Designing of portable water filter and groundwater quality assessment

Dissertation submitted for the fulfillment of the degree of

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IN

BIOTECHNOLOGY AND BIOINFORMATICS

By

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DECLARATION BY THE SCHOLAR

We hereby declare that the work reported in the B-Tech thesis entitled **"Designing a portable water filter and groundwater quality assessment"**, submitted by **Sakshi Srivastava** and **Kumud Razdan** submitted at **Jaypee University of Information Technology, Waknaghat, Solan, H.P India,** is an authentic record our work carried out under the supervision of **Dr. Sudhir Kumar** and co-guides **Dr. Ashish Kumar and Dr. Ashok Kumar**.

We have not submitted this work elsewhere for any other degree or diploma.

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This work has not been submitted elsewhere for any other degree or diploma.

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LIST OF ACRONYMS & ABBREVIATIONS

BOD	Biological Oxygen Demand
CH	Calcium Hardness
COD	Chemical Oxygen Demand
E. C	Electrical Conductivity
EMB	Eosin Methylene Blue agar
DO	Dissolved Oxygen
F1	Filter 1
F2	Filter 2
F3	Filter 3
F4	Filter 4
F5	Filter 5
FAS	Ferrous Ammoniun Sulphate
IS	Indian Standard
MH	Magnesium Hardness
MPN	Most Probable Number
LAF	Laminar Air Flow
S1	Site 1
S2	Site 2
S3	Site 3
S4	Site 4
S5	Site 5
S6	Site 6

S7	Site 7
S8	Site 8
S9	Site 9
S10	Site 10
S11	Site 11
S12	Site 12
S13	Site 13
S14	Site 14
TDS	Total Dissolved Solid
TH	Total Hardness
USEPA	United States Environmental Protection Agency
WHO	World Health Organisation

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ABSTRACT

One of the sensitive issues faced by the people throughout the world is water and environment. Water has grabbed an essential role in our lives. Apart from drinking, water is needed for irrigation and other related human activities. It has become challenging in today's time to get clean water from the local sources. The contamination of the water could be physical, chemical or biological. These contaminants are responsible for diseases like typhoid, cholera, paratyphoid fever, dysentery, alzheimer's disease, cancer, cardiovascular disease, diabetes, reproductive health, jaundice and amoebiasis. This project basically emphasizes on providing clean and potable water to people in the town of Waknaghat, Solan (30.90 ° N, 77.09 ° E) in Himachal Pradesh. This could be possible by utilizing the locally available water resources. Our project aims at providing an insight of the assessment of the water quality in Waknaghat region and designing a sustainable, low cost and portable water filter for the purification of water to combat the problems arising due to various types of contamination.

The physical, chemical and the biological parameters of water determine its suitability for the potability. The main objective of this project is to provide aid to the rural settlements and find a suitable natural resource and provide them with a low-cost water filter which could be used under various conditions.

CHAPTER 1
INTRODUCTION

1.1 General

"Water is a basic constituent and the necessity of all living beings." Water is equally precious and vital for the existence of all living organisms. This fact cannot be denied that the growth of the nation somehow is directly related to the potable water supply capacity of the population. But to our dismay, this cherished resource has been increasingly threatened time and again as human population is growing and is demanding high water quality for their various domestic purposes and economic activities. Groundwater is best known for household and technical water supply and also, for the inundation of the crop fields. Last few years in the country have witnessed a formidable accrement in the claim for crude water due to rapid urbanization and velocious industrialization. There are billions of people all over the world with limited ingress to impregnable drinking water. The constancy of the water for various purposes depends on "physical and chemical properties" of the water. According to WHO report published, approximately 80% of the diseases in humans are caused by alterations in the parameters of the water quality.

India has witnessed a major decline in the freshwater resources and hence resulting in the acute shortage of water of acceptable quality as per the considerations of the Indian Standards. A report by the United States felicitated India among those worst countries which have a deteriorated quality of water. Increase in the population, industrial growth and various other human activities are hell bound on hampering the quality of water available for people to drink.

The water quality once deteriorated cannot be restored back to its original quality easily. Therefore, various methodologies are devised to protect the groundwater quality from the noted contaminants which include physical, chemical and biological contaminants as many rural dwellers in various parts of India. The people in the rural settlements still hold a theoretical view that considers the groundwater being the "safest" water among all the sources.

1.2 Need of the project

The acute shortage of potable water has not only immensely affected the people around the globe but also the environment.

1. Due to massive extraction of water from the ground for irrigation, agriculture, industrial and domestic requirements, the drinking water is scarcely available to masses during the critical months of summer in various parts of India.

2. Many urban and rural communities lack the access to regular safe drinking water and have been majorly reported of being prone to various water-borne diseases.

3. The major concern for the sustainable drinking water among masses is the increase in various chemical contaminants which needs an immediate measure to be holistically tackled.

In the present era, the demand for water has tremendously increased for the domestic and industrial needs to meet the rural requirements and the society's need for safe, clean and potable water. It is important to reinforce the preventive measures that are needed to ensure the unceasing of the water resources. Keeping the above criteria in mind, a shot has been made by us for the evaluation of the quality of water in the present study area. We in our project we carried out a detailed study in the surrounding region of the Waknaghat. It was carried out for the better understanding of the groundwater qualities. We carried out the bio-physico, chemical and biological analysis of the town's surface water parameters. This in turn enabled us to find the relationship between them and also know the trends of the water quality in the study area.

In our project, we collected samples of various sites located in the residential area and the JUIT campus. Also, the effects of the seasonal variations and proximity to the contaminant sources on the concentrations of various parameters were considered for water quality testing. The designing of a low cost, portable water filter system for the benefit of the people of rural area.

1.3 Objective of the project

1. To assess the water quality of various identified freshwater resources in the region of Waknaghat.
2. Designing of a low-cost, portable water filter.

1.4 Purpose of investigation

1. To provide an overview of the water quality of the selected study area.
2. To identify various contaminants hampering the quality of water, if any for the benefit of the rural settlements.
3. To design a low cost portable water filter that could help people living in the rural vicinities to help them enjoy the benefits of safe potable water.

1.5 Study area

The quality of the environment faces degradation because of the increased human activities and the industrial work. To chalk out the current scenario of the contamination due to various day-to-day activities in the study area, it has become quite mandatory to identify the possibly the different sources of contamination. Waknaghat, the chosen study area found in the district of Solan, Himachal Pradesh is situated at a longitude of **30.90˚N** and latitude of **77.09˚E**. The small hills present in the area comprise of the dominant rocks with suites of gneisses and quartize. Various rock formations are present in the study area. The quality check of the water in the area was done by collecting the samples from various sites present in the study area which include sites from Waknaghat87, Dumehar and Jaypee University campus.

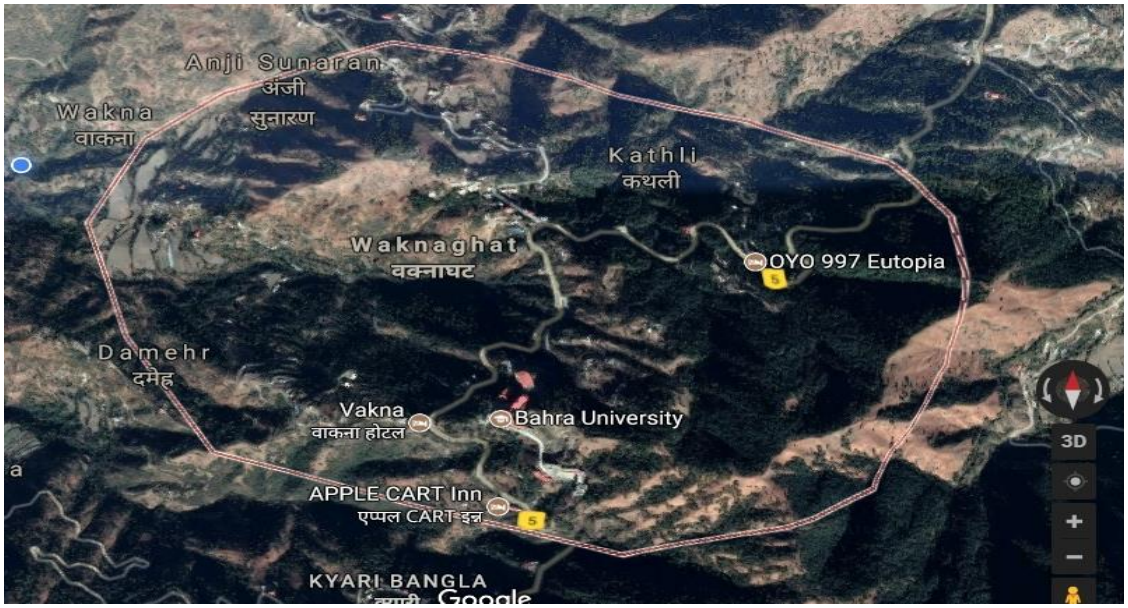

Fig 1: This figure represents the chosen study area for our project.

