ASSESMENT OF DRINKING WATER QUALATY PARAMATERS IN SELECTED VILLAGES OF DISTRICT NAGAR GILGIT

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ABSTRACT

The current study was designed to evaluate quality of drinking water parameters in selected villages of Gilgit. Two different sources were selected i.e., Tap water and Tank water. Total thirty water samples have been collected from these sources. Biological analysis comprises total bacterial count, *coliform, salmonella and shigella*. Physical parameters like pH, electrical conductivity, total dissolved solids, temperature, total hardness, carbonates etc. and heavy metals like; Ni, Pb, Cd, Cr and Mn were determined to find out the drinking water quality. Physiochemical parameters revealed that most of the results were within the acceptable limit of PAK-EPA and WHO. The water samples contain higher concentration of heavy metals (Ni and Cr). The findings indicated the overall water quality is not safe for drinking because some parameters were exceeding the permissible limit from standard values. To save lives of local people, it's important to screen the water quality, control the pollution and use different treatment techniques. Filtration plant should be fitted by local governments to provide safe and clean drink drinking water to people.

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ABBREVIATIONS

AAS	Atomic Absorption Spectroscopy
AFP	After Filtration Plant
APHA	American Public Health Association
BFP	before Filtration Plant
BDL	Below Detectable Limit
BW	Bore Well
CFU	Colony forming unit
DW	Dam Water
EC	Electrical Conductivity
E. coli	*Escherichia coli*
EDTA	Ethylene Diamine Tetra Acetic Acid
EMB	Eosin Methyl Blue
FAO	Food and Agriculture Organization
GF	Graphite Furnace
GPS	Global Positioning System
HP	Hand Pump
ICP	Inductively Coupled Plasma
MCL	Maximum Contamination level
Mg/L	milligram per Liter
Mv	milli volt
NA	Nutrient Agar

Pak-EPA	Pakistan Environmental Protection Agency
PBS	Public Broadcasting Service
PCRWR	Pakistan Council for Research on Water Resources
Pak-SECA	Pakistan; Strategic Country Environmental Assessment
SS	*Salmonella and Shigella*
TW	Tube Well
UN	United Nations
UNDP	United Nations Development program
US-EPA	United States Environmental Protection Agency
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Background

The single and most important substance in the world is water which maintains all life on earth. Life is impossible without it, and it is a most fundamental requirement for all life activities. It is essential for humans, animals, birds, and plants. To sustain life all living things depend on water. There is 80% of water is covered earth surface but the fresh water is decreasing day by day and an estimation about there are many people are without safe drinking water throughout the world (Device et al., 2014)

Drinking water from natural sources is a sign of life and it is most important natural resources (Khan et al., 2013). Everyone needs about 2 liters of clean water for drinking (Naji et al.,2011). Only 1% water is available for movable use whereas mostly water goes for irrigation then to drinking, cleaning and other uses (Khalid et al 2011).

1.2 Importance of water in life

In nature water is the most important and best gift to all living organisms and it is important for performance of all life activities such as maintenance of the human body and biological activities of all forms of life on earth and play an important role for the survival of living things. Best quality of water is a very important resource for life and human beings use this water for daily life activities. Water is an important and lifesaving substance of human and other

living things; it is also necessary for the support of all the organisms (WaterAid, 2008). About 70% of human body mass is composed of water and it is a very important component of human metabolic processes.

Water is important for maintenance and growth of our bodies and contributes too many biological processes. Water is also called the main component on earth .About 75% of the human body is made up of water and every form of life on earth depends on the water. Water plays an important role in transporting and filling up nutrients in the human body. Water bodies including lakes, seas, and ponds are home to thousands of individuals. All living things need water for their survival. Water has many uses and its utilization can be categorized in different ways (Miller, 1997)

There are so many highest mountains present in Gilgit Baltistan, such as world's high set second mountain is present in it. There are more than 700 glaciers are also present in Gilgit and theses are served as water tank for Pakistan (Ayub et al., 2020).

1.2.1 Water as a Solvent

Water is a universal solvent, and it has a capacity to dissolve different compounds like salt. Water has a capacity to attract both positive and negative ions because chemical bonds are present in water and the positive bonds attract the oxygen while negative bonds can attract the hydrogen. This permits the water to dissolve the important compounds, and these are responsible for survival (Murrays et al., 2003)

1.2.2 Water Keeps the Temperature Regulation

In the human body water keeps the limit of temperature due to these enzymes working properly and this helps the process of metabolism in human beings. Water also has a particular heat capacity to raise temperature. (Iram et al., 2009)

1.2.3 Water as a Metabolite

Water always regulates the metabolic process in the human body by improving the chemical reactions that take place in the body of humans. There are so many chemical reactions sum of chemical reactions within an organism is called metabolism and this is necessarily for both plants and animals. In plants water helps in the photosynthesis process through which they prepare their food. In this water break down hydrogen and oxygen atoms. In animals' water is helpful in the respiration process and in this process, water breaks down the adenosine triphosphate (ATP) into adenosine diphosphate (ADP) and energy is produced.

1.2.4 Water is living Environment

Water provides habitat to thousands of organisms including the ocean which are home to fish, sharks, turtles, and dolphins. There is an abundance of organisms that live in water. Water is also helpful to insulate the living environment for these organisms and water keeps organisms warm in the winter months when ice forms on the surface of water (Bakker et al., 2007)

1.3 Sources of water in Pakistan

Pakistan is one of the countries having largest glaciers outside the different regions and these glaciers provide them mountain support and the whole country. In Pakistan mostly the drinking water sources are rivers, canals, streams, lakes and underground aquifers. Out of 122 nations of the world Pakistan is **87th** rank based on water quality.

Water quality is declining mainly because of anthropogenic activities (Khan et al., 2012). There are many ways in which the water is collected. There is water scarcity in most parts of the world especially in rural areas and the

water which is available for different purposes is also a poor water. Mostly in urban areas 80% of people have access to pipeline water whereas 11% of in rural areas. In these areas, mostly people depend for domestic needs on irrigation water. (Ahmad et al., 2012).Population in Gilgit Baltistan most people use water directly from glacier melt which falls down valley streams.

1.4 Factors Affecting Drinking Water Quality and its impact on Human Health

Water is a natural solvent and is needed by every living to sustain their lives. When water is contaminated, it causes serious diseases on living things. Due to this contamination of drinking water people suffer from diseases which are related to waterborne infections. Water quality is also affected by solid waste mismanagement and sources not properly monitored (Khan et al., 2012).

The sources of water pollution are microorganisms, chemical waste, municipal waste, and industrial waste. Due to these contaminants water pollution in Pakistan is increasing rapidly. According to the report of UNICEF 20 to 40 % of patients in hospitals of Pakistan are from water related diseases (Mahwash et al.,2013).Every year diarrhea kills approximately 760 000 children under five and worldwide there are almost 1.7 billion cases of diarrheal diseases all year and has a great impact on human health (Din et al.,2016).

Contamination of water is also a major cause of increase in agricultural practices, grazing of domestic animals close to the stream and other anthropogenic activities. The pollution which is caused by chemicals have a long-term influence and cause harmful effects. Other materials like slag materials which are created from steel industries also cause great effect on the aquatic environments. Components like organic matter decomposition, nitrates and phosphorus had a large effect on water streams that flow in small forests, orchards, and agricultural land. Many people worldwide suffer from

health problems which are related to water. Human elicited causing on surface water quality shows that not only waste directly into a stream

In Pakistan many rural areas are suffering health problems because these populations do not have an approach to safe drinking water .Deficient supply, sanitation and medical results high frequency of water and sanitation related diseases in Pakistan. In Pakistan there is not a good system for monitoring and policy investigation programs in the country. Pakistan's population is rapidly increasing. Mostly the freshwater is contaminated using pesticides in agricultural fields and other human activities that completely change the physical, chemical, and biological processes which are related to water resources. Water borne diseases are diarrhea, cholera, typhoid, and hepatitis and all these are caused by the presence of pathogenic organisms that are present in drinking water. Good quality of fresh water means keeping away public from harmful water related infections (Saif-ud-din et al 2020).

The pure water is free from harmful materials and pollutants and this water is useful for public health to avoid diseases. It is also used as a strong environmental instrument which is used to find out the health of the public. Good quality of drinking water means it is free of pollutants and this water can safely people from water borne diseases. Developing countries also face pure water problems (Zubair, 2000).

Suspended and dissolved impurities are present in water and this water is not always pure for the usage of humans. There are always some environmental pollutants present in water. These are heavy metals, and these are most harmful waste which are threatening safety to human life. Heavy metals are present in the environment as well as natural processes and these metals pollute from the atmosphere directly deposition, weathering, and agricultural, residential and manufacturing runoff (Saddozai et al.,2009).Due to daily discharge of these waste materials into aquatic systems of heavy metals concentration is increased and these are deposited in the water where these heavy

Metals move to the food chain and cause harmful effects on human and as well as marine life. According to WHO there are 17 types of bacteria that can be found in tap water which are also responsible for water related diseases in human health. The most hazardous diseases which are caused by water are diarrhea and this disease is causes several deaths in infants and children in Pakistan and every 5th person is get from diseases caused by infected water and about three million Pakistanis are infected by poor quality of water each year and out of which 0.1 million lost their lives. These conditions involve the need of assessment of water quality to ensure the protection of the environment and valuable human's lives. Thus, the present study was planned to assess the water quality parameters of selected villages of Nagar district of Gilgit Baltistan and compare the result with world standards (Peeler et al 2006).

1.5 Global water demand and supply

Water scarcity and water quality need the importance of many other global problems affecting world peace and security (Khan and Hanjra, 2009). Water availability is the most critical element of food shortage (UNDP, 2007).

1.6 Water Quality Status and Demand in Pakistan

In Pakistan there is a higher level of water variations among us 37 countries. (Water aid ,2014). There is a deficiency of water in rural areas. The water which is available is poor quality for drinking. In present situation urban areas only 80% and 11% of population in ruler areas has approached the piped water supply while some population is totally dependent on irrigation water for their domestic needs instead of drinking (Ahmad et al., 2012).

According to a calculation by Pakistan Council of Research and Water Resources (PCRWR 2005), almost 50 percent of urban water supply is unable for drinking and personal use. In Pakistan Water and Sanitation is the disregarded sector. The significance of present study to investigate the drinking water quality in different areas of Gilgit Baltistan.

Treatment plants are not able to remove the pollutants are left untreated in the water (Hisam et al., 2014). Due to this many people are faced with a problem for safe drinking water. According to national statistics, the total 56% population has access to safe drinking water (Farooq et al., 2008).

According to another study, 70 % of the population in the rural areas of Pakistan has no access to safe water whereas in cities 40 to 60 % of the people have safe drinking water accessible (Amin et al., 2012).Pakistan and as well as other developing countries are also facing water scarcity problems and pollution.

