120°C temperature approximately for 15 minutes. After sterilization, cool to 45°C and prepare the plates by pouring 15 ml of melted agar per plate.
Allow to solidify, invert and incubate at 37°C for drying as well as for sterility test.

f) Nutrient agar slants- Dispense while in the melted condition about 10 ml quantity into each tube (150 mm X 15 mm). Sterilize in the autoclave at 15 ± 0.5psi gauge pressure, 120°C temperature approximately for 15 minutes. After sterilization the slants are prepared by keeping the tubes in a slanting position and allow them to solidify. Unless they are to be used, they should be stored in a refrigerator.

g) Kovac's reagent- It is used for indole test. Its composition is as under:
Paradimethyl aminobenzaldehyde 5g
Amyl alcohol or n-butanol 75ml
Concentrated hydrochloric acid 25 ml
Dissolve paradimethyl aminobenzaldehyde in amyl alcohol and then add 25 ml of hydrochloric acid. The reagent shall be yellowish in color. Store in amber colored glass stopper bottle.

h) Gram staining reagents –
1) Crystal violet is used as a primary stain.
Solution A - Crystal violet (85 percent dye content) 2 g
Ethyl alcohol (95 percent) 20 ml
Solution B - Ammonium oxalate 0-8 g
Water 80 ml
Mix solutions A and B in equal parts. It is sometimes found, however, that this gives so concentrated a stain that gram-negative organisms do not properly decolonize. To avoid this, dilute solution A as much as ten times. Use 20 ml of this diluted solution and mix with solution B.
2) Lugol's iodine - Dissolve 1 g of iodine crystals and 2 g of potassium iodide in 300 ml of distilled water.
3) Safranin is used as a counter stain. Dissolve 25 g of safranin dye in 100 ml of 95 percent ethyl alcohol. Add 10 ml of the solution to 100 ml of distilled water.
4) Ethyl Alcohol- 95 percent.

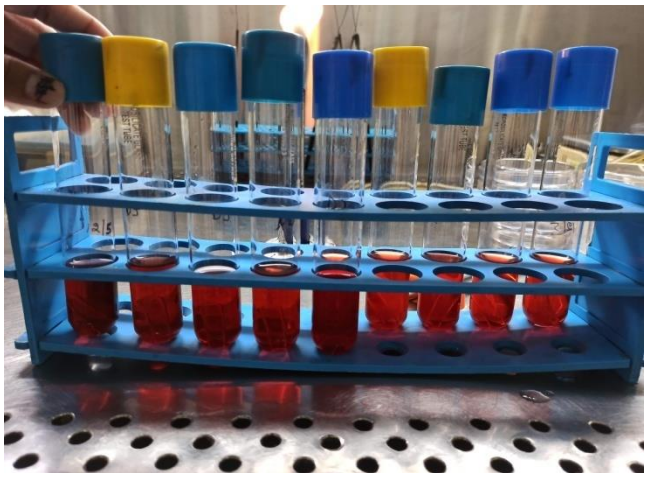


FIGURE3.3.11.2c: media + Durham tube containing sample.

PROCEDURE:

Shake the water samples thoroughly before making dilutions or before inoculation.

a) Presumptive test:

I) Use Mac Conkey broth: Inoculate a series of fermentation tubes with appropriate measured quantities of the water to be tested. The concentration of nutritive ingredients in the mixture should be sufficient and according to requirements. Ten ml and above aliquots should be inoculated in double strength and 1 ml and its dilution should be inoculated into single strength medium.

II) Incubate all tubes at 37°C for 24 to 48 hours. Examine each tube at the end of 24 ± 2 hours for gas production and if no gas has been formed, re-incubate for another 24 hours and at the end of 48 hours, examine again. Record the presence of or absence of gas at each examination of the tubes regardless of the amount.

III) Formation of the gas within 48 ± 3 hours in any amount, in the inner fermentation tubes, constitutes a ·possible presumptive test. The absence of gas formation at the end of 48 ± 3 hours of incubation constitutes a negative test.

b) Confirmed test:

The medium used for confirmed test is brilliant green bile lactose broth (BGB).

I) Submit all primary fermentation tubes showing any amount of gas at the end of 24 hours incubation to the confirmed test, If additional primary fermentation tubes show gas at the end of 48 hours incubation, these too shall be submitted to the confirmed test. Use a sterile metal loop 3 to 4 mm in diameter to transfer one or two loop full of medium from the presumptive positive tubes to a tube of BGB broth. When making such transfers, gently shake the tube first or mix by rotating. Incubate the inoculated tubes at 37°C for 48 ± 3 hours.

II) The formation of gas in any amount in the Durham's tubes of BOB tube at any time within 48 ± 3 hours constitutes a positive confirmed test.

C) Completed test:

I) It may be applied to positive BOB tubes. Shake the tube, and streak with the help of a loop on the Mac- Conkey agar plates as soon as possible 10 such a way so as to get discrete colonies. Incubate the plates at 37°C for 24 ± 2 hours.

II) From each plate pick up typical or atypical colonies and inoculate lactose broth and nutrient agar slants. Incubate at 37°C for 24 to 48 hours.

III) Nutrient agar slants can be used for gram stain. If organisms are gram negative, non-spore forming bacilli and if gas is produced in lactose broth the test is considered completed and the presence of coliform organisms is demonstrated.

IV) Gram-stain technique - Prepare a thin smear of the growth on the agar slant on a clean glass slide. Air dry, fix by passing the slide through a flame, and stain for 1 minute with ammonium oxalate-crystal violet solution. Wash the slide in water immerse in Lugol's iodine solution for 1 minute. Wash the slide in water, blot dry; decolorize with ethyl alcohol for 30 seconds, using gentle agitation. Blot and cover with counter stain for 10 seconds with safranin, then wash, dry and examine under oil immersion.

Cells which decolorize and accept the safranin stain are pink in color and defined as gram-negative in reaction. Cells which do not decolorize but retain the crystal violet stain, are deep blue in color and are defined as gram-positive.

Computing and recording of MPN the number of positive findings of coliform group organisms (either presumptive, confirmed, or completed) resulting from the multiple portion decimal dilution planting should be computed as combination of the positives and recorded in terms of the Most Probable Number.