It is located on National Highway 22 with an elevation of 1544 m from the mean sea level. Waknaghat is situated at an altitude of 1700m. It shares a cool climate and experiences a moderate set of conditions. Temperature here in Waknaghat typically ranges from -4°C to 32°C over the course of a year. There are two main parameters, temperature and humidity, which collectively represent a token of the pleasantness and comforts of the climate to people around.

CHAPTER 2

REVIEW OF LITERATURE

The most profiteering natural system comprises of the water resources. Since the man has begun lumbering the Earth, a particular kind of nuisance has likely created its way. The physical appearance, odor, taste and ultimately the quality has rendered to the unsuitability of the water required for drinking. This is because of the some of the contaminants which come uninvited in the form of wastes. This requires an urgent dire need for the assessment of quality parameters of various resources of water.

This reviewed literature concerns to the ambition of the project, that is, the prominence of water quality as well as the cue needed for the augmentation of a portable water filter and its use in the discarding of major contaminants from water. This literature study also gives a brief account of the nature of different adsorbents and the various ways to remove the contamination. An expostulation on the current ideology about the water quality for rural people has also been incorporated. The most common threat that has become widespread is the contamination caused due to sewages. Also, it may result due to the abounding deterioration by other wastes or by human or animal excreta. The drinking water nowadays is so contaminated that its use in the preparation of certain things may even result in further cases of infection.

The main issue going round the globe is the availability of potable water. Increased rates of morbidity and mortality are the consequences of insubstantial water supply and wretched sanitation [1]. About 80% of the cases related to human disorders are waterborne as per the World Health Organization (WHO). It has been approximated that 1.1 billion people globally have route to unsafe water and the vast majority of diarrhea disease around the globe is attributed to unsafe water, sanitation and hygiene [2]. The main objective of our project is to provide an insight about how to provide safe drinking water to the people belonging to rural settlements in developing countries at very low to help them to sustain their lives. In order to accomplish the purpose, we have tested a number of water samples. Also, we have designed water filter which is capable enough to reduce various parametric contaminants to the specified drinking standards recommended by the Indian Standards and WHO. The design of the filter model was made in such a manner that ensured assembling of the filter materials easy and cheap which is enough to encourage us. The water filter model has undergone all the needed laboratory scale tests for monitoring to acquire accurate results on regular basis. We studied various methodological research papers on groundwater quality assessment for different cities. The reported work on the assessment of groundwater quality index is summarized below.

2.1 Study of physio-chemical parameters

Water has sceptically posed as an imperative component of our lives. The water resources are exploited in the form of utilization for the diversified purposes. The result of the increase in the activities based on the geogenic and the anthropogenic factors is the concern referencing the deterioration of the potable water quality. It is of utmost importance to find the suitability of water. Groundwater, being fragile must be carefully managed to maintain its purity within standard limit. The main factors resulting in the deterioration of the water quality include industrialization, over-use of the chem1ical fertilizers and pesticides. Parameters that can be tested include temperature, turbidity, pH, BOD, COD, electrical conductivity, calcium- magnesium hardness, most probable number, total count, etc. Drinking water quality specifications typically fall under two broad grades-Chemical and Physical. Where chemical criterion is responsible for causing chronic health risks through accumulation of various heavy metals; the physical criterion is responsible for affecting the taste and the aesthetics of the drinking water. Water is analyzed for various parameters such as pH, temperature, turbidity, hardness, alkalinity, acidity and other ions.

The determining key to distinguish between the hard and the soft water is to check the pH of the water. It can be studied as the magnitude of the acidity, alkalinity and the the concentration of the hydrogen ions in water [3]. Premature damage to metal piping is known to be caused by the extensive use of the acidic water. It is associated with the aesthetic problems such as metallic and the sour taste in the water. Turbidity can be defined as the degree to which water is able to lose its transparency due to the notable presence of suspended particles [4]. Alkaline water also causes problems associated with the scale deposits on metals. Alkalinity is the capacity of water to resist changes in pH which is responsible to make the water more acidic [5]. Higher alkalinity levels in surface water tend to neutralize the acid rain which further helps prevent the pH changes and prove to be harmful to aquatic life. The total hardness can be referred to as the measurement of the mineral content in a water sample. It is the determinant of multivalent cations' concentration present in water. Total hardness basically comprises of the two- calcium and the magnesium hardness. The hardness in water is the key factor influencing cardiovascular mortality [6]. It is not only the calcium and the magnesium affecting factors but also various other constituents which affect different health aspects. Electrical conductivity of water is another terminology which is being given much weightage as it reflects the capacity of water for wielding the electrical current, and is related to the concentration of salts dissolved in water directly [7].

In a previous study by Kumar et al., (2016) we conferred that it was idealized on the hydrochemistry of groundwater for determining its adequacy for drinking and agricultural purpose. In the study he gave an insight on how the groundwater samples were collected during the monsoon period. The agglomeration of the water samples was done from eleven stations of Jaipur city. The samples after collection were analyzed for physico-chemical parameters such as pH, EC, TDS, sodium, potassium, calcium, magnesium, chloride, sulphate, carbonate, bicarbonate, nitrate and fluoride. Exemplifations of the concentration of the chemical constituents in his work were done comparable to the WHO drinking water standards of 1983. The parameters like pH, sodium, potassium, carbonate, bicarbonate, chloride are found to be within the endorsed limits but calcium, magnesium and nitrates values were exceeding the limits. Sarla et.al (2012) study proclaimed that the tests for the groundwater quality parameters were carried out in the surrounding well of Jawahar nagar, Madhya Pradesh. In her research, the repository data was collected from the study area for consecutive two junctures that is the post monsoon and pre monsoon in December 2007 and pre monsoon in June 200. The observations threw light on how the groundwater is acidic in nature and very hard. For this purpose the Arc GIS software was used. The study disclosed that the concentrations of major constituents are well within sanctioned limits of IS-10500-1994, except in few cases which experience high levels of the total hardness and fluoride concentration. From the analysis it was concluded that the groundwater was polluted in the entire study area. Kashyap (2016) implemented his study on the water quality of Rewalsar Lake Himachal Pradesh of with respect to matriculation, spatial arrangements and the usage of the resources in the area. Results have shown that the water was slightly alkaline in nature with high dissolved solids and low visibility. Significantly high concentration of BOD and COD showed that the lake water was unfit for human and animal consumption. Maximum values of each parameter during baisakhi fair showed presence of organic and inorganic pollutants in lake water.

Rosu et. al (2011) performed their piece of work on the groundwater in the Tureni Village. The village is till devoid of a medium to have an access of the groundwater quality. The settlements in the rural area are still in the progress to deal with such kind of problem. The work presented a case study involving monitoring of weekly samples for 3 months for the quality of well water from the village. Dohare et al. (2014) made their way into carrying out the physio-chemical analysis in 32 locations in Delhi. The last decade has been a problem for the people in terms of ability to have safe water. 32 water samples were collected from various sites in Delhi. Different parameters for the water testing were analysed using the Indian Standards. It was done to check the suitability of water for drinking purposes.