1.7 Water quality Status in Gilgit Baltistan

Gilgit Baltistan is home to the world's second highest mountain peak and there are more than 7000 glaciers. The snow and glacial resources of the Himalayan region are a major source of freshwater. Geographically the area is covered by mountains, glaciers and highlands and springs, waterfalls, lakes and rivers moving out of these snow- covered mountains. The world's lengthy glaciers are found in Gilgit Baltistan, and which are located outside of the Polar Regions. In winter season there are heavy snow rainfall on the top of the mountains and in summer by melt of theses glaciers, water release down the hills in the form of nallahs and streams and some water move into villages in the form of springs (Ahmad et al., 2012).

In Gilgit Baltistan the important source of domestic and household usage of water is glaciers and snow melt which is overflow in streams, lakes, rivers

and springs. In summer particularly from April to August and slowly declined from September to November after that there is snowfall during December to February this result there is shortage of drinking water in some areas .If there are no water sources villagers use snowmelt and this water is normally muddy and turbid. The spring water is warm in winter and in summer it is cold. There the spring water desirable to be used for drinking and other purposes (Tveiten, 2007).

The aggregate surveys reveal that 79% of Gilgit Baltistan used the developed sources of drinking water and the common water supply system for most of the villagers is pipeline. In water shortage areas the people to store water in large pits, and this water is used for drinking and other household purposes. Water pits are constructed near the stream and channels and the locals use the same channel for drinking and washing. They fill the pit in the early morning with fresh water to prevent contamination from washed clothes, irrigation, waste and other wastewater activities(Daud et al.,2017). Minor demand of Gilgit Baltistan is water availability and the quality of abundantly

Accessible water. To separate and freeze glaciers in northern areas is a challenge, thus it was hard to often measure the quality of natural waters used for drinking function. Few studies have revealed the spread of gastrointestinal diseases (Ahmed et al., 2012).

The principal water sources in Gilgit Baltistan are Glaciers and snow deposits and when these are melted water enters streams, and this water is used for all daily life purposes. In rural areas people mostly use the water from channels. The supply during the winter month is decreased and in summer in summer filled again frequently. In natural water the physical and chemical properties are analyzed including trace element tables are very important for the study or public health (Soomro et al.,2011).

1.7 Literature Review

Tahir investigated the contamination problems in water schemes of Rawalpindi and Islamabad city. The water supply system of both cities was found acceptable with regards to alkalinity, hardness, TDS (Tahir et al., 1998).

A study conducted in Islamabad for the determination of microbiological quality in which they collect water and foods items from different schools and colleges. There is total 40 out of which 30 water and 10 food samples, in which 20 samples of water and 7 samples of food were highly toxic due to this are not safe for water use (Saddozi et al., 2009).

In Kohat (KPK) Similarly a study investigated that most of the samples which are collected from different sources like wells, hand pumps, tube wells, tanks and stream which are Similarly polluted mostly in Shakardrara. In Charsada district another study was conducted that drinking water is mostly contaminated by No_3, So_4 and heavy metals like Pb, Fe, Ni ,Zn, Cd, and coliform from bacteria (Khan et al.,2012).

Another study reveals that water quality of the drinking water which is stored in China the values of PH and total alkalinity has high (Din et al.,2019). Another study which was directed in Rawalpindi district to evaluate the water quality of ruler areas. The results pretend that there are high concentrations of levels of nitrate, iron, and sodium in some water samples (Tahir et al., 1998).

Malik et al examines water samples for physicochemical parameters such as Temperature, pH, turbidity, EC, and TDS in Karachi. The results revealed that the treated water from the treatment plants met the guidelines of WHO (Malik et al., 2010).

The study is conducted in Ravi River in which dissolved oxygen, and total dissolved solids were determined overtime. The untreated wastewater which is discharged from the city and close to industrial property into the river and

the important causes of water quality impairment. They found 43.2% polluted water for drinking,10.3% samples contained physicochemical as well as bacteriological pollutants from Islamabad and 22.4% were insecure by physicochemical parameters while 3.6% by both physicochemical chemical and bacteriological contamination in CDA (Sun et al., 2010).

Ajagu and Ajiwe (2017) conducted a study of the specific sources of water and checked the physicochemical parameters. They collected the samples in two phases from Enugu, Nigeria for a duration of seven months. They collected samples from November, December 2013 and January 2014 and May, June and July 2014.They Checked the parameters including pH, temperature, Turbidity, dissolved oxygen, total suspended solids, electrical conductivity, total hardness, calcium and magnesium by standard method. The concentration of pH was low and showed acidic properties in all the samples. Turbidity was found in two samples of water; turbidity was above the standard level. One sample shows high concentration of TDS and EC. Results revealed that water was polluted with pleasant and non-harmonious substances so without treatment this is not suitable for drinking purposes.

In Islamabad and Rawalpindi another study was conducted on pollution which causes difficulties in the water system. The results indicated that 76% samples in Islamabad and 82% samples in Rawalpindi were contaminated due to bacterial presence (Tahir et al., 1998).

Another study revealed that 94% water samples which are collected from Islamabad and Rawalpindi contain bacteriological contaminations and 34% have got fecal contamination (Jahangir et al., 2018).

Ibrahim et al., (2015) conducted a study on Zulfi Northwest of Riyadh region to evaluate the heavy metal concentration and their effect on health. In which 10 water samples were collected from wells for three levels and Inductively Coupled Plasma (ICP) spectrophotometry is used for the examination of

heavy metal concentration. The resulting collection of heavy metals shows the acceptable limits set by WHO. The results revealed that water of the Zulfi region did not have any health effect but some of the heavy metal concentrations were above the standard given by WHO, so precautionary action will be taken for future.

Zahir et al., (2015) conducted a study in Sahiwal District, Pakistan to check the concentrations of heavy metal in the drinking water. They analyzed Pb, Cr. They collected a total 20 samples for the analysis of heavy metals. From different sources i.e., tap water, filter plant, tube well and hand pump. They use inductively couple Plasma-Mass Spectrometry for the analysis purpose. Study showed that there are differences in each site of sample as compared with alternative sites. Results were also compared with Pak-EPA, WHO and US-EPA. The concentration of Pb and as were within the acceptable limits that was set by Pak-EPA, except for concentration of Cr was just above the limits of WHO and US-EPA standard value in the whole region.

Bilal and Rahman (2013) directed a study in Hassan Abdal to assess the water quality parameters. The goal of this study was to identify the heavy metals and they used the method AAS. The results show that all elements were found under the acceptable limit which are given by Pak –EPA and WHO.

In Nagar district a study was conducted to elaborate the water quality parameters and the results showed that the water quality parameters from different villages exposed that all the confirmed parameters i.e., temperature, pH, turbidity, electrical conductivity etc. were meeting the approved standards of WHO and EPA. Through cautious attention towards contamination of water sources is suggested so that the future will be safe in terms of environmental pollution and human health and this effect will be controlled and can be reduced (Ajagu *et al.,* 2017). Another study was conducted in Gilgit District Nagar in which the outcomes obtainable that all the samples which are taken from water supply system were contaminated

bacteriologically with *E. Coli* colonies which are causing agent of water borne diseases and are high threat to the health according to the WHO guidelines and are not fit for human daily usage (Faria *et al.*, 2010).

1.8 OBJECTIVES

1. To assess the biological (*Total Bacterial Count, Total Coliform, Salmonella and Shigella)* and physicochemical parameters (pH, EC, TDS, salt, Temperature, Turbidity, NaCl total hardness, Ca, Mg, Carbonates) in selected areas of different villages of district Nagar.

2. To examine Heavy Metals (pb, Ni, Cr, Cd and Mn) concentration in the study area.

CHAPTER 2

MATERIALS AND METHODS

2.1 Study Area

Nagar is situated in the northern part of Gilgit–Baltistan, Pakistan. In south and west Nagar is surrounded by Gilgit Agency, and District Hunza to the north and east. It was a largest state of Pakistan and its capital was town of Nagar. The state capital was the town of Nagar. The population of Nagar District is around 90,000 (AKRSP Census, 2000). The topography of Nagar is particularly mountainous. The highest mountain is the 7,788 m (25,551 ft) Mount Rakaposhi, which is the highest mountain also present in the south of Nagar. Nagar Valley is divided into two parts. Nagar Shinaki and Nagar Burusho. Villages are Chalat (Paaeen/bala) Thol valley, Ghulmit valley, Sikandar Abad Minapin Yal and SAS valley.

2.2 Sampling Methods

To examine biological, physicochemical parameters and heavy metals analysis sampling was completed in the water sources of different villages of district Nagar. In which 15 villages were selected. The samples were collected, and the sampling points are selected randomly. Total 30 samples were collected from two different sources in each village that is tap water and tank water. To analyze physicochemical and heavy metals sterilized bottles were used to collect samples. Sterilized plastic bottles of 100ml were used for biological assessment. Prior to water sampling tap water and tank water was allowed to run for 2 to 3 minutes. Standard sampling techniques were used to collect samples from different sources (Khan et al., 2012).All the water samples are transported for further analysis (APHA, 2005).

2.2.1 Area of Sampling Points

From different locations of drinking water i.e., tap water and tank water total 30 samples were gathered.

2.3 Biological Analysis

For biological analysis the standard plate count method was used. Samples were spreader on various media to determine the presence and number of total bacteria, total *Coliforms, salmonella* and *shigella* samples were spread on three different media i.e., Nutrient agar, EMB agar and *Salmonella and Shigella* agar. After that the media plates were coded and kept in an incubator for 37℃ for 24 to 36 hours. Growth on NA, indicated Total bacteria in water while EMB for *coli* forms and SS agar specified presence of *Salmonella and Shigella* (APHA, 2011).

2.4 Physical parameters Analysis

Physical parameters like pH, Electrical Conductivity, total dissolved solids, salts, and Temperature were measured by multi meter on site to avoid any variability. EC/TDS/pH were used to measure pH and EC. The water samples were examined by using American Public Health Association (APHA, 2005). Before analysis, the apparatus and tools are tested and calibrated.

All the Instrument were adjusted before use and washed with distilled water to get exact results. To avoid any change in results, samples were well shaken and permitted to stabilize until no air bubble was left. Electrode was dipped into the sample and stirred continuously until the values for EC and pH get stabilized. Those stabilized 18 values of pH and EC were recorded as results. Temperature was measured using digital thermometer.

2.5 pH

The pH analysis is measure of the hydrogen or hydroxyl particle action of the water framework shows whether the water is acidic, nonpartisan (neutral) or soluble in response. The pH of fresh pure water is around 7. By and large, water with a pH lower than 7 is viewed as acidic, 22 and with a pH more remarkable than 7 is viewed as essential. The ordinary range for pH in surface water is 6.5 to 8.5. (Mehmood et al., 2012).