CHAPTER-IV
RESULT AND DISCUSSION

4 RESULT AND DISCUSSION:

4.1 pH:

The pH is a measure of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water. It has no direct adverse effect on health, however, a low value, below 4.0 will produce sour taste and higher value above 8.5 shows alkaline taste. A pH range of 6.5 – 8.5 is normally acceptable as per guidelines suggested by IS. In the present study, the fluctuation of pH in the samples is from 7.30 to 7.75. It is very much clear from the study that the concentration of the ions in the water is adequate. As per the study and the finding of N.Rahmanian et al.(2015) the drinking water was clean and safe to drink. And the pH of some was in range of 7.3 that what also labelled in the packaged drinking water, it proves that the information provided by the manufacturer is accurate. And the same ranges of pH were noticed in my samples: BW001, BW004, BW009 having pH range 7.37, 7.30, 7.36 that further proves the safe water quality provided by manufacturer in packaged bottles.

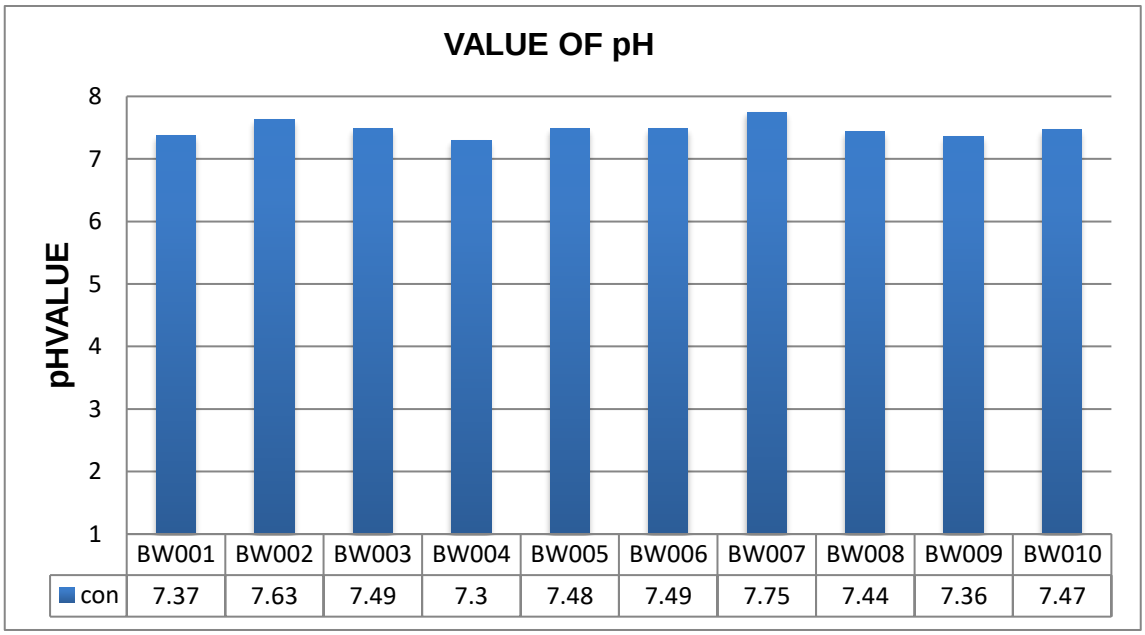


FIGURE4.1: Average pH of the water samples from different areas.

4.2 TURBIDITY:

Measurement of Turbidity reflects the transparency in water. It is caused by the substances present in water in suspension. In natural water, it is caused by clay, silt, organic matter and other microscopic organisms. It ranged from 0.21 to 2.96 NTU. However, the prescribed limit of

Turbidity for drinking water is 5 NTU (IS: 10500). Turbidity was found within the permissible limit in all the water samples. The WHO stated that drinking water is best foe consumption with NTU less than 1for health purpose. C.L. Chan et al (2007) analyzed that the turbidity of drinking water samples and found mostly they were suitable for consumption. The water with higher turbidity can cause health risk and the highly turbid water after long storage can stimulate growth of bacteria.