2.2 Study on bacteriological parameter of drinking water

Bacteriological analysis enables us to determine the biological contamination in the water supply which embarks itself as an important aspect in the analysis of water contamination. These types of contaminations are often prone to cause water borne diseases which pose as a risk factor to human health as well as the environment. Samples were taken from various sites and MPN test was performed to mark the presence of coliform bacteria. This number counts for the probable estimate of the mean number of coliforms marking their presence in the sample. The precision of this test confides on number of tubes employed for analysis. This technique is popularly inexpensive and is comparatively easy to implement. Sulcheria et. al. (2011) made an effort by carrying out the tests to canvass the fecal coliforms using the MPN. The tests for these samples confirmed the existence of the bacterial cells with the values to be higher than the standards established by WHO. The values of pH ringed within the limits of WHO standards. Therefore, they wrapped up their findings by stating that the water quality in Mughalpura is not upto WHO standards.

Olawuyi et. al (2012) in his study exemplified that how the samples of water were collected from the water holes of different communities in the Ogun state. For analysing the bacterial counts, pour plate technique was used. The samples were analyzed bacteriologically using pour plate technique for total viable counts and tube fermentation technique for Most Probable Number (MPN) counts. Some of the samples showed satisfying the WHO requirements for the bacterial coliform count. Where few samples were just found to be suspicious of marking the bacterial presence, there were few others which did not satisfy the WHO requirements.

2.3 Study of various designs and features of slow sand filter

In his paper, Peter-Varbanets et. al (2010) gave a brief account about the gravity-driven membrane (GDM) sought to be a membrane filtration technology that requires gravity as the only input to remove biological contaminants like bacteria and viruses. It was demonstrated in the study that it is indeed based on the ultra-low pressure membrane filtration technique which comprises of no back washing as well. This type of filtration aids the formation of a biofilm. Resistance caused by the deposition of particles can also be tackled effectively by counteracting the prior. Weber–Shirk et. al (1997) exemplified that there are two major variants of the freightage in the slow sand filtration. These mechanisms present are the staining and the screening. In this methodology, the particulates which were larger than the size of the pores of the media were expunged physically. Ooman et.al (1978) suggested that slow sand filtration has the potential to achieve 99 and 99.9% of pathogenic removal of bacteria. Efficiency of removal is somewhat peculiar to sites as there were differences in the notings from several other authors. The bacterial removal variations are attributable to differences in source water quality conditions and filter operational conditions.

2.4 Study of various designs and features of glasswool filter

Millen et. al (2012) in their study showed how to construct a glasswool filter for concentrating water borne organisms. They emphasized the construct of the filter to be easy and known to have various potential advantages. The parts of the filter are inexpensive, and also, has the ability to collect a large number of samples at one go. The filters add advantage to themselves as highly portable and with minimal equipment. Lambertini et.al (2008) flourished through their study by describing about the filtration methods which are available to trap the diseases borne due to water. The commendable use of the filters has allowed to filter out the pathogenic concentrations which are either in large quantities or require a large or small number of samples. The filtration method involving the sodocalcic glasswool could be differentiated as a cost effective and easy to use application. This study helped them evaluate the performance of the glass wool filter.

CHAPTER 3
MATERIALS AND METHODS

Water samples were collected from the various sites located in the study area. The water quality analysis was carried out for the parameters such as pH, total alkalinity, electrical conductivity, dissolved oxygen, total dissolved solids, total hardness, calcium hardness, magnesium hardness, acidity, BOD, COD, etc by following the standard methods prescribed as per IS: 10500-1994 codes. Along with the physical and chemical parameters carried out for the sampling sites, microbiological parameters such as Most probable Number and total Plate Count were also conducted for the same following the standard methods prescribed as per IS: 1622-1984 code.

Table.3.1: List of sites of sample collection

SITE NUMBER	SAMPLES
S1	Hand pump, Waknaghat
S2	Hand pump, Waknaghat
S3	Tap water, Mandir Side, Dumehar
S4	Hand pump near Thank you Gate, Dumehar
S5	Sewage Treatment Plant (Inlet), Jaypee Campus
S6	Sewage Treatment Plant (Outlet), Jaypee Campus
S7	Sewage Treatment Plant (Outlet), Jaypee Campus
S8	Surface water (Pond), Garu Village
S9	Filtered sample through F1 filter
S10	Sewage Treatment Plant (Outlet), Jaypee Campus
S11	Filtered sample through F2 filter
S12	Filtered sample through F3 filter
S13	Filtered sample through F4 filter
S14	Filtered sample through F5 filter

3.1 Sampling

For sampling, extra preventive measures had to be taken in order to avoid water sample contamination and that of the container. We avoided the contamination of the bottle by touching the inside of the bottle or lid. The lid of the bottle was not put on ground while doing sampling. The bottle was thoroughly rinsed before sampling was done. The lid of the sampling bottle was opened and closed inside the sample source only.

3.2 Sampling collection procedure

1. A labeled sterile sample bottle was taken. It was made sure that the lid was tightly closed.

2. The sterile bottle was opened within the water sample so that there was no air contamination in the water sample.

3. Enough water was overflown through the sample bottle to prevent air contamination.

4. The lid of the sampling bottle was closed immediately.

3.3 Experimental analysis

Experimental analysis was carried out of the water samples to check their quality. The parameters that were conducted were -

1. Physical Parameters
2. Chemical Parameters
3. Microbiological Parameters

The experiments were carried out at the Environmental Biotechnology Laboratory of Department of Biotechnology and Department of Civil Engineering. The basic purpose of conducting this work is to compare the results for various parameters of the given water sample with the IS:10500 drinking water standard and as well as the required steps can also be taken for purification of water and bring them in use for others purposes.

3.3.1 Physical parameters

Materials

Beakers, burette, conical flask, water sample , distilled water, thermometer, pH meter, electrical conductivity meter, nephlometer, BOD sensor, BOD bottles, 0.25N potassium dichromtate, sulphuric acid (1gm of silver sulphate in 75ml of sulphuric acid), ferroin indicator, FAS solution

3.3.1.1 Temperature

The rate of biochemical degradation affecting organism growth, reproduction and immunity is immensely affected by the temperature of the water. Temperature changes that take place drastically can be fatal to human health.

Procedure:-

1. The temperature values of given water samples were measured directly by using a thermometer.
2. The thermometer was pre-calibrated by washing the thermometer with distilled water.
3. The thermometer was placed gently in the beaker containing the water samples and the values were noted down.

3.3.1.2 pH

pH is most important aspect which aids in the determination of the corrosive nature of water. The lower is the value of the pH, the corrosive nature of the water gets higher. pH has positively correlated with electrical conductance and total alkalinity. There are various factors that bring about changes in the pH of water.

Procedure:-

1. The pH value of a given water sample was measured directly by using a pH meter.
2. The pH meter was calibration using the standard buffer solution and error was noted down.pH of distilled was measured.

3. Then sample was taken in a clean beaker and its pH was noted down.

3.3.1.3 Electrical conductivity

Conductivity is one feature which shows significant correlation with as many as ten parameters such as temperature, pH value, alkalinity, total hardness, calcium, total solids, total dissolved solids, chemical oxygen demand, chloride and iron concentration of water. It is a measure of the resistance which is offered by the water between two platinized electrodes and can be measured with the help of EC meter. The instrument (EC meter) is standardized with known values of conductance which are keenly observed with standard KCl solution.

Procedure:

1. A small beaker was used to measure the electrical conductivity.
2. Distilled water was taken in beaker and electrical conductivity meter rod was dipped in the distilled water and reading was noted down.
3. In another beaker water sample was taken and the reading was noted down.