2.6 Electrical conductivity

EC or Electrical Conductivity of water is its capacity to lead an electric flow. The EC meter (electrical conductivity meter) measures in Siemens and the unit is µS, which implies smaller scale siemens (one millionth of a siemens). Salts or different chemicals that disintegrate in dilute can break into negative as well as positive charged particles. These free particles in the water lead power, so the water electrical conductivity relies upon the centralization of particles. Saltiness and aggregate broke down solids (TDS) are utilized to figure the EC of water, which shows the water's virtue. More the fresh water is, lower will be the conductivity. To give a genuine illustration, also refined knowns as distilled water is just about a cover, yet saltwater is an extremely proficient electrical transmitter. Most positively charged particles that influence the conductivity of water are sodium, calcium, potassium as well as magnesium. Positively charged particles are chloride, sulfate, carbonate and bicarbonate. Nitrates and phosphates are minor supporters of conductivity, yet they are critical natural. The normal effects on EC in water are rain, geography and dissipation (Hoque et al., 2017)

2.7 Experimental Procedure

Electrical conductivity of the samples was determined operating the standard methodology. The conductivity meter was applied to numeral the electrical conductivity of the water tests. The power important and the conductivity key of the conductivity meter was turned on, and the temperature of the meter balanced,

the instrument was adjusted with 0.001M KCl to give an estimate of 14.7ms/m at 25℃ The test was charged below the surface of test. Time was permitted the readings were recorded for all collected samples.

2.8 Total Dissolves solids (TDS)

A Total Dissolved Solid (TDS) is characterized as all inorganic and natural substances contained in water that can go through a 2-micron channel. When all is said is done, TDS is the entirety of the cations and anions in water. Particles and ionic mixes making up TDS as a rule incorporate carbonate along with bicarbonate, chloride, and fluoride, also sulfate, phosphate nitrate, calcium, magnesium, sodium, and potassium, yet any particle that is available will add to the aggregate. The natural particles incorporate poisons, herbicides, and hydrocarbons. There is an assortment of approaches to gauge TDS. The expansion in weight of the dish speaks to the TDS, and it is accounted for in mg/l. TDS can likewise be ascertained by TDS meter. Essential hotspots for TDS in getting waters are farming and private overflow, earth rich mountain waters, filtering of soil defilement and point source water contamination release from mechanical or sewage treatment plants(Hayder et al.,2009).

2.9 Experimental Procedure

The TDS meter was utilized to find the TDS of the water test in the Lab. The readout screen indicates TDS in parts per million, similar numbers can likewise be perused as milligrams per liter. A similar catch was utilized to turn it off. When testing, more than 50 ml in the bigger (250 ml) receptacle all together for the tests on the TDS meter to be tested. The meter was submerged between the green line and the red line. Try not to submerge the meter any lower in the water than where the red line is. To take an understanding, I just plunge the tests into the water being estimated. I mix the meter tenderly with the goal that any air pockets sticking to the metal posts are removed. The perusing was showed up on the screen and afterward the qualities were recorded for Total Dissolved Solids.

2.10 Chemical parameters Analysis

Chemical parameters like chlorides, alkalinity, hardness, and carbonates were evaluated by using standard methods.

2.10.1 Chlorides

Chlorides are the important element which are present in both marine and freshwater. Chlorides in the environment are combinations of either sodium or magnesium chloride. Scientific studies show that water basins use higher chloride levels as one indicator of pollution in water bodies (Hunt et al., 2012). Chloride in water samples was measured by an argent metric titration. In this type of titration silver nitrate ($AgNO_3$) reacts with chloride to form insoluble white precipitates of silver chloride.

Cl (mg/l)=NxVx35.5x1000/ml of sample

Where,

N, is the normality of solution and V is the volume used against burette.

The entire process consists of following steps:

Equations

AgNO3 + NaCl → AgCl + NaNO3 2AgNO3 + K2CrO4 → AgCrO4 + 2KNO3 ¬

Standard Solution: 0.01 N

AgNO3 ¬ **Indicator:** Potassium

Chromate ¬ **End Point:** Orange

Yellow Color

Procedure

In burette 0.01 N solution of AgNO3 was taken with the help of funnel. Then in

the titration flask 50/20ml of water sample was taken. After that, as an indicator 2 or 3 drops of potassium chromate was added. It was titrated against AgNO3 till the orange yellow color was obtained. ¬

Observations: Normality of AgNO3= N= 0.01 Volume of AgNO3= V= a mL Sample Volume= 50/20 mL 19 ¬

Calculations: mg/L = V*N*35.45*1000/25

2.10.2 Alkalinity

It is the ability of water to deactivate acids. It also determines the water protecting capacity or its ability in which changes take place in pH by addition of acid or a base (John, 2009). In the titration flask 10 ml of water sample was taken and then 2or 3 drops of methyl orange indicator was added. After that, drop by drop standard solution i.e., 0.02M H_2SO_4 were added. At the end, red color was seemed (WHO, 2010)

Mg/L = N x V x 1000/sample volume

Where,

N, is the normality of solution and V is the volume used against burette.

2.10.3 Total Hardness

It is the estimation of mineral content in a water sample permanent by boiling and are equal to the total calcium and Magnesium. A washed flask and cylinder were taken and then I added 0.01M standard solution EDTA in the burette. After that in titration flask 50ml of water sample was taken and then 2ml of NH_4CL_3 were added as a buffer solution to the water samples and then shake. The pH of the buffer was determined.

After that, 2 drops of indicator that is Eriochrome Black T was added, thrilling until the indicator becomes dissolved and wine-red color is presented. Then this

solution was titrated with 0.01M EDTA, till sky blue color is gained as the end point (WHO, 1984).

Total hardness = A x B x 1000/sample

volume Where,

A, is calculated by a burette reading that is used against sample and B,

is the 0.01M standard solution of EDTA.

2.10.4 Carbonates

It is a salt of carbonic acid. Categorized by the presence of the carbonate ion with the formula of CO_3**.**When positive and oxygen atoms of the carbonate ion come into contact these elements are formed. Carbonate salts are insoluble in water at standard temperature and pressure. In aqueous solution they show both the level of acidity and basicity (John and Wiley, 2009). The washed flask was taken and 10ml of water sample and 2or 3 drops of methyl orange indicator was added. After those 2 or 3 drops of standards solution that is 0.1MHCL was added till red color is obtained (WHO, 1884).

$$M1V1=M2V2$$

Where,

M_1 is molarity of whole sample, V_1, is the sample volume, M_1, is the 0.1M standard solution and V_1 and is the burette reading which is used against sample.

When M_1 find then, Amount/dm^3 (g/L) = Molarity x mol. Weight of carbonates

2.11 Heavy Metals Analysis

Five different heavy metals were analyzed including Ni, pb, Cr, and Mn. They are generally present in trace amounts but many of them are toxic even at low concentration (Nouri et al., 2008). Heavy metals were examined by using Atomic Absorption Spectrometer Vairo 6 at PCRWR (Pakistan Council of Research in Water Resources). Before examination, the water is stored in 100ml of polythene bottles. Firstly, the samples were filtered with filter paper to avoid contamination.

This process was repeated twice. Then 2-3 ml of nitric acid was added to digest metals. (Rasheed et al, 2011). After that, samples were properly labeled, and transported to PCRW for analysis.

2.11.1 AAS Working Principle

An Analytic Jena AAS Vario 6 is a graphite furnace spectrometer. It is equipped with a PC- controlled 6-piece lamp turret and argon gas was used for all the absorption measurements (Rand et al., 2005). In this method, hollow cathode lamps were fitted for specific elements that had to be examined with their wavelength and split width was adjusted consequently. Signal measurement was observed in the peak area. Calibration was in linear mode. The sample injection volume is 20µl. The heating program of GF-AAS is drying (sample injection into the filter furnace), pyrolysis, atomization and cleansing. All containers and glassware were drenched in 1.4 mol L^{-1} nitric acid for at least 24 hours and cleaned two to three times with water before use (Jarup et al., 2000).

Figure 2.1 AAS Vario Instrument

CHAPTER 3

RESULTS AND DISCUSSIONS

3.1 Physio-chemical and Microbial Analysis

The samples were examined for pH, EC, Temperature, Chlorides, and biological analysis

3.1.1 Microbial analysis results

The pollution of drinking water in many parts of the world is estimated as one of the most extreme severe threats to the human health resulting in severe diseases**.** Numerous diseases like typhoid, paratyphoid, diarrhea, cholera, hepatitis and many other everlasting health diseases are caused due to the polluted water and this water is polluted due to the presence of pathogenic microbes (Butt and Iqbal, 2007).

Diseases which are caused with polluted water frequently occur when water is polluted with fecal matter waterborne diseases frequently occur when water is polluted with fecal matter, particularly human faces that contain pathogenic microorganisms.

In the present samples were examined for the presence of different kinds of bacteria in which four different media were used to quantify different bacteria. Nutrient agar (NA) was used to identify the presence of total microbial load of the water..

It was found that people throw most of their domestic waste in open areas like diapers and other wastes which create pollution and these waste contact with water and water become polluted this polluted water enters the streams, wells

and tanks which are not covered properly and due to this there are a strong chance of fecal contamination of water sources. Other wastes like animal's waste can also mix with water when rain fall, and this water directly enter in to the streams and this stream water is stored in tank and distributed to all population through tap water.

In this study, for the presence of different types of bacteria all samples were analyzed. To check the growth for microorganism, three different media were used i.e., Nutrient agar (NA) was used to calculate the total bacteria in water sample. EMB and SS agar were used for *E. coli* and *Salmonella and Shigella*.

Table 3.1 Biological Analysis of water samples

Sample no	Growth in Nutrient agar	Growth in EMB agar	Growth in SS agar
1	03	0	0
2	04	0	4
3	30	8	0
4	35	0	0
5	07	0	0
6	05	0	0
7	17	0	11
8	19	0	0
9	55	0	0
10	65	3	0
11	06	0	0
12	04	0	0
13	75	0	7
14	69	0	9
15	07	0	0
16	09	0	0
17	05	7	0
18	04	0	0
19	07	0	0
20	06	0	0
21	37	0	9
22	35	0	0
23	02	0	0
24	04	0	0
25	30	0	0
26	35	4	2
27	81	0	0
28	77	0	0
29	17	0	01
30	15	0	0

3.1 Results and Discussions

Drinking water sources like streams, rivers, lakes, dams were polluted through different sources. The direct pollution is produced by chemicals and disease-causing organisms. The sources of pollution may be human and animal wastes discharging generally into water where pollution causes. Without accessibility of safe drinking water people cannot have creative lives (Batterman et al, 2009). The water values were related to the WHO guidelines to determine the excellence of water. The Physio- chemical parameters were found to be within recommended limits of WHO standards. Parameters that were found to be somewhat out of range were temperature and turbidity. The results of some physical parameters evaluated in the water samples collected are following.