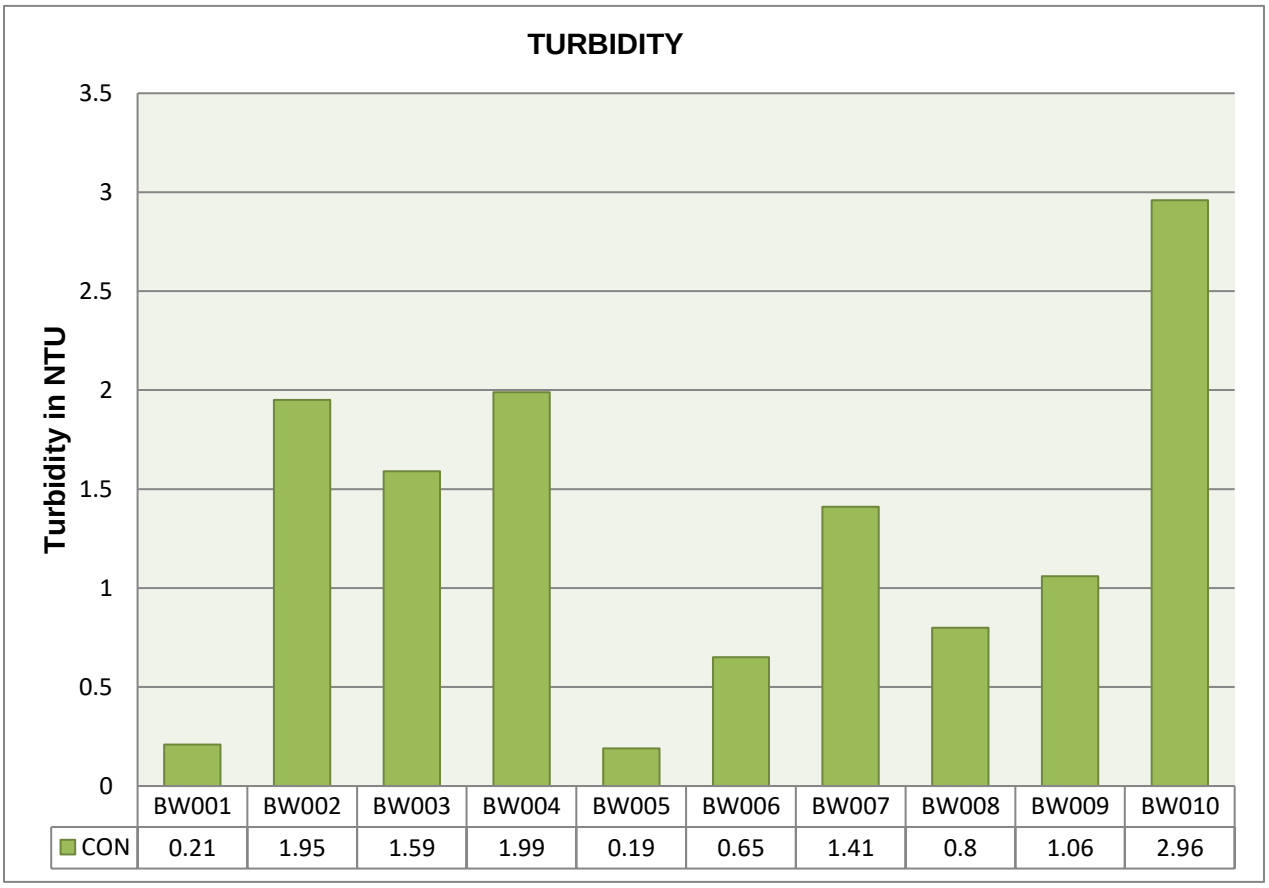


FIGURE4.2: Average Turbidity of water samples from different location.

4.3 TOTAL DISSLOVED SOLIDS:

Total Dissolved Solids may be considered as salinity indicator for classification of groundwater, drinking water. The TDS in water is due to the presence of Calcium, Magnesium, Sodium, Potassium, Bicarbonate, Chloride and Sulphate ions. TDS is the basic and very important parameter that initially determines if the water is safe for drinking or not and describes the category of the water sample/water source comes from (such as groundwater, potable water, borewell water, natural mineral water, packaged drinking water). In the study area TDS varied from 58 to 144 mg/l. As prescribed limit of TDS for drinking water is 500 mg/l, all the water samples have TDS concentration below the prescribed limit. Mohammad Rafiqul Islam (2016) made a study and seen that the packaged drinking water has the minerals low to the certain limits and concluded that the low level of minerals TDS is not good for health. It is proven that certain limit of TDS should be in water because it shows the presence of minerals that are beneficial to the health of people. Mineral intake in certain amount is beneficial and mandatory for good health.

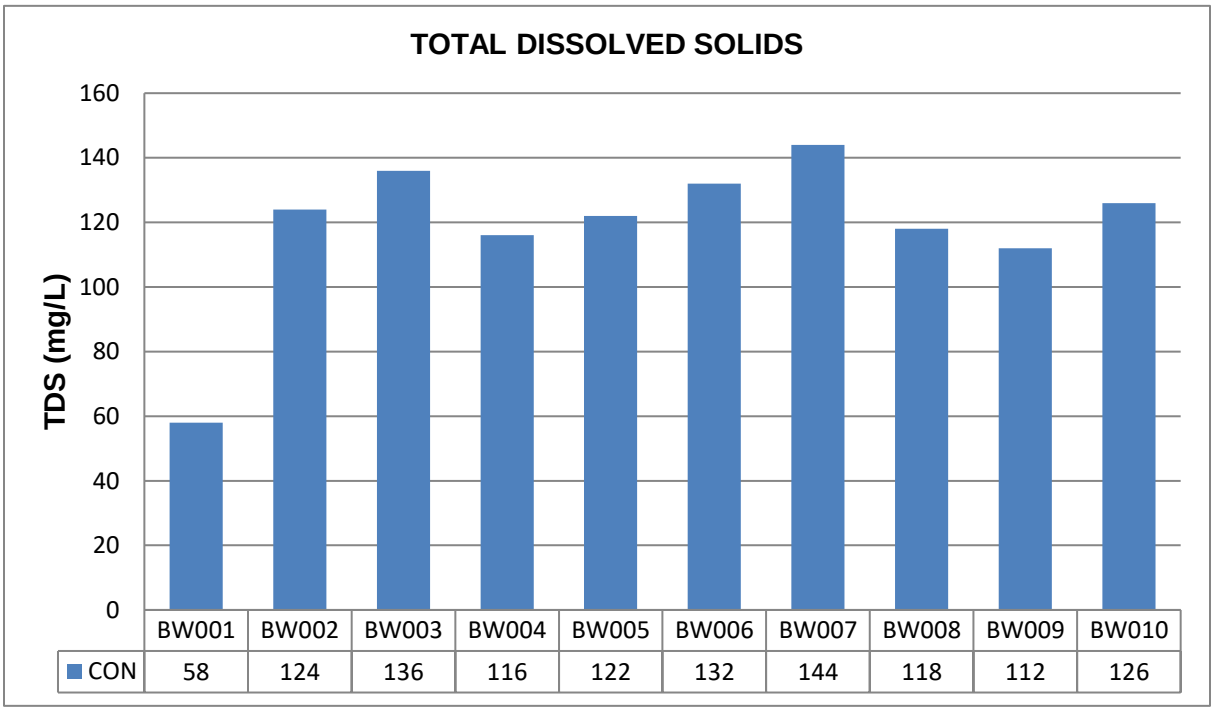


FIGURE4.3: Average TDS of the water samples taken from the different location.

4.4 TOTAL HARDNESS:

Hardness of water is objectionable from the view point of water use for laundry and domestic purposes since it consumes a large quantity of soap. Based on present investigation, hardness varied from 112 to 144mg/l. However, the permissible limit of Hardness for drinking water is 200 mg/l (IS 10500). According to Hardness classification (Durfor and Backer, 1964), the no of water samples of the study area can be classified as given in table 4.1. It is found that the water supplied to the Sukhrali village at different location is moderately hard and hard.

The water following in this category can be used for drinking but after boiling and filtration. The limits are not adverse that the water cannot be used for drinking and other household purpose.