3.3.1.4 Turbidity

Finely divided suspended particles of clay, silt, sand or some organic materials are the cause of turbidity. It can be termed as a measured value of the opaque particulates available in the samples of water. The apparatus used for measuring turbidity of water sample is 'Nephelometer' which uses the principle of scattering of light.

Procedure:-

1. A small beaker was used for testing the sample inside the Nephelometer.
2. It was first properly cleaned and filled with distilled water.The beaker containing distilled water was kept inside the instrument and the value was adjusted to zero.
3. The sample of water was then replaced in the beaker with the water samples and test was carried out.

4. The value of turbidity was displayed on the monitor and it was taken down.

3.3.1.5 Dissolved oxygen

DO in sample is measured by the DO sensor.This procedure needs special BOD bottles which seal the inside environment from atmospheric oxygen.

Procedure:

1. Water sample was diluted with distilled water accordingly to the sample.
2. BOD bottles were filled with the diluted water sample and with the help of DO sensor dissolved oxygen value was noted down.

3.3.1.6 Biological oxygen demand

BOD is calculated in mg/l. BOD is defined as the amount of dissolved oxygen required for the biochemical decomposition of organic compounds and also, the oxidation of certain inorganic materials (e.g. iron, sulfites). In short words, it can be defined as measure of organic material contamination in water. The typically the test for BOD is conducted for a period of five days.

Procedure:

1. Water sample was diluted with distilled water accordingly to the sample.
2. BOD bottles were filled with the diluted water sample and dissolved oxygen value was noted down.
3. The BOD bottles were kept in an incubator for five days at 20°C.
4. After five days dissolve oxygen value was taken by Dissolved Oxygen sensor.

3.3.1.7 Chemical oxygen demand

COD is another measure of organic material contamination in water specified in mg/l. COD is referred as the amount of dissolved oxygen required to cause chemical oxidation of the organic material in water. It is a measure of the contamination of the organic material. Both BOD and COD are key indicators of the environmental health of a surface water supply. They are commonly used in waste water treatment but rarely in general water treatment.

Procedure:

1. Dilute 2 ml sample in 100 ml of distilled water.
2. Add 2.5 ml of diluted sample to a tube.
3. Add 1.5 ml of potassium dichromate to the sample.
4. Add 3.5 ml of sulphuric acid to the sample.
5. Heat the tube for 2 hours at 150ºC.
6. Cool the sample and pour the sample in conical flask.
7. Titrate with FAS solution.
8. Note down the values of titrate used.

Calculations: $\mathbf{(A - B) \times C \times 8 \times 1000 \div ml\ of\ sample\ taken}$

where, A = ml FAS used for blank

B = ml of FAS used for sample

C = Normality of FAS solution used.

3.3.2 Chemical parameters

Materials Required: Burette, burette stand, conical flask, funnel, water sample, distilled water, methyl orange indicator, phenolphthalein Indicator, 0.02N sulphuric acid, 0.02 sodium hydroxide solution, erichrome black t Indicator, 0.02 EDTA solution, ammonia buffer, ammonium purpeurate indicator, 1N sodium hydroxide solution.

3.3.2.1 Alkalinity

Alkalinity comprises primarily of the carbonates and bicarbonates. Alkalinity acts as a stabilizer for its pH. Alkalinity, pH and hardness are the main factors which affect the toxicity of many substances in the water. It is the determinant of a simple sulphuric acid titration in presence of phenolphthalein and methyl orange indicators.

Carbonate**:** Whenever the pH touches 8.3, the presence of carbonates is indicated. Below pH 8.3, the carbonates are converted into equivalent amount of bicarbonates.
Bicarbonate**:** It is also measured by titration with standardized sulphuric acid using methyl orange as indicator. Methyl orange has the ability to turn color yellow below pH of 4.0. At this pH, decomposition of the carbonic acid takes place to give carbon dioxide and water as products.

Procedure:

1. The burette was rinsed and filled with sulphuric acid and the mark was adjusted to zero.
2. 25 ml of the water sample was added in the conical flask 4-5 drops of phenolphthalein indicator were added.
3. If no colour is present then phenolphthalein alkalinity is absent.
4. If the pink color persists, titration is carried out till pink color disappears and the titrated value reading is noted down.

5. Few drops of methyl orange were added in it till a yellow color persisted.
6. Titration was carried out against 0.02N sulphuric acid till the yellow color turned orange.
7. The burette readings were measured.

Calculations: $\mathbf{V_1 \times N \times equivalent\ weight\ of\ CaCO_3 \times 1000 \div V_2}$

where, V_1= Volume of sulphuric acid used

V_2= Volume of sample used

N= Normality of sulphuric acid used

3.3.2.2 Acidity

Sum of the all the acids which can be titrated that are present in the water comprises of the acidity of water. Various strong and weak mineral acids contribute to the acidity of water.

Procedure

1. The burette was rinsed and filled with sodium hydroxide solution and initial mark was adjusted to zero.
2. 25 ml of the water sample was added in the conical flask.4-5 drops of phenolphthalein indicator were added.
3. If no color persists, titration is carried out till pink color appears and the burette reading is noted down.
4. Few drops of methyl orange were added in it to see if orangish color persists.
5. Titration was carried out against 0.02N sulphuric acid till the color changed to yellow.
6. The burette reading was noted down.

Calculations: $\boldsymbol{V_1 \times N \times equivalent\ weight\ of\ CaCO_3 \times 1000 \div V_2}$

where, V_1 = Volume of NaOH used

V_2 = Volume of Sample used

N = Normality of NaOH used

3.3.2.3 Total hardness

Hardness of water is that characteristic which prevents the formation of sufficient foam. The hardness is usually caused by the presence of calcium and magnesium present in water and both of these are abundant in the water available as the groundwater. It is the presence of the divalent metallic ions principally of Ca^{2+} and Mg^{2+} that result in the values for total hardness.

Procedure

1. The burette was rinsed and filled with EDTA solution and the initial mark was adjusted to zero.
2. 25 ml of the water sample was added in the conical flask.
3. 4-5 drops of Erichrome black T indicator were added and 1 ml of ammonia buffer was added.
4. Titration was carried out till colour changed from wine red to dark blue.
5. The burette reading was noted down.

Calculations: $\boldsymbol{V_1 \times N \times equivalent\ weight\ of\ CaCO_3 \times 1000 \div V_2}$

where, V_1 = Volume of EDTA used

V_2 = Volume of Sample used

N = Normality of EDTA used

3.3.2.4 Calcium hardness

It refers to the hardness of water due to the presence of calcium ions which are a major component of the total hardness.

Procedure:

1. The burette was rinsed and filled with EDTA solution and adjusted it to zero.
2. 25 ml of the water sample was added in the conical flask.
3. Pinch of ammonium perpurate indicator was added and 2ml of 1N sodium hydroxide solution was added.
4. Titration was carried out till colour changed from pink to purple.
5. The burette reading was noted down.

Calculations: $\boldsymbol{V_1 \times N \times equivalent\ weight\ of\ CaCO_3 \times 1000 \div V_2}$

where, V_1 = Volume of EDTA used

V_2 = Volume of sample used

N = Normality of EDTA used

3.3.2.5 Magnesium hardness

Magnesium is the derived part from the silicates. Magnesium hardness is termed as the hardness which is responsible due to the presence of magnesium ions. It can be defined as the difference of the total hardness and calcium hardness.

Table 3.2: Different analytical water quality parameters with their analytical technique and guideline values as per WHO and Indian Standard.