All over the world, the reason behind the people dying is the poor quality of water per year than from all forms of destruction including war and it is roughly calculated that 26% of deaths are from infectious diseases caused by pathogenic bacteria (WHO, 2002; UNEP GEMS/Water Program, 2008). Due to acute health risk of biological contamination, it is considered as the highly important water quality test even though onetime consumption can cause chronic health issues as compared to chemical contaminants (New Hampshire Department of Environmental Services, 2010). Waterborne diseases are caused by the lack of access to safe and clean water, but excessively due to anthropogenic activities that harm the water quality (Baig et al., 2009). Several diseases like typhoid, diarrhea, cholera, dermatitis, enteric fever and hepatitis A are caused by the consumption of water that is polluted with harmful bacteria (Butt and Iqbal. 2007). In the country diarrhea is the leading cause of death in infants and children while every fifth citizens suffer from diseases caused by the contaminated water (Radjevic et al., 1999).

In this study, for the presence of different types of bacteria all samples were analyzed. To check the growth for microorganism, three different media were used i.e., Nutrient agar (NA) was used to calculate the total bacteria in water sample. EMB and SS agar were used for E. coli and *Salmonella and Shigella.*

In Table 3. 30 samples show the biological results of collected samples of different villages of Nagar District. *E. coli* was not found in all samples and other two samples showed growth of bacteria. *Salmonella and shigella* was found in two samples few samples were having growth for *salmonella and shigella*. All the samples were gathered from two locations in each village, so the results shows that there is no contamination was found in samples and the water is suitable for drinking purpose. Only two samples showed *salmonella* and *shigella* growth and this is under the permissible limit.

A study directed by Ahmad et al. (2014) about drinking water safety in Bagh determined that water sources which are not covered properly, and people throw their wastes vulnerable wastes which are main cause of water pollution. Kistemann et al., (2002) states that during rain fall the mostly contaminants are mixed in water due to the rain fall and runoff.

As per an assessment, almost 80 % of the diseases in humans in developing countries are because of bacteriological contamination of drinking water (Wright et al., 2004).

Amount of the fecal coliform in water may determine that has been polluted with the fecal material of human beings and other animals. Large amounts of pathogens in water can cause higher risk of infections like ear infections, typhoid fever, dysentery, bacterial and viral gastroenteritis and hepatitis A (Edmunds et al., 2006).

In developing countries *salmonella* and *shigella* are the main reason of disorders among children(Kotloff et al., 2013).Typhoid in human being are typically causes of salmonella and other diseases like gastrointestinal

diarrhea, nausea, vomiting, infection are the major signs of *salmonella* (James and Willam 2021).

3.2

3.3 Physical Parameters Analysis

WHO stated that in less developed countries many children die due to water connected diseases (Daud et al., 2017) In Pakistan, 40% of urban death is because of polluted water (Rashid et al., 1998). The quality of water in term of pH, temperature, electrical conductivity, turbidity and salts are not affected as much caused by the biological and heavy metals. pH of all water samples ranged from 7.1 to 12.1 which is within permissible limits but one sample that has taken from filtration plant. Electrical conductance in all the collected samples was ranged from 3.1 to 1576 µS/cm. This difference based on the different concentration of ions like Cl, Na, K, Ca and Mg. These physiochemical parameters were linked with the WHO standards (WHO,2011) that has the given accepted limits for pH, EC, turbidity, and TDS that are 6.5-8.5 pH, 250 µS cm-1 , >5 and 10 NTU.

Turbidity has no serious health impact; however, it provides a medium for microbial organism. Its range in different water samples is 0.6-4.5 NTU, which is within the standard value set by PAK-EPA. The amount of TDS varies from 1.03-980 mg/L, which is taken from different sources.75% of solids are organic in nature i.e., municipal solid. Salts are present in all types of water. In this study, its amount ranges from 8.8 to 868mg/l. Temperature may be depending on seasonal variation; it shows changes due to different conditions. COD shows variation at different location, which is shown in the table 3.2.

Table 3.2 Physical Parameter of Water Samples

Sample#	pH	EC (µs/cm)	TDS (mg/l)	Total Salts (mg/l)	Temperature (°C)	Turbidity (NTU)
01	8.04	133.4	95.4	71.2	22.8	0
02	7.79	134.2	96.1	71	22.8	0
03	8.05	131.6	94	69.9	22.7	0
04	8	130.9	93	68.5	22.7	0
05	7.99	134.1	94.6	70	22.6	0
06	7.79	132.2	92	71	22.6	0
07	8	137.2	97.4	72.2	22.6	0
08	7.9	131	95.5	70	22.6	0
09	7.95	135.4	96.2	71.6	22.5	0
10	8	136	97	72	22.5	0
11	8.05	126.2	89.4	66.6	22.5	0
12	8.09	126.5	89.7	66.2	22.5	0
13	8.13	111.7	79.2	59.4	22	0
14	8	110.9	79	58.9	22	0
15	7.95	136.1	96.6	71.5	22.1	0
16	8	136.4	97	72	22.1	0
17	8.05	128.4	91.1	67.8	21.8	0
18	8.07	128.6	91.5	67.9	21.8	0
19	8.22	145.1	103	75.9	22.1	0
20	8.2	145	102.9	75.7	22.1	0
21	8.24	155.2	110	80.9	21.9	0
22	8.5	156	110.9	81.8	21.9	0
23	8.01	151.4	107	79.1	21.9	0
24	7.89	150.5	106.5	78.8	21.9	0
25	8.13	140	99.1	73	22	0
26	8.12	142	102	73	22	0
27	8.1	135.5	96.8	71.1	22	0
28	8.1	135.6	96.9	71.1	22	0
29	8.30	164	116	85.4	22	0
30	8.1	160	105	80	22	0

3.3.1 pH

In tap water samples the values range from 7.9 -8.13 The pH values of samples are described in table 3.2The identified samples results were compared with standards set by WHO standard values for pH in drinking water. It was detected that all samples were within the range of acceptable level of WHO standards which are set in 2008. At room temperature pure water is neither acidic nor basic and has pH of 7 which is neutral (hem book, 2003).

If the values of pH are higher than it may cause eyes and skin problems. pH values range from 10-12.5 can cause swelling of hair and other gastrointestinal irritation (khan and Ahmed 2001).

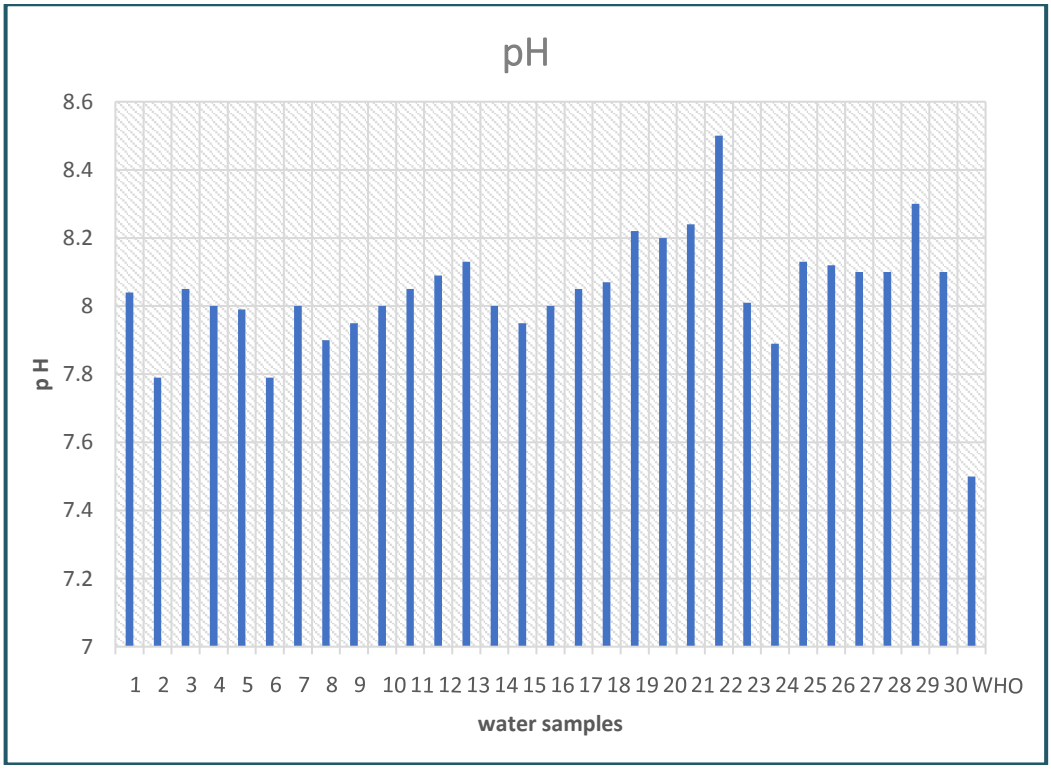

Figure 3.1 pH values in water samples.

3.3.2 Electrical Conductivity

It is the capacity of aqueous solution to deliver and electric charge. Its value represents the presence of ions in water and these dissolved ions may depend on the minerals that come from water, poor irrigation or other sewages.

In ground water there is high dissolved ions which are responsible for higher concentration EC. The higher concentration of EC values refers to higher amount of salinity in water (Srinivas at all 2000) the unit of EC is sermons per meter (khan et al., 2013)

The values of both tap and tank water are described in table 3.2 .The EC of tap water are ranging from 110.9 to137.2 (µs/cm) and whereas the tank water fluctuates from 128.4 to 164 (µs/cm) which are shown in figure. However, no standards set by WHO for electric conductivity in drinking water.