TABLE 4.4 Classification of the water according to hardness:

TDS Range	Description
0-60	Soft
61-120	Moderately Hard
121- 180	Hard
>180	Very Hard

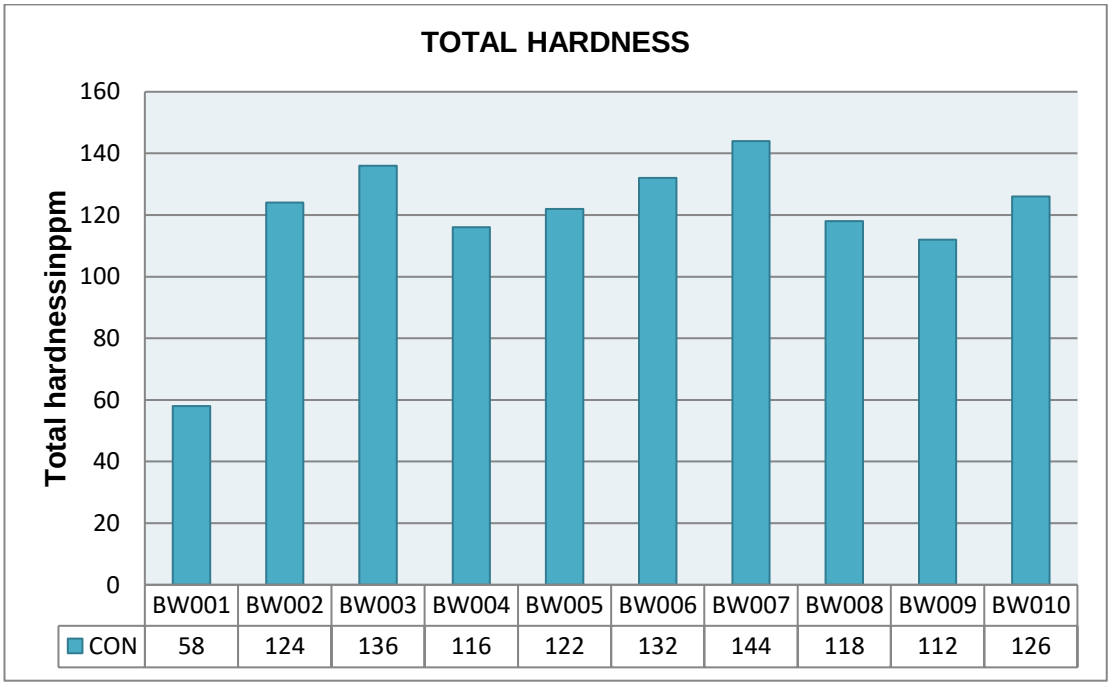


FIGURE4.4: Average hardness of water sample from different area.

4.5 CALCIUM:

Adequate calcium intake is essential for achieving peak bone mass and subsequent prevention of osteoporosis. Based on present investigation, calcium varied from 25.6 to 30.4mg/l. However, the permissible limit of calcium for drinking water is 75 mg/l (IS 10500). The calcium limits are adequate in the water supplied in the sampling locations of Sukhrali, the water can be used for drinking purpose and other household purpose.

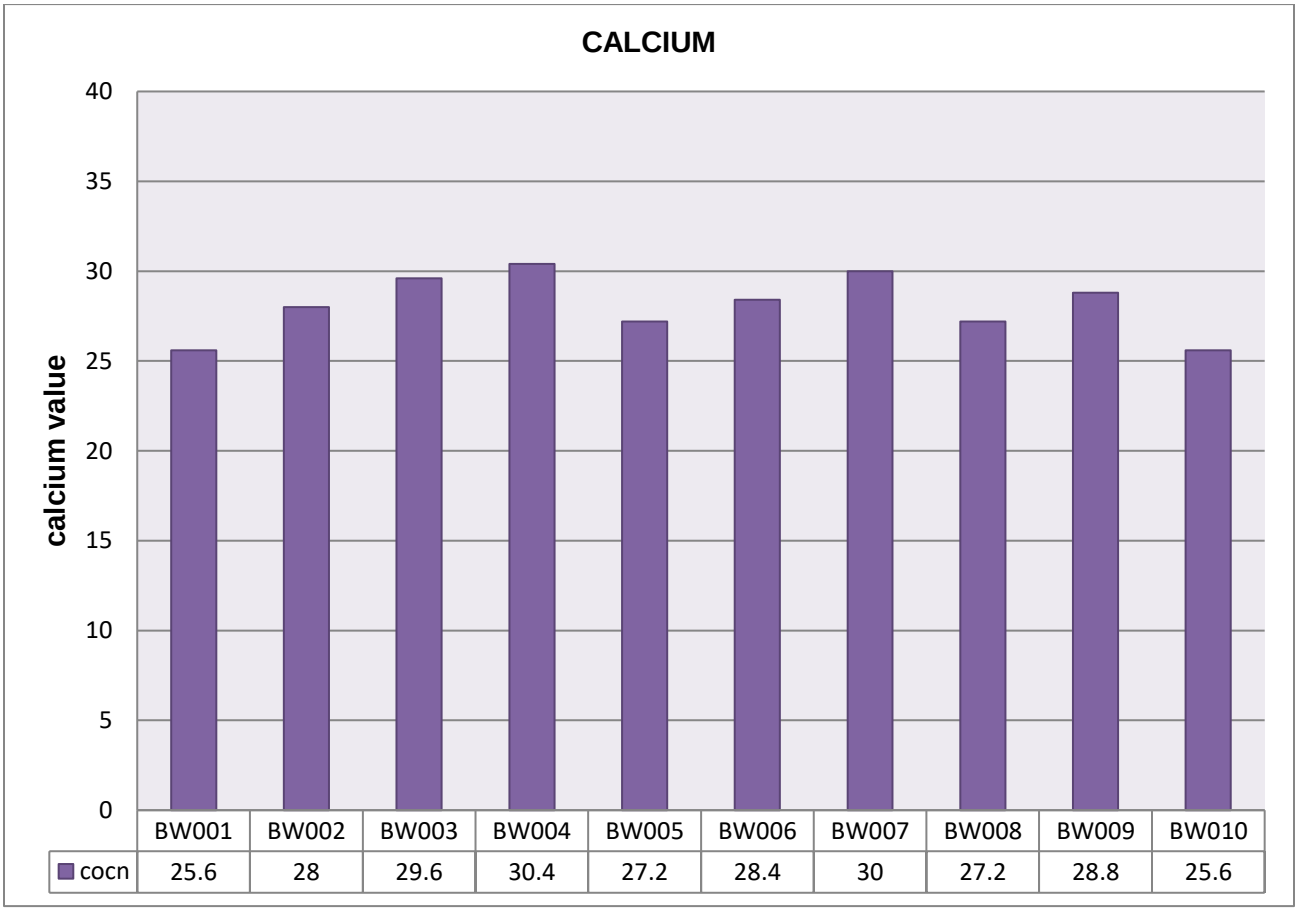


FIGURE4.5: Average calcium of the water samples from different areas.