S. No.	Parameter	Technique used	WHO standard	Indian Standards	EPA guidelines
01	Temperature	Thermometer	-	-	-
02	Color	Visual / color kit	-	5 Hazen units	-
03	Odour	Physiological sense	Acceptable	Acceptable	-
04	Electrical conductivity	Conductivity meter / Water analysis kit	-	-	2500 us/cm
05	pH	pH meter	6.5 – 9.5	6.5 – 9.5	6.5 – 9.5
06	Dissolved oxygen	Redox titration	-	-	-
07	Total Hardness	Complexometric titration	200 ppm	300 ppm	< 200 ppm
08	Alkalinity	Acid – Base titration	-	200 ppm	-
09	Acidity	Acid – Base titration	-	-	-
11	Bi carbonate	Titration	-	-	-
12	Biochemical Oxygen Demand (B.O.D.)	Incubation followed by titration	6	30	5
13	Carbonate	Titration	-	-	-
14	Chemical Oxygen Demand (C.O.D.)	C.O.D. digester	10	-	40
15	Chloride	Argentometric titration	250 ppm	250 ppm	250 ppm
16	Magnesium	Complexometric titration	150 ppm	30 ppm	-

Ref.:- [WHO, USEPA, Indian Standard, National Primary Drinking Water Regulations, Drinking Water Contaminants US EPA]

Table 3.3: Different analytical water quality parameters used for testing of quality of water and their source of occurrences and potential health effects with USEPA guidelines.

S.No.	Parameter	Source of occurrence	Potential health effect
01	Turbidity	Soil runoff	Higher level of turbidity are associated with disease causing bacteria's.
02	Color	Due to presence of dissolved salts	-
03	Odor	Due to biological degradation.	Bad odor unpleasant
04	Electrical conductivity	Due to different dissolved solids.	Conductivity due to ionizable ions. High conductivity increases corrosive nature of water.
05	pH	pH is changed due to different dissolved gases and solids.	Affects mucous membrane; bitter taste; corrosion
06	Dissolved oxygen	Presence due to dissolved oxygen.	D. O. corrode water lines, boilers and heat exchangers, at low level marine animals cannot survive.
07	Total Hardness	Presence of calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions in a water supply. It is expressed. Hardness minerals exist to some degree in every water supply.	Poor lathering with soap; deterioration of the quality of clothes; scale forming
08	Total Alkalinity	Due to dissolved gases (CO_2)	Embrittlement of boiler steel. Boiled rice turns yellowish
09	TDS	Presence all dissolved salts	Undesirable taste; gastro-intestinal irritation; corrosion or incrustation
10	Calcium	Precipitate soaps, anionic	Interference in dyeing, textile.

3.3.3 Microbial parameter

Various methods of examining bacteriological parameters of water are set forth in the book "Standard Methods the Examination of Water and Wastewater." The Environment Protection Agency (EPA) developed a manual to serve this purpose that was titled "Microbiological Methods for Monitoring the Environment-water and wastewater." i.e. IS: 1662-1981(reaffirmed 1996). It is of utmost importance that strict attention is to be given to following details during the collection of the water samples for bacteriological analysis.

1. Sterile bottles must be used for the collection of the samples.
2. The sample must clearly indicate and represent the supply that had been used to collect the sample.
3. During and after sampling, contamination of the sample must be avoided.
4. The sample should be stored at a temperature between 0 and 10°C in case of any delay in the examination of the sample.

The routine bacteriological procedures consisted of-

1. A standard plate counts to determine the number of bacteria present.
2. MPN method to reveal the presence of coliform bacteria.
3. E coli test to check the presence of E.coli in water sample

3.3.3.1 Total count

Colony counts were performed after plating aliquots of the water sample. The interpretations of the results of the standard plate count were that, water of good quality is expected to give a low count, less than 100 per millimeter. Plate Count method is useful in determining the efficiency of operations for removing or destroying organisms. A count can be made before and after specific treatment. The results of the protocol indicate the extent to which the microbial population has been reduced.

Material Required

Nutrient broth, nutrient agar, petri plates, test tubes, spreader, burner, LAF chamber, autoclave, water sample, distilled water, cotton, conical flask, parafilm.

Procedure

1. 9.9 ml of distilled water was taken in test tubes.
2. Media was prepared by adding nutrient broth and agar to distilled water.
3. Media and dilution tubes were then autoclaved.
4. Pouring of the media was done in LAF chambers.
5. Solidified petri plates were kept in incubator for 24 hour for contamination check.
6. Dilutions were made by adding 0.1 ml of sample to the dilution tubes.
7. The sample was spread on the petri plates.
8. After 24 hours of incubation at 37°C, bacterial colonies were counted.

3.3.3.2 Most probable number

Several selective and differential media greatly accelerate the process of examining water for coliform organisms. The standard microbiological technique involves two successive steps -

1. Presumptive Test
2. Confirmed Test

Material Required

Test tubes, burner, LAF chamber, autoclave, water sample, distilled water, durham tubes, cotton, MacConkey broth, micropipettes, micropipette tips.

Procedure

1. The media was prepared needed for the test to be performed by adding 6.9g of MacConkey Broth in 100 ml of water for the double strength medium and in 200ml of water for single strength medium.
2. 10 ml of the double strength media was poured in each of the 5 double strength tubes with Durham tubes in it.
3. 10 ml of the single strength media was poured in 10 single strength tubes with Durham tubes in it.
4. The tubes were then autoclaved.
5. The tubes were then incubated for 24 hours.

6. In the LAF 10ml, 1ml, 0.1ml of the sample was poured in 10ml, 1ml and 0.1ml tubes, respectively.
7. The tubes were then incubated for 24 hours at 37°C.
8. The total coliform counts were then calculated using MPN charts.

3.3.3.3 *E. coli* test: confirmatory test

Material required

EMB agar, petri plates, test tubes, spreader, burner, LAF chamber, autoclave, water sample

Procedure

1. EMB agar was prepared and autoclaved.
2. The agar was then poured into petri plates in a laminar air flow and then plates were incubated at 37°C to check the contamination.
3. The sample was spreaded over the agar plates and kept in incubator for 24 hour.
4. The bacterial colonies were then counted.

3.4 Slow sand filter

One of the economical ways of purifying the raw water is the use of the slow sand filter. The construction of the first slow sand filter paved way for the fruitful realization that these filters can effectively remove bacteria from the water. Slow sand filters find a vast set of possibilities in the removal of parasites from the untreated water. This filter can be considered as one of the remarkable and efficient ways of treatment of water in the rural settlements. Filtration rate also has an important part to play in effectiveness of the treated water. By increasing the hydraulic rate, filtration rate can also be increased to a level where this change can definitely aid in the decrease of the filtration quality of the filtered water.

3.4.1 Work mechanism

The mechanism followed by the filter is simple sieve method. The larger unwanted particles compared to the sand pore particles get trapped and the filtered water flows through. This results in the formation of the filter cake layer. The efficiency of the filter increases as the finer particles keep trapping in the filter. The filtration rate decreases because the efficiency of the removal of unwanted particles increases.

3.4.2 Materials used for water filter

Basic and readily available components are required for the construction of the slow sand filter. In this project, we designed the sand-gravel filter and glasswool cotton filter. The components proposed for the making include-