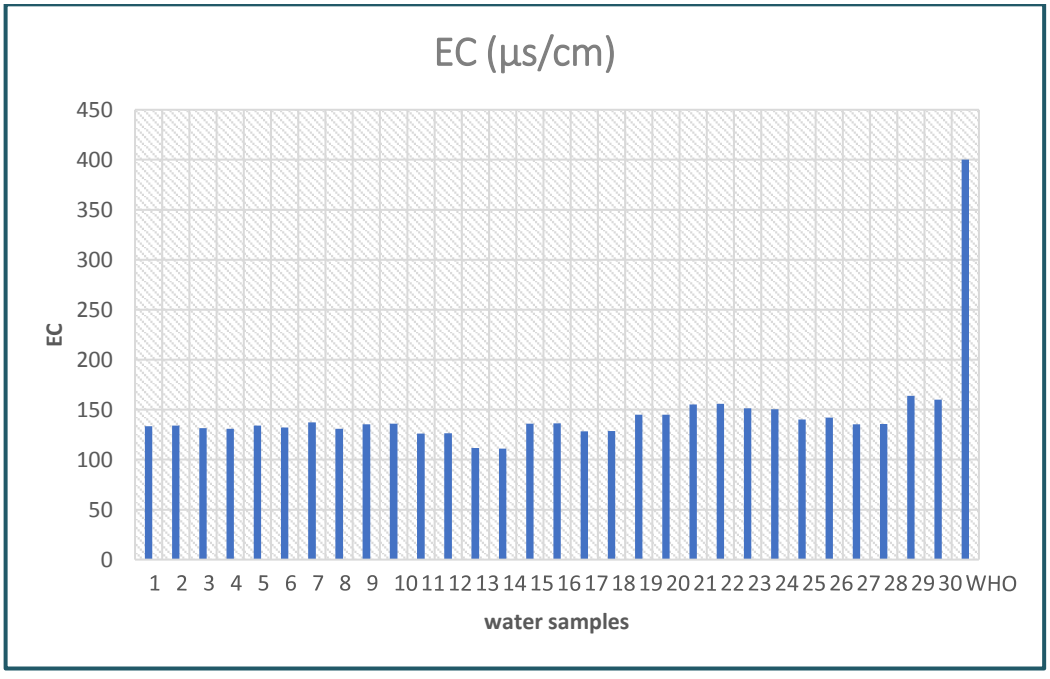

Figure no 3.2 Electric conductivity values in water samples .

3.3.3 Total dissolved solids (TDS)

TDS comprises of (carbonates, potassium, calcium and magnesium) which are in organic salt in nature other organic matter which are mostly water soluble. These are the sum of total anion and cations in water. Figure 3.3 shows the TDS values for the water samples ranges from 79 to 96.6(mg/l) and tank water whose ranges from 79 to 116 and this is in the permissible limit and is compare with WHO (2010) respectively which indicated that all samples were in the range and if there is higher amount was present in water it is harmful and hard. Water transparency decreases by increasing the TDS contents in water (Chukwid at al., 2012) TDS in drinking water and limit is 100 mg/L. All the results are demonstrated in figure 3.3.

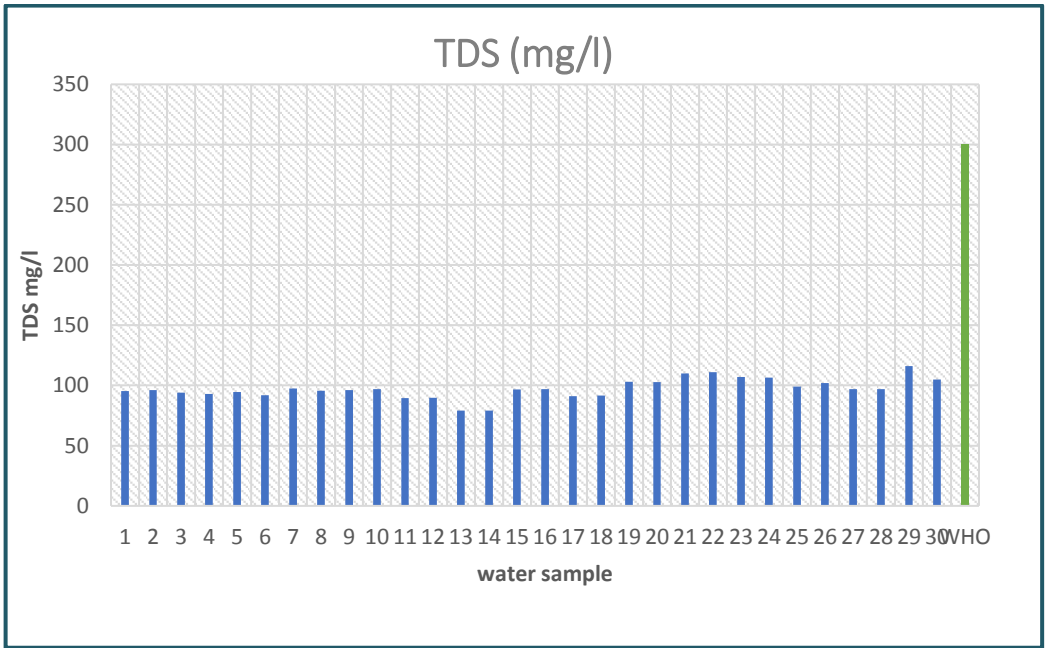

Figure 3.3 Values of TDS in water samples.

3.3.4 Salts

Salt is a chemical compound made up of combination of anions and cations. These may be organic such as fluoride (F^-) and inorganic such as chloride (Cl^-). The presence of sodium in water makes the salty taste. When the concentration exceeded 180mg /l. Salts value in tap water ranges from 59.4to 71.6(mg/l) which is shown in graphical presentation and in a tank water the values are ranging from to 71.1 to 81.8 (mg/l) and these values are varying between 91-868ml/L corresponding results are shown in figure 3.4.

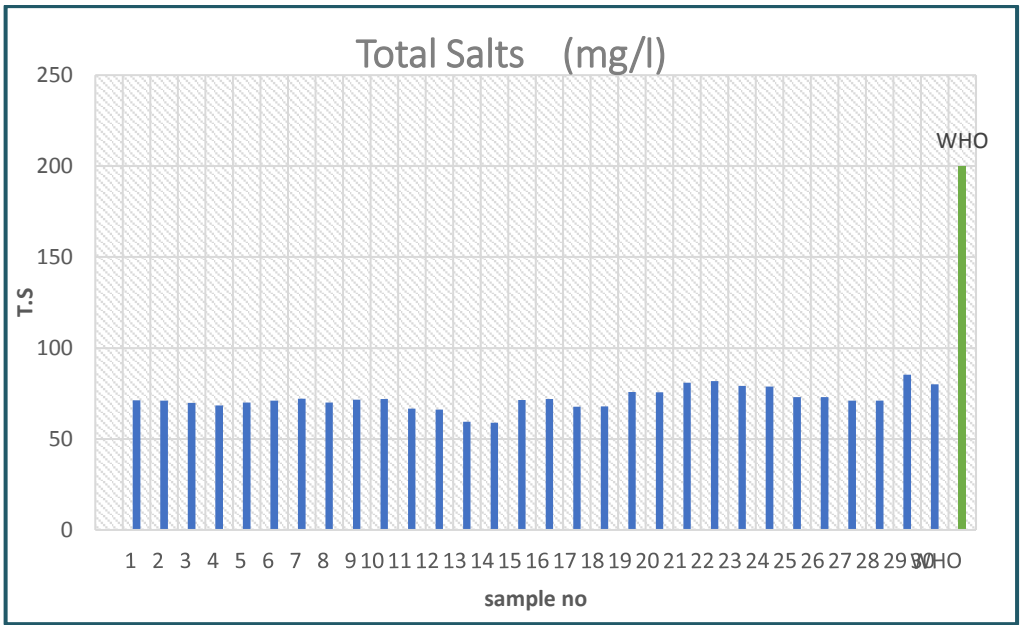

Figure 3.4 Salt concentration in water samples

If the salt concentration is higher in drinking water it causes of salty taste, so the low sodium concentration is important for heart diseases patients, high blood pressure or kidney problem so such patients be aware of sodium level in their daily use water (Shakirullah et al., 2005)

3.3.5 Temperature

Temperature reflects the physical properties of water either it is hot or cold both are random terms. It is also defined as an average energy of substances. Temperature distresses the water quality and change the physical and chemical properties (Jain et al., 2005).If the temperature will increase higher

it can cause the higher solubility and toxicity of other compounds. As a result, other gases and oxygen solubility is decreased the increasing in temperature .In tap water temperature are ranging from 22 to 22.8 ℃ and while on the other point the values are different between 20.3—21.8℃ from the other sources. In water samples the temperature ranges from 21.1 to 22.1 ℃

3.3.6 Turbidity

The current study indicated the maximum turbidity 10 NTU.WHO (1996) approved that highest limit 25.6 NTU. Drinking water should have turbid of < 5NTU fit for human intake (Davis, 2002). Filter depends on source of dry way such as streams, rivers, lakes, and dams. The pollution is due to human and animals wastes which entered directly into the wells and tanks because of surface runoff by air pollution or rain. Turbidity values are under the range of permissible limit within WHO standard.

3.4 Chemical Parameters

In Pakistan (2025) population is predictable to grow due to this increase population directly affected the water resources such as domestic and agricultural needs. Now a time Pakistan has a scarcity of water. The value of both ground and surface water declining because of untreated industrial and municipal wastewater and extreme usage of fertilizers and insecticides due to this waste the water become polluted and effected human health by causing different water borne diseases like cancer may be caused (DAWN,1989).Water quality parameters like hardness carbonates, salinity and bicarbonates. Total hardness for hard water samples were ranging which are permissible limits of WHO, shown in table 3.3.

Table 3.3 chemical analysis results of water samples

Sample#	Cl^- mg/l	Na^+ mg/l	$NaHC0_3$ mg/l	Na_2CO_3 mg/l	HCO_3 mg/l	CO_3 mg/l	Hardness mg/l	Arsenic mg/l
01	42.5	27.7	8.4	10.6	6.1	6	0.56	0
02	41.5	26.3	8.3	10.5	5.9	5.7	0.66	0
03	106.2	69.3	8.1	10.3	5.7	5.4	0.56	0
04	104.1	66.5	8	10.1	5.5	5.1	0.52	0
05	24.8	16.2	7.9	10	5.4	5	0.57	0
06	24.3	15.6	8.5	10.7	6.2	6.1	0.56	0
07	67.3	44.1	8.6	10.8	6.3	6.2	0.55	0
08	65.9	42.8	8.4	10.6	6.1	6	0.52	0
09	17.7	11.6	8.5	10.7	6.2	6.1	0.52	0
10	18.2	12.5	7.8	8.9	5.8	5.6	0.55	0
11	95.6	62.4	8	10.1	5.5	5.1	0.52	0
12	96.3	60.2	7.9	10	5.4	5	0.66	0
13	28.3	46.8	7.5	9.1	5.1	4.9	0.7	0
14	30	20	7.4	8.9	5.7	4.8	0.7	0
15	21.2	13.9	8.4	10.6	6.1	6	0.88	0
16	20.1	14.6	8.3	10.5	5.9	5.7	0.7	0
17	73.6	48.1	8.1	10.3	5.7	5.4	0.68	0
18	70.5	45.3	8	10.1	5.5	5.1	0.88	0
19	46.02	30.03	7.9	10	5.4	5	0.55	0
20	45	35	8.5	10.7	6.2	6.1	0.77	0
21	38.2	24.95	10.8	12.72	7.32	7.2	0.53	0
22	37.5	25.5	10.2	12.72	7.32	7.2	0.66	0
23	22.7	14.7	8.4	10.6	6.1	6	0.51	0
24	22.1	15.1	8.5	10.7	6.2	6.1	0.67	0
25	85	55.2	7.4	8.9	5.7	4.8	0.80	0
26	84.5	51.3	12.6	15.9	9.15	9	0.54	0
27	31.9	20.7	8	10.1	5.5	5.3	0.49	0
28	30.5	18.5	8.1	10.2	5.6	5.2	0.39	0
29	29.7	19.44	8.3	10.6	6	5.5	0.62	0
30	28.9	20.3.	8.5	10.7	6.2	6	0.66	0