4.6 ALKALINITY:

Alkalinity is a measure of the presence of constituents such as of bicarbonate, carbonate or hydroxide. Concentrations less than 100 ppm are desirable for domestic water supplies. The drinking water and all water should be a pH of 7 meaning that it's neutral. High alkalinity up to a certain range is good to have in our drinking water because it keeps the water safe for us to drink. In the present study Phenolphthalein Alkalinity was absent in all samples and Methyl Orange Alkalinity was ranged from 98 mg/l to 106.3 mg/l, this indicates the absence of Hydroxyl and Carbonate and presence of Bicarbonate. However, the prescribed limit for Total Alkalinity is 120 mg/l.

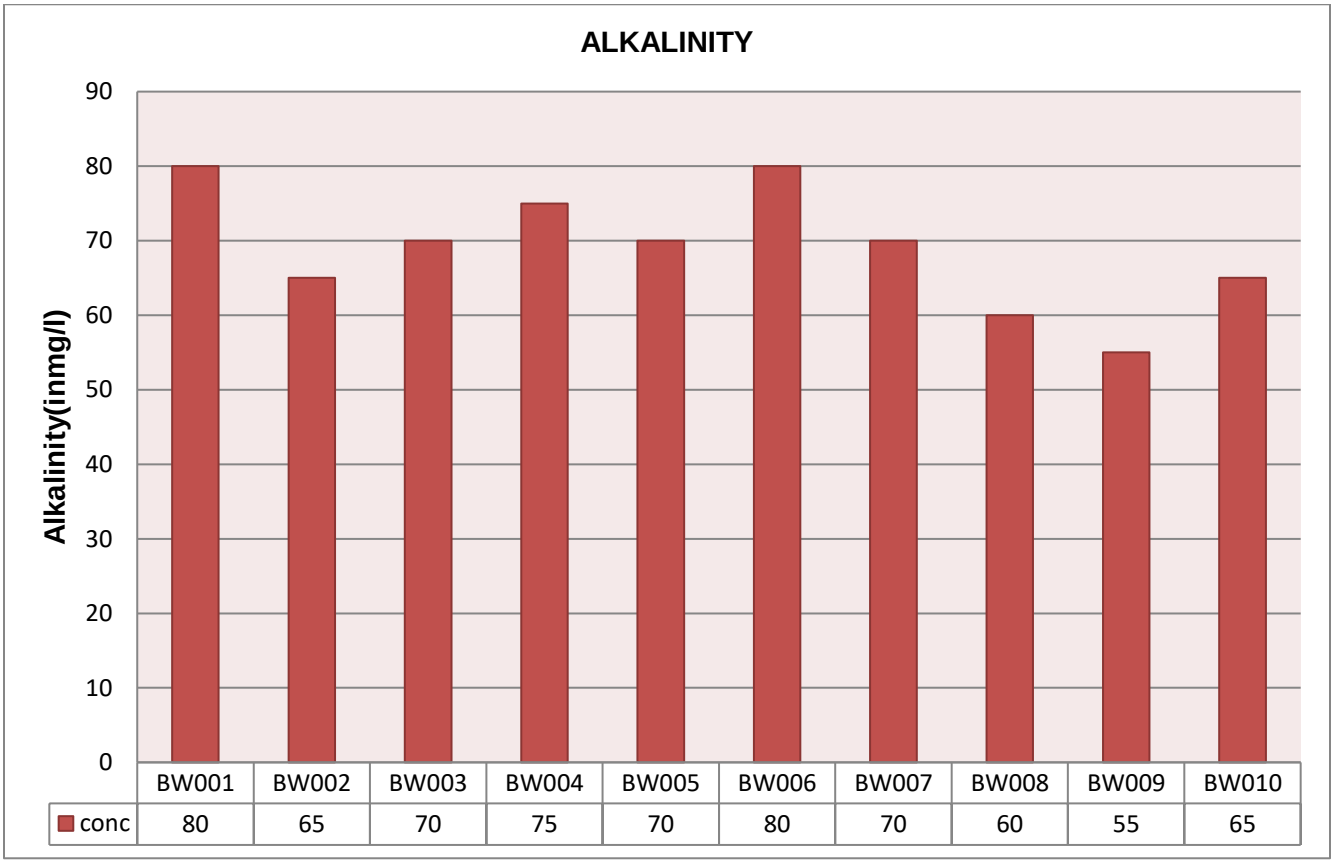


FIGURE 4.6: Average Alkalinity of the water samples from different areas.

4.7 CHLORIDE:

In the study area the chloride concentration ranges from 11.99 to 21.49 mg/l. Chloride which have been associated with pollution as an index are found below the permissible value set at 250 mg/l in most of the study area. Chloride in excess (> 250 mg/l) imparts a salty taste to water and people who are not accustomed to high Chlorides can be subjected to laxative effects.