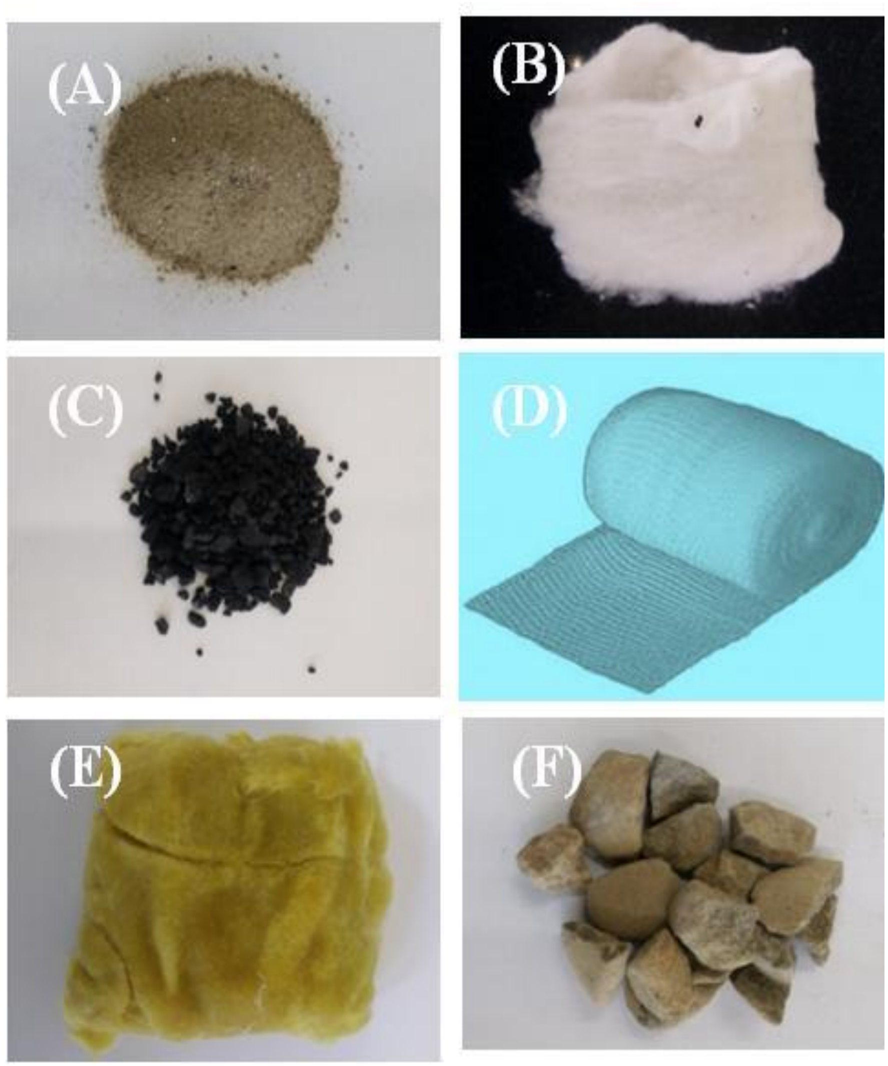

Fig 3: (A) sand (B) cotton (C) activated charcoal (D) cotton bandage (E) glasswool (F) gravel

3.4.3 Assembly of the slow sand filter

1. Glasswool and gravel was washed with tap water first.
2. Then they were washed with distilled water for 3-4 times and kept in hot oven for drying.
3. Glasswool, sand and gravel was autoclaved.

4. In LAF all the materials required were kept such as bottles, glasswool, sand and gravel, bottle etc and UV was kept on for 20 minutes.
5. After the sterilization of the materials the packaging of the water filter was done.
6. At the bottom of the bottle 4cm of glasswool then 4cm of gravel bed then again 2.5 cm of glasswool layer then 4cm of sand and at last 4 cm of gravel.

3.4.4 Assembly of glasswool and cotton filter

1. Glasswool was washed with tap water first.
2. Then it was washed with distilled water for 3-4 times and kept in hot oven for drying.
3. Activated charcoal, cotton was autoclaved.
4. In LAF all the materials required were kept such as bottles, glasswool, cotton, bandage, activated charcoal, etc and UV was kept on for 20 minutes.
5. After the sterilization of the materials the packaging of the water filter was done.
6. 4 types of water filter were designed.

Type 1 filter

1. It consists of glasswool, cotton, activated charcoal and bandage was used to cover the glasswool and cotton so they remain fixed in their positions.
2. Bottom of the bottle was cut with the help of paper cutter of about 0.5 cm so that materials can be fitted inside the bottle.
3. Sufficient amount of glasswool was taken and was wrapped in cotton bandage and was fitted in the bottle of about 2 cm of the bottle.
4. 1 cm of activated charcoal was added on the top of the glasswool.
5. Above it cotton was placed of about 4 cm which was also covered with bandage.
6. Again 1 cm of activated charcoal was added.
7. And at last 2 cm of glasswool was added on the top of activated charcoal

Type 2 filter

1. It also consists of glasswool, cotton, activated charcoal and bandage.
2. Bottom of the bottle was cut with the help of paper cutter of about 0.5 cm so that materials can be fitted inside the bottle.

3. Sufficient amount of glasswool was taken and was wrapped in cotton bandage and was fitted in the bottle of about 2.5 cm of the bottle.
4. 0.5cm of activated charcoal was added on the top of the glasswool.
5. Above it cotton was placed of about 4 cm which was also covered with bandage.
6. Again 0.5 cm of activated charcoal was added.
7. And at last 2.5 cm of glasswool was added on the top of activated charcoal.

Type 3 filter

1. It consists of glasswool and bandage.
2. Bottom of the bottle was cut with the help of paper cutter of about 0.5 cm so that materials can be fitted inside the bottle.
3. Sufficient amount of glasswool was taken and was wrapped in cotton bandage and was fitted in the bottle of about 3 cm of the bottle.
4. Above it cotton was placed of about 4 cm which was also covered with bandage.
5. And at last 3 cm of glasswool was added on the top.

Type 4 filter

1. It also consists of glasswool and bandage.
2. Bottom of the bottle was cut with the help of paper cutter of about 0.5 cm so that materials can be fitted inside the bottle.
3. Sufficient amount of glasswool was taken and was wrapped in cotton bandage and was fitted in the bottle of about 4 cm of the bottle.
4. Above it cotton was placed of about 2 cm which was also covered with bandage.
5. And at last 4 cm of glasswool was added on the top