3.4.1 Sodium (Na)

It is a metabolic element and in color silver white and frequently found in low quality in water. There is a suitable amount of sodium in human body may avoid different disease like headache, kidney destruction and hypertension etc. Majority of the country water supplies allows the range of 20mg/but in some countries the quantity exceeded from 250mg/l (WHO, 1984). In study area the outcomes show its range from 11.6 to69.3 (mg/l)in tap water and tank water the concentration is 20.1 to85(mg/l)

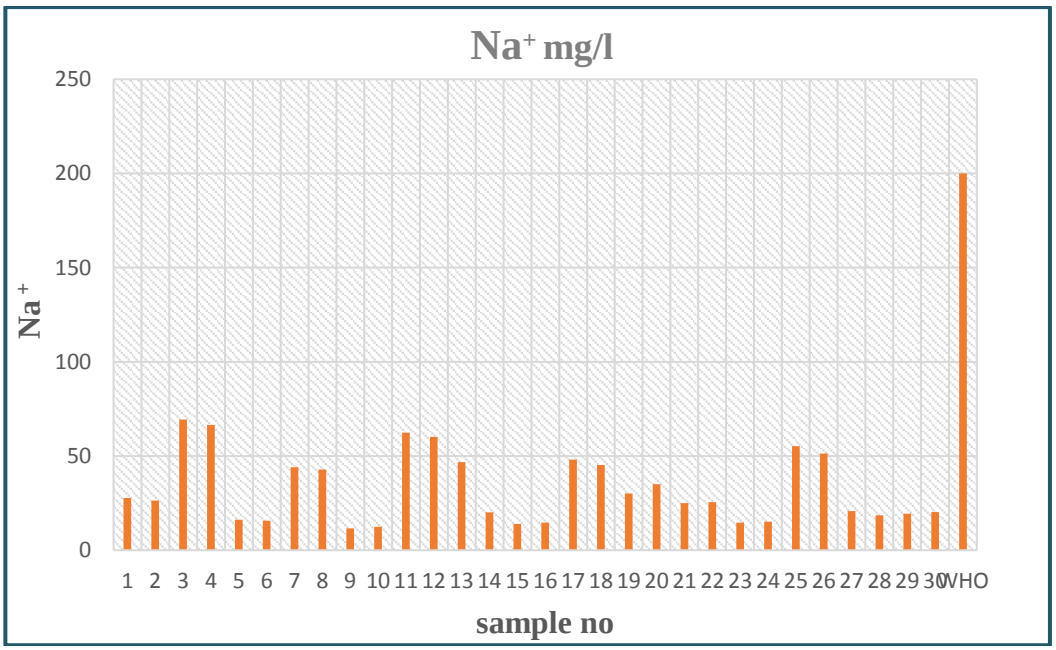

Figure 3.5 Concentration of Sodium in water samples

While in tank water sodium concentration vary from 13.9 to 48.1(mg/l)

A standard set by WHO for sodium range is 20mg/l for drinking water. All the analyzable samples are in the acceptable range of WHO. Higher concentration of sodium level in water may be dangerous for human health like hypertension and heart disease (Radojevic and Bashkin, 1999).

3.4.2 Chloride (Cl^-)

It is also related to the salt water. It is gained from the solution of table salt which is mixed in water through industrial waste and sea water etc. Surface water has lower concentration as compared to ground water. Higher concentration of chlorides may cause taste problems (Jain et al., 2005). The chloride ranges in tap water 17.7 to 106.2(mg/l)In this study chloride values in tank water were varied between 20.1 to 85 mg/l .

Chloride concentration for the drinking water quality is 25ml/l. which is set by WHO. In this study all samples were associated, and outcomes revealed that all finding were within the acceptable limit. If there is higher concentration of chloride present in water it effects irritation, gastrointestinal problem, dehydration and diarrhea (Shakirullah et al., 2005; Qadir, 2004).

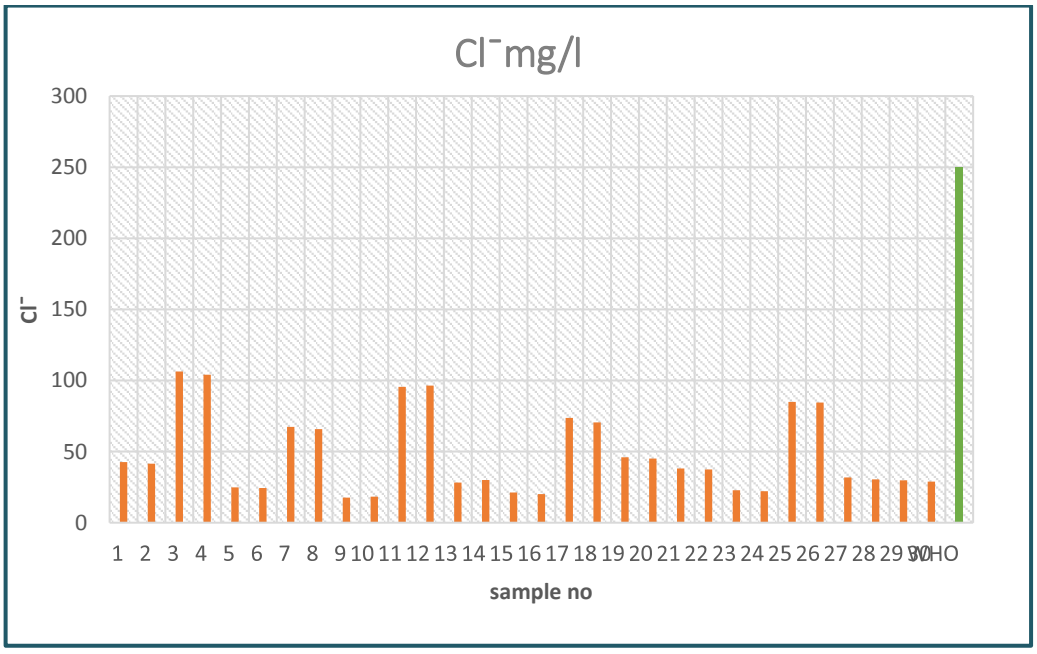

Figure 3.6 concentration of chlorine in water samples

3.4.3 Bicarbonates and Carbonates:

When carbon dioxide is dissolved in water under pressure carbonates are formed, they are use in industries extensively and used as a raw material for lime production and Portland cement for the alignment of ceramic. In aqueous solution it may occur in the form of carbonates, bicarbonate, and carbonic acid. In tap water carbonates concentration ranges from 5 to 6.2 mg/l as described in figure 3.3.

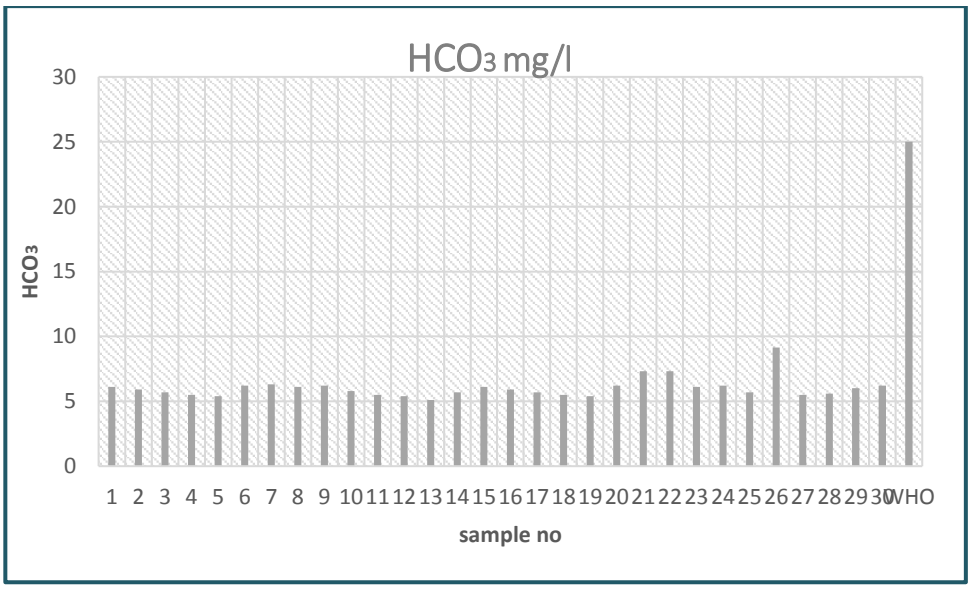

Figure 3.7 Concentration of bicarbonates in water sample

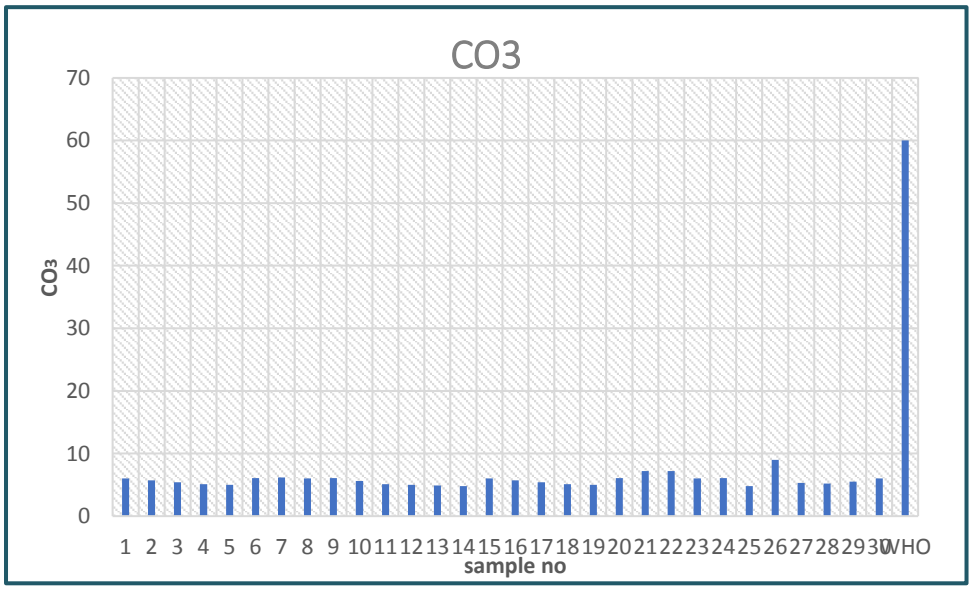

Figure 3.9 Concentration of carbonates in water sample

All results were compared with WHO standards which revealed that all the samples were within the acceptable limit describe by WHO. The value of 60mg/l shows the water is soft and above 60mg/l is a hard water which is not suitable for daily life activities.