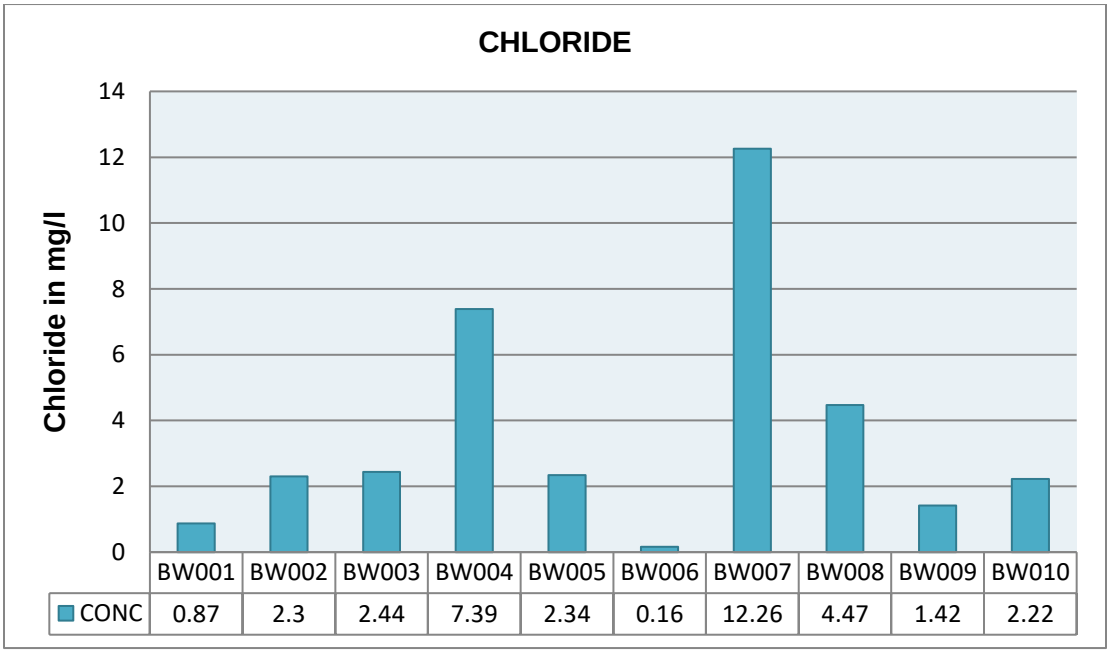


FIGURE4.7: Average chloride present in the samples from different areas.

4.8 RESIDUAL FREE CHLORINE:

The chlorination of water is one of the key treatments of the water before the supply of drinking water in potable water treatment process. The chlorination of water is carried out using chlorinating agents such as chlorine-containing substances for the oxidation and disinfection of potable water source. The limit of residual free chlorine in water should be 0.2 mg/L as per the drinking water guidelines passes by WHO and APHA. It was noticed that the samples has the chlorine concentration under the measured limits the samples range of chlorine is in between 0.09 to 0.15mg/L.The presence of residual free chlorine in drinking water indicates the likely absence of disease-causing organisms, it is used as one measure of the potability of drinking water , the study by the CDC SWS Project safewater@cdc.gov has tested the water quality and came to the conclusion.

4.9 NITRATE:

Nitrate levels in our water resources have increased in many areas of the world largely due to applications of inorganic fertilizer and animal manure in agricultural areas. People if unknowingly consuming nitrate in higher concentration through water may-induced methemoglobinemia or “Blue Baby Syndrome”, anemia, cardiovascular disease, lung disease, sepsis, according to the world health organization, the guideline value for nitrate in drinking water is 50 mg/liter. According to my study the concentration of nitrate was found under range it varies from 0.16mg/l to 12.26mg/l which is not harmful or toxic to human or any other living organism’s health. The nitrate concentration in water is adequate and not over the range in any of the sample from different location. Nitrate if present in overrange causes colorectal cancer, thyroid disease, and neural tube defects. Mary H Ward(2018) has studied that the nitrate has adversely affected the human health and causes deadly diseases. And also, that nitrate concentration in water also has been affected by the climatic factors. As my case study shows all the samples has nitrate concentration among the range.

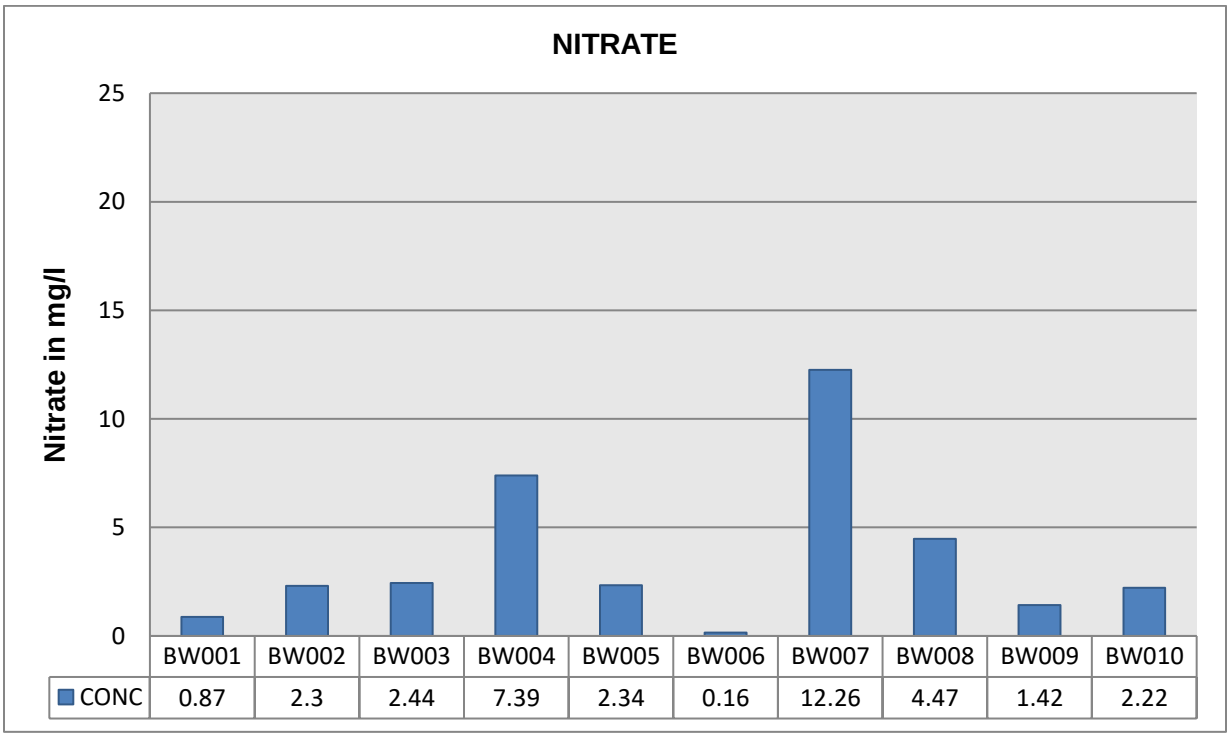


FIGURE4.9: Average nitrate present in the samples from different areas.