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Designing of water filters

4.1.1 Type 1 filter

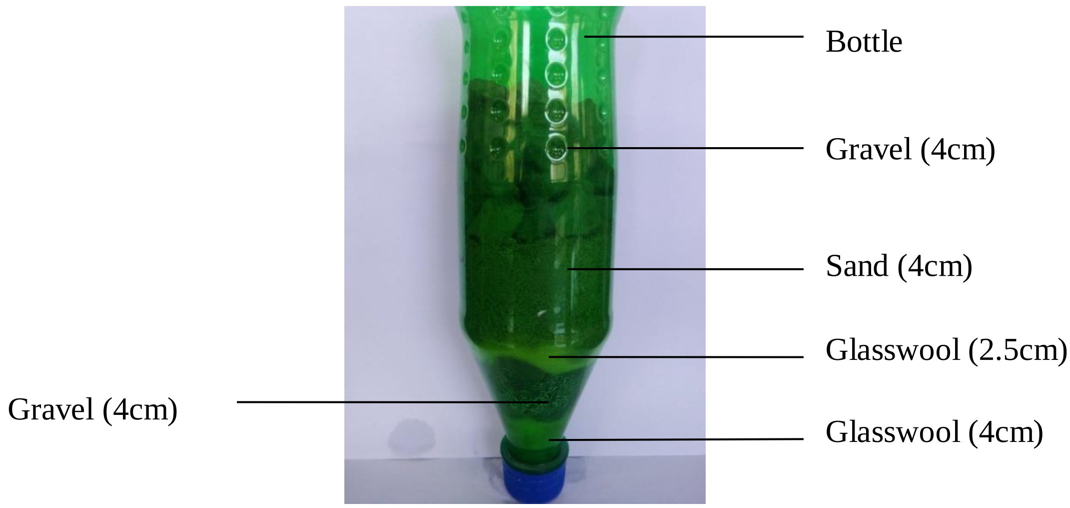

Fig 4.1 Filter 1

4.1.2 Type 2 filter

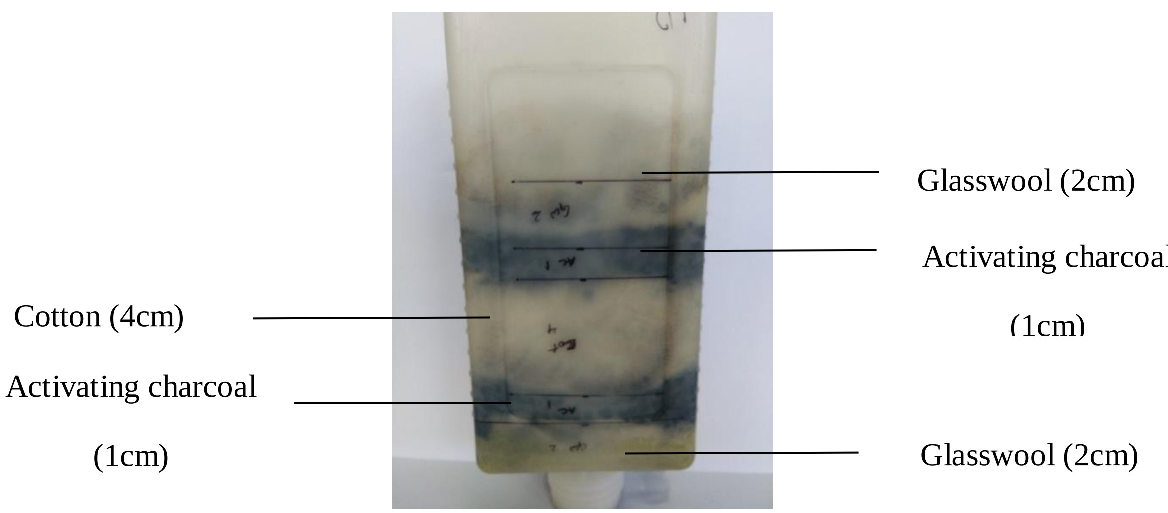

Fig 4.2 Filter 2

4.1.3 Type 3 filter

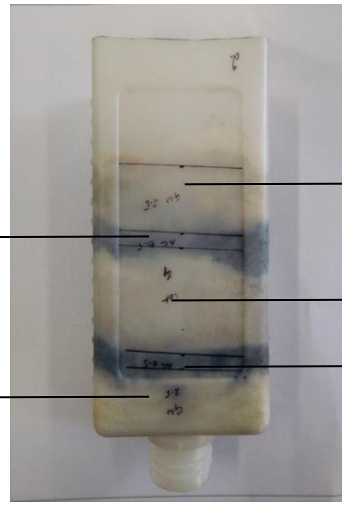

Fig 4.3 Filter 3

4.1.4 Type 4 filter

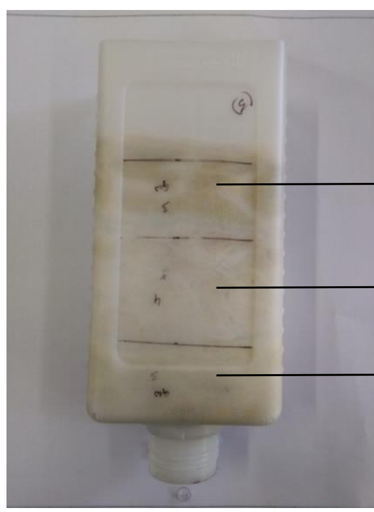

Fig 4.4 Filter 4

4.1.5 Type 5 filter

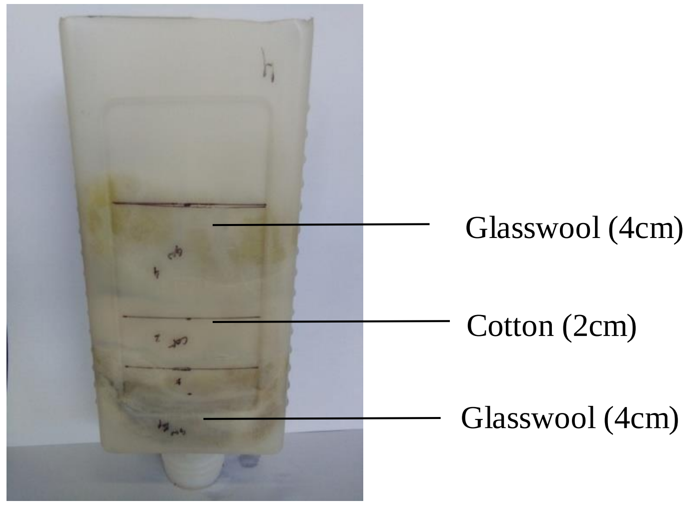

Fig 4.5 Filter 5

The results obtained for different parameters from the timely site samplings and subsequent tests are expressed through the following table. The values for the investigated physico-chemical and biological quality parameters of water samples together with the drinking specifications stated by the Indian Standards are presented in table. Seemingly, most parameters exhibited relative changes, indicating that the physicochemical composition of the water is affected by various processes, including water-rock interactions and anthropogenic activities.

Table 4.1 Physical Parameters of the water samples

Samples	pH	Temp (°C)	E.C (µS)	Turbidity (NTU)	TDS (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)
S1	6.64	24.0	207.0	0.0	132	-	-	-
S2	6.63	25.0	42.00	0.0	26.9	-	-	-
S3	6.67	22.7	331.0	0.0	170	-	-	-
S4	6.64	20.0	198.0	0.0	127	-	-	-
S5	7.70	21.0	1144	71	732	7.36	468	480.0
S6	6.80	21.0	667.0	7.0	427	5.02	113	384.0
S7	7.28	19.0	1034.0	18	662	8.74	53.0	
S8	6.74	20.0	225.0	0.0	144	-	-	-
S9	7.79	21.0	1149	2.0	735	6.72	235	1135
S10	8.00	20.0	993.0	6.0	635	6.83	40.0	456.0
S11	7.06	20.0	656.0	4.0	420	6.78	55.0	832.0
S12	7.65	20.0	326.0	4.0	209	6.77	79.0	1248
S13	7.32	20.0	313.0	4.0	200	6.73	238	1280
S14	7.72	20.0	563.0	4.0	360	6.70	64.0	1280

Table 4.2 Chemical parameters of water samples

Samples	Alkalinity (mg/l)	Acidity (mg/l)	T.H (mg/l)	C.H (mg/l)	M.H (mg/l)
S1	207.6	16.00	272.6	260.0	12.63
S2	211.0	08.00	280.6	272.0	8.68
S3	210.0	18.67	282.6	272.0	10.67
S4	206.0	16.66	272.0	263.0	09.00
S5	840.0	120.0	354.6	328.0	26.66
S6	485.3	82.67	340.6	285.3	55.33
S7	333.2	26.80	338.8	327.0	11.80
S8	46.80	12.00	90.80	50.80	40.80
S9	399.0	00.00	344.0	332.0	12.00
S10	313.2	166.8	193.2	120.0	73.20
S11	97.20	124.0	88.00	69.20	18.80
S12	214.8	304.0	122.8	42.80	80.00
S13	238.8	180.0	00.00	00.00	00.00
S14	170.8	96.00	122.8	40.00	82.80

Table 4.3 Biological Parameters of water samples:

Samples	Total Count	MPN
S1	$1*10^9$	0
S2	$2*10^9$	0
S3	$1*10^9$	0
S4	$1*10^9$	0
S5	$9*10^2$	>1600
S6	$7*10^2$	>1600
S7	$1.72*10^3$	>1600
S8	$1.64*10^2$	>1600
S9	$1.5*10^3$	>1600
S10	$1.83*10^3$	>1600
S11	$1.67*10^3$	>1600
S12	$1.59*10^3$	>1600
S13	$1.68*10^3$	>1600
S14	$1.72*10^3$	>1600

4.2 DISCUSSION

We made an inference about the pH by calculating its values for the drinking sites from S1-S4 and S8 ranged from 6.64 to 6.67. The values obtained showed that the quality of water present in the study area is slightly acidic to neutral, It has a mean value of 6.66. In consequential variations in pH values could be accredited to the nature of formations of the soil and the rocks in the area. It might be the geology of the sampling site that would be partially contributed to the pH of water. The pH of water at sites S5-S7 and S9-S14 ranged from 6.8 -8 with an average of 7.7 which shows that the water samples are alkaline in nature. According to WHO high water temperature imparts undesirable taste, odour and corrosive ability to the water which may lead to growth of microorganisms and thus affecting the quality of water. In our project the temperature of the water samples from S1-S4 and S8 ranged from 20-25 with an average of 22.34 which is within the permissible limits. The temperature of sites S5-S7 and S9-S14 ranged from 19- 21 with an average of 20.22 which were within the permissible limit of Indian Standards.