3.4.4 Total Hardness.

WHO standard if water hardness is ranges from 0-50 mg/lit is considered soft water, if the value is exceeded from 150 -300 it is a hard water? The above sample analyzed showed that 80% is soft water and 20% is hard water and therefore hard water is not fit for human health it may causes different diseases .The present study results showed less values as compared to calcium hardness ranged 160-200mg/l (Jabeen and shedayi, 2011) Gilgit Pakistan.

Water hardness is due to the calcium and magnesium cation concentration in a water sample. The concentration of metallic ions combines with hardness anions and produce scales.

Higher concentration of hardness is harmful for economic reaction, and it must be removed before use. Levels above 50mg/l hardness are also toxic for domestic use and most drinking water supplies average about 250mg/l (Ahmed and Ali (1994) determined some values for calcium hardness in analyzing water quality from different cities of Punjab i.e., in between 100-200mg/ l.

Hardness below 300mg/l is considered potable but beyond this limit causes different ailment like cardiovascular diseases hypertension and mental disorders which are due to the usage of water hardness (Anon 1992).

The present studies results are in permissible limit which are set by WHO. In

tap water the values ranging from 0.7 to 0.88and results are described in figure 3.3.

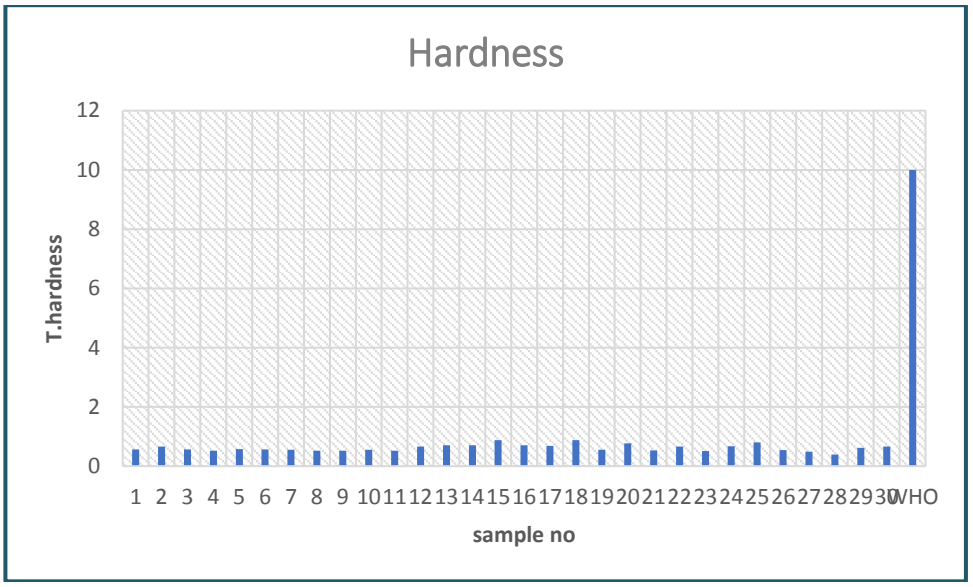

Figure 3. 9 Concentration of hardness in water samples

3.4.5 Heavy Metals Analysis.

In environment heavy metals are severe contaminant due to their bioaccumulation products and toxic effect (Nouri et al., 2008) when these metals are entered in different water sources by the anthropogenic activities like over usage of chemicals and municipal waste disposals. Most of them are important for human being overusing may cause water pollution and as a result unembellished health issues caused in both humans as well as living organisms (Mirdar-ul-Haq et al., 2005).All the samples were studied for the presence of different heavy metals like Ni, Pb, Cd,and Mn by using AAs vario 6 in PCRW laboratory.

Table 3.4 Heavy metals detection in water samples

Sample No	Ni^{+2} mg/l	Pb^{+2} mg/l	Cd^{+1} mg/l	Cr^{+3} mg/l	Mn^{+2} mg/l
1	0.01	0.03	0.01	0.06	0.01
2	0.02	0.04	0.02	0.07	0.02
3	0.02	0.04	0.009	0.02	0.3
4	0.03	0.05	0.01	0.03	0.4
5	0.011	0.03	0.01	0.03	0.02
6	0.012	0.04	0.02	0.04	0.03
7	0.02	0.03	0.009	0.045	0.1
8	0.03	0.04	0.001	0.046	0.3
9	0.03	0.06	0.02	0.07	0.3
10	0.04	0.07	0.03	0.08	0.1
11	0.01	0.03	0.014	0.06	0.4
12	0.02	0.04	0.015	0.07	0.3
13	0.002	0.02	0.003	0.01	0.1
14	0.003	0.03	0.004	0.02	0.02
15	0.009	0.04	0.015	0.05	0.1
16	0.01	0.05	0.016	0.06	0.5
17	0.01	0.01	0.011	0.02	0.5
18	0.02	0.02	0.012	0.03	0.06
19	0.011	0.01	0.01	0.05	0.04
20	0.012	0.02	0.02	0.06	0.06
21	0.005	0.03	0.005	0.01	0.001
22	0.006	0.04	0.006	0.02	0.002
23	0.014	0.02	0.014	0.06	0.02
24	0.015	0.03	0.015	0.07	0.03
25	0.02	0.01	0.007	0.03	0.03
26	0.03	0.02	0.008	0.04	0.03
27	0.012	0.01	0.009	0.05	0.01
28	0.013	0.02	0.001	0.06	0.04
29	0.02	0.02	0.01	0.04	0.05
30	0.02	0.04	0.02	0.05	0.05
WHO	0.02	0.04	0.005	0.05	0.5

3.4.6 Nickle (N)

Nickle is the most allergenic in nature due to this it is known as allergen of the year, in 2008 because it is noxious in the environment and can also be identified in all areas of the environment (Duda-Chodoc and Blaszczyk, 2008). It may cause different health special effects like nickel allergy when came in to contact with skin, kidney problem, heart diseases and respiratory tract cancer (Coller et al.,1997).When Ni is consumed in higher amount it may cause fatal effect in human health. If a human visible to Ni free radical can produce in body and can affect the enzyme activity and the DNA structure (Das et al., 2008)

In the following water sample Ni concentration are ranges from 0.01 to 0.012mg/l as shown in the figure. All samples were compared with the standard limits of WHO 0.02mg/l which revealed that all results in which samples that shows higher concentration of Ni and remaining samples are in permissible limit which are set by WHO.

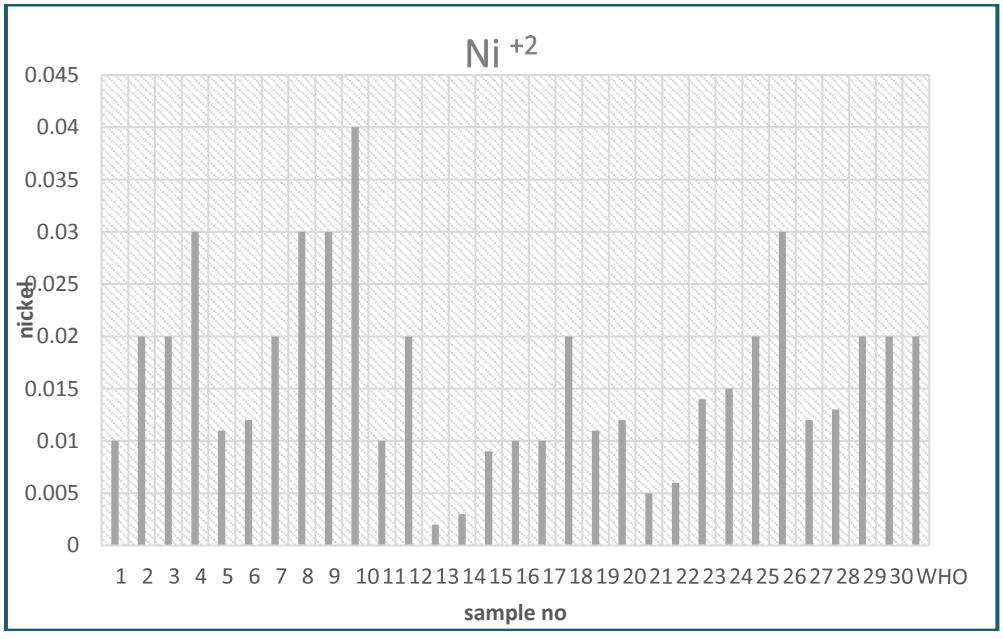

Figure 3.10 Concentration Nickel in water sample mg/l

3.4.7 Lead (Pb)

Lead Pb show a significant role for human health .Higher concentration of Pb in drinking may affect mantle and physical health of newborn babies and young ones. It also causes some ailments in human such as hypertension and kidney problems (Qadeer, 2004). Pb concentration in tap water ranges from 0.02 to 0.07mg/L which are shown in figure 3.12

Higher concentration of pb that is 0.07 and 0.06 which are found in tap water 9 and tap water 10.Reamaining samples are revealed the permissible limit which are set by WHO. The concentration of lead in tank water varies from o.o1-0.04mg/l in tank water all samples are in permissible limit and the water is safe for all purposes.

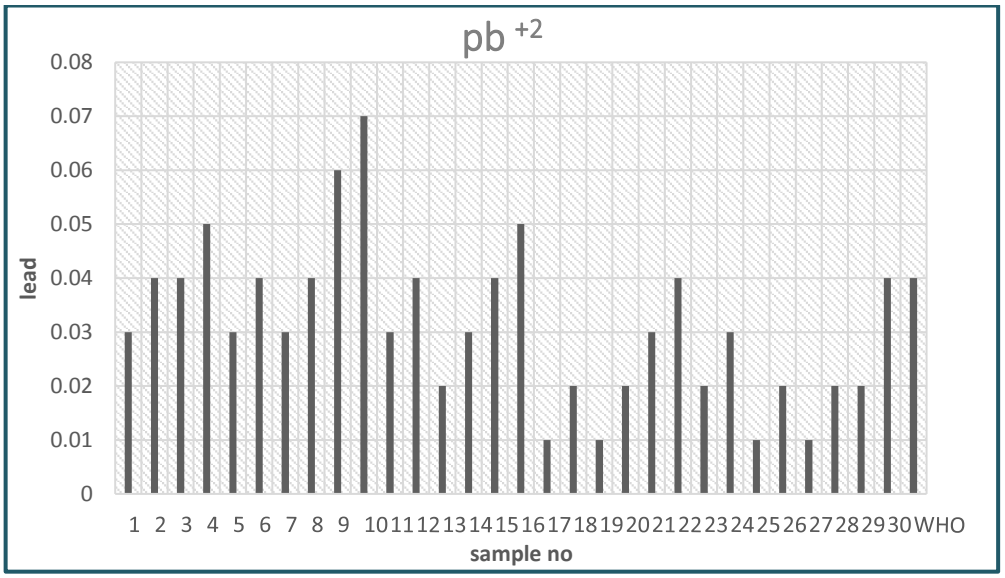

Figure 3.11 Concentration of Lead Pb in water samples mg/l

When there is a higher amount of pb is found in drinking water it may cause different ailments in human blood (ATSDR,1993) Pb is present in the form of inorganic that is digest through water, food, and inhalation **(ferner,2001**).The most dangerous issue of Pb is tetratomic effect related with lead noxiousness.