4.10 SULPHATE:

Sulphate is a constituent of gypsum and other minerals and is discharged into water streams due to leaching from these mineral deposits and from industrial wastes. The study by SMS Nadeem (2014) said variation is most probably due to the discharge of sulphate ions into water streams by leakage into the water supply pipelines from industrial wastes and domestic activities. The concentration of sulphate in all the water samples is in compliance with WHO and PSQCA limits. The concentration of sulphate in my samples was in the range of 34.39 to 44.84 mg/L. the limits settled by the WHO and APHA are 200mg/l for the sulphate concentration in water.

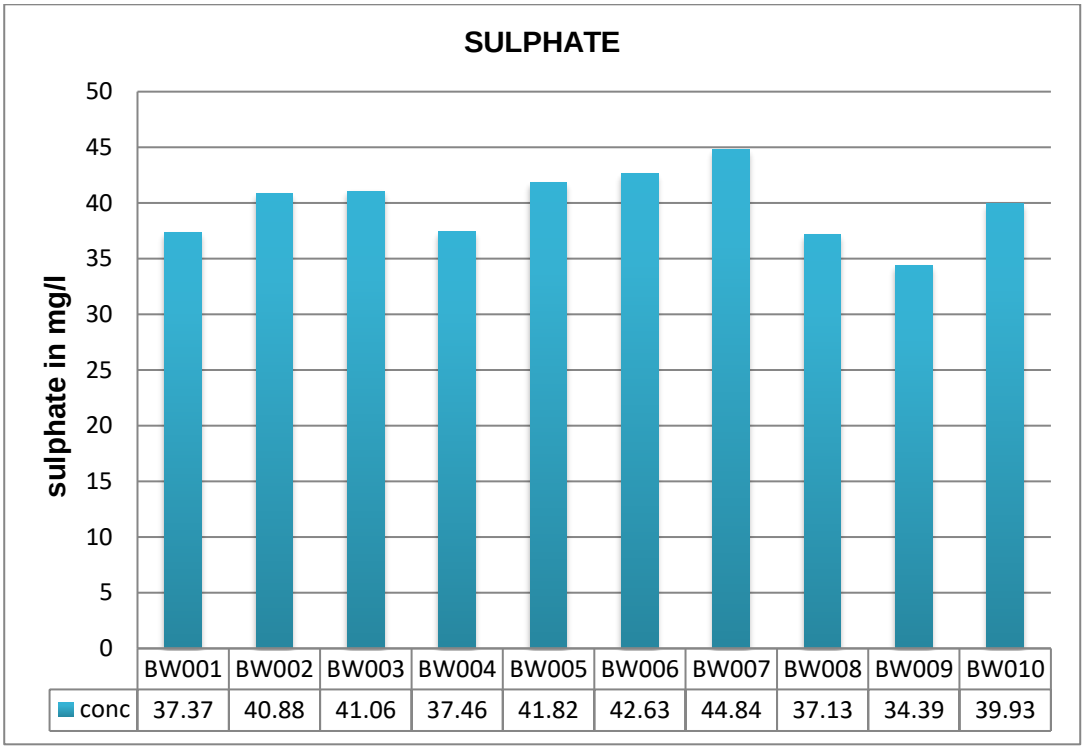


FIGURE 4.10: Average sulphate present in the samples from different areas.

4.11 STANDARD PLATE COUNT (SPC)

The test has been conducted to check the colony count of the mesophilic bacteria growing under aerobic condition on standard plate. The 0.1 to 1ml sample volume is taken from the collected samples in a nutrient agar and incubated aerobically for a fixed period at temperature 35°C for 24 to 48 hrs. the result was noted were so satisfactory the growth in all the serial dilutions made were below the 30 colonies in all the respective samples. The CFUs/mL (colony forming units) of each sample was too low. As per the standards made the colonies should be between 30 to 300 for the selection of plate for the counting and analysis. In our study the colonies were found TFTC (too few to count). As per the norms made the presence of any kind of bacteria or microbe in the drinking water is not good for health, so considering our study on the drinking water the result obtained was so impactful and satisfactory. Various studies have been made n analyzed in some results are positive in some negative results are shown. One of the studies says 700 standard plate count bacteria were found in the drinking water and untreated surface water. The number were too numerous water that contained high densities of bacteria known to be antagonistic to coliforms had low coliform isolation rates by M W Lechevallier et al. (1980). The chlorination of the water is proper that is also one main reason that our samples has shown least colonies forming units in the plate. And the force of water and pipe quality has also remained so good.

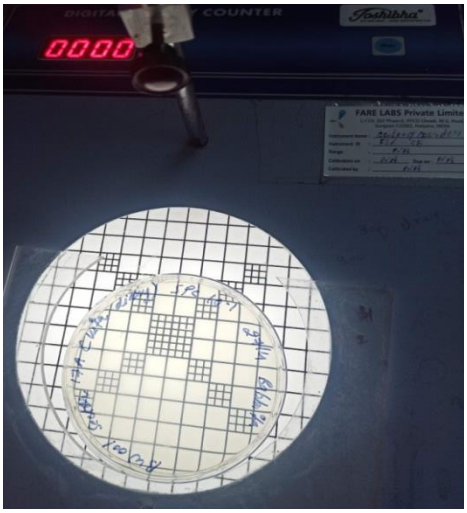


FIGURE 4.11a: Counting colonies

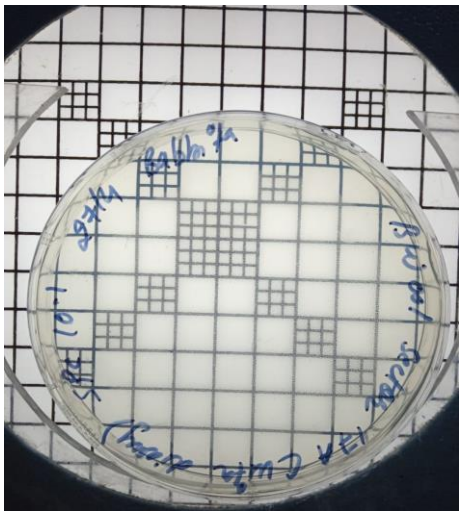
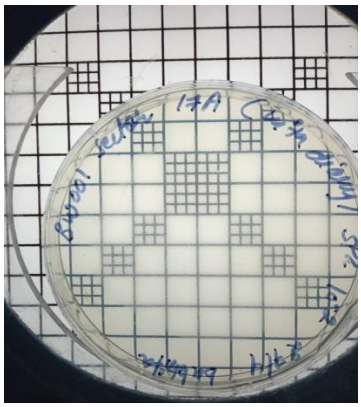