The value of electrical conductivity is associated with the concentration, varied soluble ions and the temperature of the water (Hem 1985). In this project, the conductivity values came to be between 42μS/cm to 331 μS/cm (Table 4.1). The mean conductivity value when analyzed the samples was 200.6 μS/cm. The water quality of this region implies that the water here has low mineral content and may therefore be referred to as fresh water. The EC of sites S5-S7 and S9-S14 ranged from 313-1149 μS/cm with a mediocre value of 760.56 μS/cm. These values range within the permissible limit of Indian Standards.

Turbidity of the water samples were 0 NTU. The values of turbidity of all the samples were within the limits of the Indian Standard. This could be inference from the values that there is no suspended matter present in the water samples. The turbidity of sites S5-S7 and S9-S14 ranged from 2-71NTU with an average of 13.33 NTU which is exceeding the permissible limits. . Turbidity also constantly gives a nil value for all the drinking sampling points on the particular day on account of the boat floating culture of the state on the same day and access to the river increases exponentially on that festival. The Dumehar sampling site showed the flexible values for all the parameters performed.

Dissolved Oxygen determines the biological process undergoing. Low values of the dissolved oxygen adversely affect the potability and potentiability of water and may cause fish kill. The average DO values of sites S5-S7 and S9-S14 ranged around a value of mean 6.85. BOD values of sites S5-S7 and S9-S14 are of mean 148.8 mg/ml. The basis for the COD test is that nearly all organic compounds can be fully oxidised to carbon dioxide with strong oxidising agent under the acidic conditions. We used the dichromate for the determination of the COD. The dichromate does not counts for the nitrification as it doesn't undergo the expression of nitrate from the ammonia. After the test was performed, COD values of sites S5-S7 and S9-S14 are of mean 886.8mg/ml.

Alkalinity has the ability to neutralize the water (United States Environmental Protection Agency 2012). Alkalinity of water is mainly caused by the presence of ions such as HCO_3^{-}, CO_3^{2-} or OH^{-} in ground water (United States Environmental Protection Agency 2012). In our project, we studied every aspect of the alkalinity and after performing procedures for it, we concluded that alkalinity of the water samples was within the Indian Standards (Table 4.2). The values obtained ranged from 46.8mg/l to 211mg/l with an average value of 176.29 mg/l. The notable presence of the low values of alkalinity of the water samples in the study area may be adjourned to the geology and diversification of the area. The area is dominated by rocks and weathered derivatives that have been identified to impart acidity to underground as well as the surface water. The alkalinity of sites S5-S7 and S9-S14 ranged from 97.2mg/l - 840mg/l with an average of 340mg/l which were within the limits. Acidity values of sites S1-S4 and S8 are of mean 14.26mg/l which are presumed to be exceeding the permissible limits set by the Indian Standards. And the values for sites S5-S7 and S9-S14 are of mean 122.25 mg/l.

Total hardness is a characteristic that chemically gets expressed as the sum total concentration of Ca^{2+} and Mg^{2+} as milligram per liter equivalent of $CaCO_3$ (Nitsch et. al 2000). To explain the concept of harness, it could be adduced as the resistance of water to lather soap (Todd 2008). The total hardness values ranging from 90.8 to 280.67 mg/l for all the samples were recorded and analyzed (Table 4.2). This project report produced an outcome of an average of 239.35 mg/l. The total hardness measurements for all the samples were below the 500 mg/l that is precisely recommended by the Indian Standards for drinking water. The values suggested its compliance with the standard guidelines and can also be remarked as safe for drinking.The TH of sites S5-S7 and S9-S14 ranged from 0mg/l – 354.66mg/l with an average of 211.65mg/l which were within the limits.

Calcium contents in the groundwater are very common because of the igneous rock and is present abundantly and easily soluble. The calcium hardness for the water samples ranged from 50.8 mg/l to 272 mg/l having an average of 223.56 mg/l (Table 4.2) which is exceeding the permissible limits. It may be due to rapid urbanization near the region. The CH of sites S5-S7 and S9-S14 ranged from 0mg/l - 328mg/l with an average of 171.54mg/l which were within the limits. Magnesium occurs in fewer amounts in water sample because the dissolution of Mg is a slower process than Ca dissolution. In the study of sites S-S4 and S8 the magnesium hardness ranged from 8.68mg/l - 40.8 mg/l with an average of 16.35 mg/l which is within the permissible limit. The magnesium hardness of sites S5-S7 and S9-S14 ranged from 0mg/l – 82.8mg/l with an average of 40.06mg/l which were not within the permissible limits.

The finding, as such, suggests no threats to the health of the people drinking the water. Also, a wide range of microbes can be present in the drinking water and often, it is impossible to test all these organisms. The parameter used in the project by us was the usage of the MPN assay for the presence of the bacterial contaminants. The total number of coliforms ranged from 0.0mg/ml to 100mg/ml. Therefore, all the water samples without the coliforms were considered suitable for the drinking purpose. The measured water quality parameters were compared with values reported in selected examples of similar studies from different regions within the country. In terms of acidity, samples were generally neutral and close to pH values reported. The major cation levels in Waknaghat area were relatively lower than the levels determined in Wadi Fayd, Jeddah. Meanwhile, the concentration of major cations are comparable to those reported in Abar AlMashi,(city) and AlUla, and they are relatively higher than those measured .

Therefore, parameters which were tested for the sites in Waknaghat area generally always lied in between the prescribed values only except some anomalies. The reason behind these exceptions can be attributed to various facts, example, faulty methods of sampling, faulty analysis, considerable increase in the activity of the population some particular days effluents on a particular time of a day or etc. The sampling site showed the most exceptions as it is a village and people directly depend on the natural resources for their daily activities because of which BOD at times was too high as compared to the other points The results that were obtained were within the permissible limits set by the Indian Standards despite the fact that 2-3 villages surround this area and people are directly dependent on the natural water resources.

The data obtained for the Jaypee study area their physio-chemical parameters were not within the permissible limits according to the Indian Standard and WHO, so the water can be stated for not drinking and any other purposes.

The data obtained for Dumehar study area water sample, their physio-chemical parameters that were performed is within the standard requirements set for drinking water by Indian Standards and WHO, so the water can be stated as safe for the performed parameters.

CHAPTER 5

CONCLUSION

This work presented the assessment of the water quality around the regions of the Waknaghat which is taken as the study area in the project. The quality check in the region exclaimed the alkaline nature of its water.The water quality is dependent on its monitoring which is done by collecting representative water samples and analysis of the water sample at different location in the Waknaghat District.

The data obtained for Waknaghat study area water sample, their physio-chemical parameters that were performed is within the standard requirements set for drinking water by Indian Standards and WHO, so the water can be stated as safe for the performed parameters. The total hardness which gives a measure of the calcium and the magnesium ions falls under the standard requirements set by the Indian standards. Comparable study was also done of calcium hardness against the magnesium hardness. The values for the turbidity showed that the water in the region lacked the measure of the suspended matter in it waters. In order to know the suitability of water to drink, the physio-chemical constituents were compared with the Bureau of Indian Standards. All the values obtained after calculation of the average of all indicates that the water obtained from the region were within the permissible limits. The water in the region is suitable for drinking. As a suggested measure to improve the quality of the water, we designed a portable, low-cost water filter system which has managed to clear off the sewage water of various contaminants. The results of the raw water in this project were compared to that of the filtered water. This gives an insight of the working of the slow sand filter and the glasswool filter models. The filters that are designed share their own set of advantages. The cost of construction of the filters was cheap, filter is highly portable and represents the audacity of water beds. The filters are effective and can be used to concentrate many types of the water-borne diseases. After a lot of research, this could be implied that the entire project totally relies on the assessment of the water quality and henceforth designing a portable water filter for the betterment of the people.

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