3.4.8 Cadmium (Cd)

It is not a very important metal and occurs both naturally and toxic as well. In aquatic organism and plants cd take part in different metabolic events, then finally enter a food chain (Hoque and Deb, 2016) the dangerous suitable concentration of cadmium in drinking water is 0.005mg/l given by WHO. All samples of the tap water are ranges from 0.01 to 0.05. In tap water tap 1 and tap5 are normal and under the permissible limit while other remaining samples shows higher concentration of Cd in water.

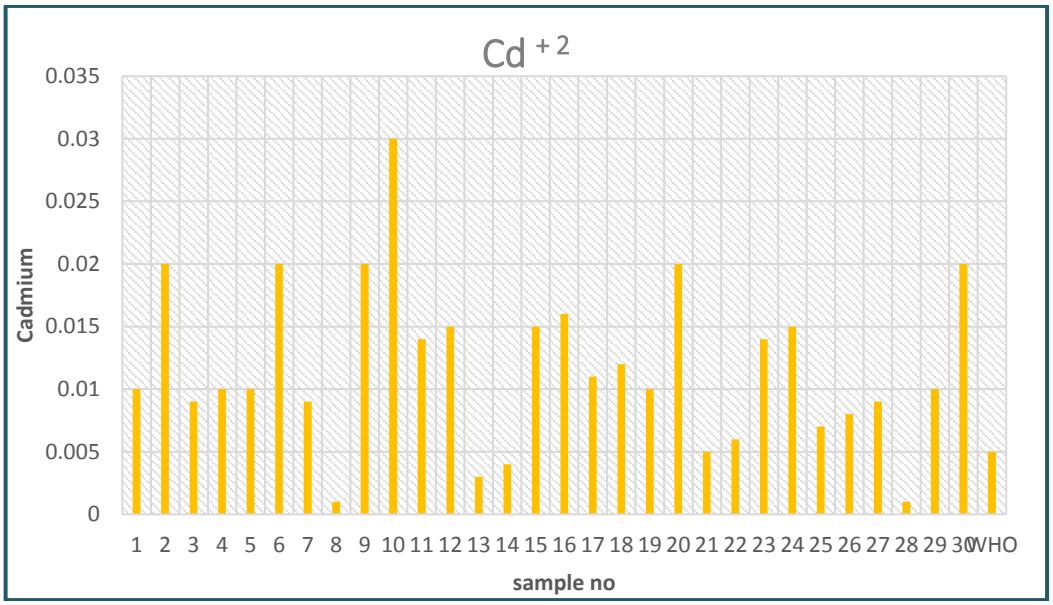

Figure 3.12 Concentration of cadmium in tap water mg/l

The concentration of Cd is in the permissible limit of WHO while other 12 samples revealed higher concentration of cd in water as shown in figure 3.13

3.4.9 Chromium (Cr)

Chromium is found on the top of the earth and in natural environment. Main source of chromium are wastes which are produced from metal industries and electro plating (Deb and Hoque, 2016) but there are no industries in a study area that can release chromium in the water it can dissolve in water rocks and surface runoff. Chromium is also produced from leather burning chrome coating and treatment of different wood materials. All samples gathered from different sources were studied for the presence of Cr. In tap water Cr concentration in all samples are ranged from 0.01 to 0.046mg/l as shown in the Figure in which the higher concentration of Cr was found in 2 of them while other samples are in a permissible limit which are set by WHO that is 0.05mg/l.

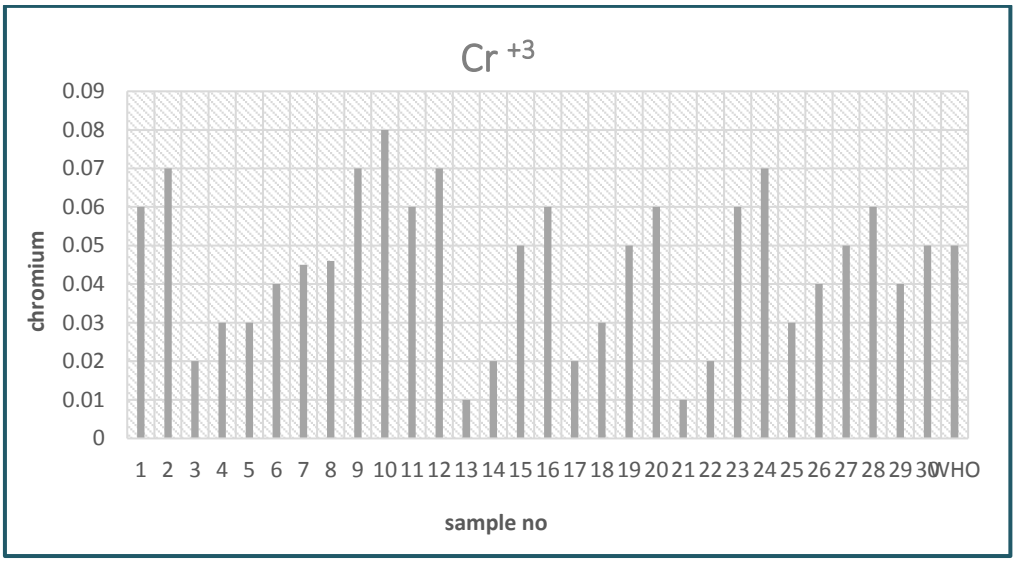

Figure 3.13 Concentration of chromium in water samples mg/l

Though chromium is significant for body but when higher concentration of Cr is consumed, it creates kidney problems (Strachan, 2010).If Cr is present in human body for a long period of time it can destruct respiratory functions and cause lung cancer (Henritig, 2006)

3.4.10 Manganese (Mn)

It is significant for human health and naturally found in surface and ground water. Humans are open to very low amount of Mn in drinking water as related to the amount of Mn consumption by different foods. Most of Mn was melted in water due to anthropogenic activities (USEPA, 2004). Concentration of Mn in Tap water are ranged from 0-0.2 mg/L as shown in the Figure 3.15. All samples are within the permissible range.

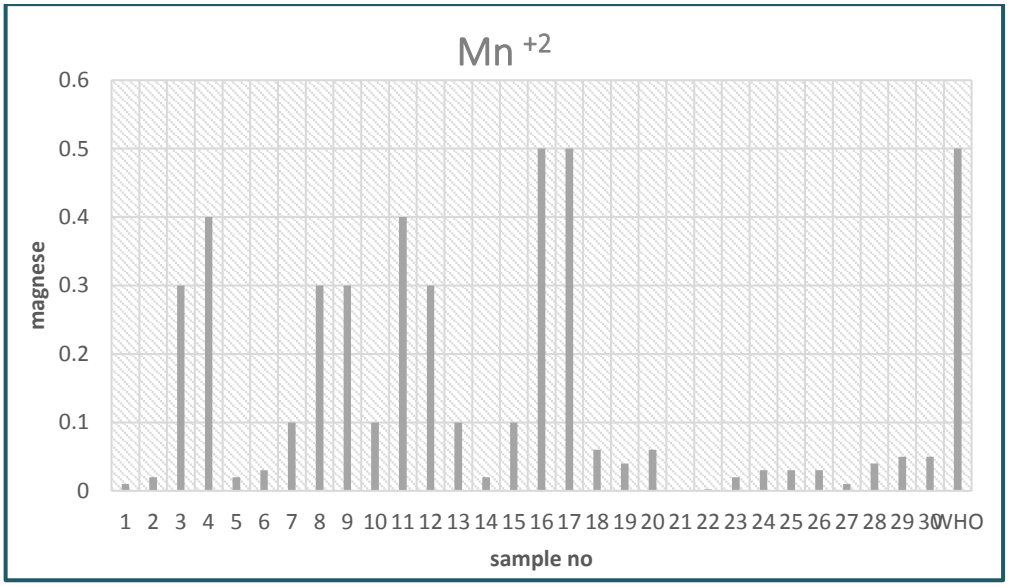

Figure 3.14 Concentration Manganese in water samples mg/l

It is important nutrient for all living organism because it controls many enzymes function in the body (Emsley, 2003). Extra amount may cause generative problems, skeletal abnormalities, and faults in carbohydrate and lipid metabolisms, exhaustion and mental disease (WHO, 1996). Due to overexposure, poorest form of Mn is in the form of neurological complaints with the indications like Parkinson's disease (Inoue and Makita, 1996).

CONCLUSIONS

All the results showed that mostly water is contaminated with salmonella and shigella bacteria.

- The physicochemical parameters showed pH values of water samples sample is higher than the neutral pH. Few samples of drinking water were within the permissible limits, and few indicate the limits above them the acceptable level. TDS values for all samples were within the permissible range, Turbidity levels of all samples were within acceptable range, Concentration of Na and Cl were also within the permissible limits. Total hardness, Ca and Mg range were also within acceptable limits.
- Heavy metals examination showed that most samples of drinking water were found safe with metals. Pb, Cr and Mn in all samples of drinking water were found within the permissible range of standard set by WHO and Pak-EPA. Concentration of Ni was found above the permissible level in few samples of drinking water. Chromium was also showing increasing level in analysis of drinking water.
- It was determined from the study that quality of water in the selected areas is not suitable.
- Few samples of drinking water showed the presence *of E. Coli, Salmonella and Shigella bacteria.* Heavy metals results were within permissible range except Ni and Cr range was higher than acceptable level in several samples of drinking water. It was observed that naturally metals are entering into the water from the environment although there is no industry was found in the particular study area.

RECOMMENDATIONS

Based on the outcomes of this study it is recommended that:

- Create awareness among people about water quality and treatment of water should be started.
- Water treatment plants or facilities should be installed in each town and villages.
- Intensive research should be conducted on water quality parameters.

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