FIGURE 4.11b: No growth observed



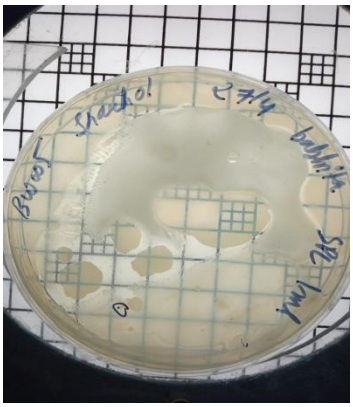


FIGURE 4.11c: No growth observed **FIGURE 4.11d: No growth observed**

4.12 MOST PROBABLE NUMBER (MPN):

4.12.1MULTI DILUTION TEST RESULT OF COLIFORM:

1. PRESUMPTIVE TEST: Most Probable Number (MPN) of water sample collected from the different locations.
Out of 5 double strength tubes, **0** tubes indicate positive presumptive test.
Out of 5 single strength (1ml) tubes, **0** tubes indicate positive presumptive test.
Out of 5 single strength (0.1 ml) tubes, **0** tubes indicate positive presumptive test. So, the combination of positive tubes is: **0-0-0**
Most Probable Number (MPN) is: **0 per 100 ml water**
No Acid and gas formation.

FIGURE4.12.1a: No Acid and Gas Formation (Presumptive test)

2.CONFIRMED TEST: Most Probable Number (MPN) of water sample collected from different locations.
Out of 5 double strength tubes, **0** tubes indicate positive confirmed test.
Out of 5 single strength (1ml) tubes, **0** positive confirmed tests.
Out of 5 single strength (0.1 ml) tubes, **0** tube indicate positive confirmed test.

So, the combination of positive tubes**: 0-0-0**
Most Probable Number (MPN) is: **0 per 100 ml water.**
No gas formation was shown.

3.COMPLETE TEST: Most Probable Number (MPN) of water sample collected from different location.
Out of 5 double strength tubes, **0** tubes indicate positive complete test.
Out of 5 single strength (1ml) tubes, **0** positive complete tests.
Out of 5 single strength (0.1 ml) tubes, **0** tubes indicate positive complete test.
So, the combination of positive tubes is: **0-0-0**
Most Probable Number (MPN) is: **0 per 100 ml water**
No gas production.

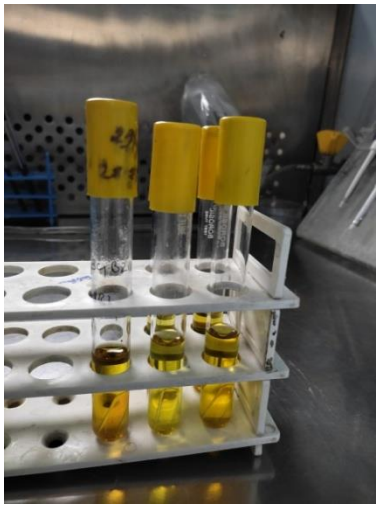


FIGURE4.12.2b: No Gas Production (complete test)

The test for the coliform came negative. All the samples nearby shown the same results. Every sample has the absence of coliform bacteria in the water, as per the data observed and collected it can be said that microbiological stage of the water is inactive and water is of good and quality. A great result came forward and the microbial growth was shown zero. It states that microbiological analysis of the water samples was so satisfactory. The 152 drinking water samples were collected from the valley and their microbiological analysis were carried out and it was noted that the total coliform and E. coli colonies are being developing ad showing the positive result for the test conducted T. Parsai(2007). It was noted that the microbiological property of the water at the location was critical for the human health. The drinking water should be contamination and microbial growth free as tested in our water samples. “Safe to use, safe to drink.”

CHAPTER: V
CONCLUSION

As the introduction began by noting that: Water is the core to sustain life, but the pollution is deteriorating the nature of the water. The safe drinking water has become dream to many. The water quality has gone down due to adverse effects of pollution, climate change and increasing population. The drinking water supply system are somehow managing the supply of safe and clean drinking water. After going through the recent studies and after completing my own study/work on the "Drinking Water Quality Analysis" the result observed by the various physicochemical and microbiological parameters were so satisfactory and all lies under the acceptable and permissible limits given by World Health Organization (WHO) and American Public Health Association (APHA).The supply drinking water samples that were collected from the different locations of SUKHRALI VILLAGE , GURGAON , HARYANA undergone the analysis for the different parameters. The parameters analysis includes $\boldsymbol{pH}$ TDS, Turbidity, Hardness, Calcium, Alkalinity, Chloride, RFC, Nitrate, Sulphate, and microbiological analysis such as SPC, MPN. The $\boldsymbol{pH}$ ranges from 7.30 to 7.63 that was under the acceptable and permissible range, TDS also ranges from 58mg/L to 144mg/L. Nitrate was also in the acceptable and permissible range 0.16mg/L to 12.26mg/L. Suphate test of each sample was conducted and noted that it ranges from 34.39mg/L to 44.84mg/L that was also with the acceptable and permissible limits. The microbiological analysis Standard Plate Count (SPC) was conducted and no growth was shown on the nutrient media containing petri plates as the water supplied should contain <1coliform bacteria/100ml that was what our analyses also noted. The Most Probable Number MPN test was also conducted and we got the same result no growth was noted. So, the microbial growth/contamination in the water is not at all noticed.

Keeping the future in consideration the water supply done by municipality corporation should undergo the proper treatment. The pipe quality should be timely checked and the chlorination of water should be timely (weekly) conducted. After the observation of my study, I concluded that the Municipal Corporation supplying drinking water from the respective tanks to the Sukhrali village are concerned with public health and safety and contribution their part to society with high determination. The drinking water supply should be strictly maintained in future also, because it directly effects the human health. During rainy and winter season the treatment of water should be given more attention with routine water parameter analysis, pipe material checking and proper chlorination.

With the Quality water check of drinking water, the other sources of water should also be routinely checked and proper water treatment should be done for saving our rivers, lakes, streams. The pollution and climate change (such as global warming and greenhouse effects) should be controlled to save water.

"**Save water save life"**

"Jal hi Jeevan Hai"

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