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Water Quality Analysis of Nekemte Town Water Supply

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Abstract: This study aimed to assess and compare water quality of Nekemte Town water supply with WHO standards and suggest suitable solutions for water quality problem. Certain physical and chemical water quality parameters like turbidity, color, odor, electrical conductivity, pH, sulfates, iron and manganese, zinc, copper, sulfates, nitrates, nitrites, chromium, and similar parameters were examined in water quality laboratory to check quality of Nekemte town water supply. To check water quality of Nekemte Town Water Supply, water sample was collected randomly at different sampling times and different sampling sites. From laboratory work, most of water quality parameters like turbidity, pH, iron and manganese, residual chlorine content were found not to agree with the standard set by WHO. In case of turbidity analysis, water sample was collected randomly at different sites and different sampling times and the mean turbidity values were 5.1, 4.2 and 6.3NTU. These values do not agree with the WHO standard limit of 5NTU. In similar manner Iron and manganes ewere sampled and analyzed in laboratory at different times and the mean values for iron were found to be 0.547, 0.403 and 0.556mg/L which is greater than the WHO guide value of 0.3mg/L. In similar way, the concentration of manganese was analyzed in water quality laboratory at different sampling times and different sampling sites and the results were 0.4, 0.867 and 0.46mg/L as observed from laboratory result. In addition to this, the study shows that there is color and odor problem in the water supply of the town. On the other hand, water quality parameters like nitrates, nitrites, sulfates, chromium, copper, zinc, potassium, Fluorine were found to agree with the standard set by World Health Organization (WHO). To save the residents of Nekemte Town, the study suggests regular monitoring of water quality should be practiced by municipality of Nekemte town to provide safe drinking water.

Keywords: Water, Analysis, Laboratory, Quality, Sample, Concentration

1. Introduction

"Water quality" is a term used here to express the suitability of water to sustain various uses or processes. Any particular use will have certain requirements for the physical, chemical or biological characteristics of water; for example limits on the concentrations of toxic substances for drinking water use, or restrictions on temperature and pH ranges for water supporting invertebrate communities [1]. Consequently, water quality can be defined by a range of variables which limit water use. Although many uses have some common requirements for certain variables, each use will have its own demands and influences on water quality. Quantity and quality demands of different users will not always be compatible, and the activities of one user may restrict the activities of another, either by demanding water of a quality outside the range required by the other user or by lowering quality during use of the water.

Increase in urbanization, industrialization, agriculture activity and various human activities have increased the pollution of surface water & ground water [2]. Safe & potable drinking water is needed for human beings. Therefore, Water should be free from the various contaminations, Organic and Inorganic pollutants, Heavy metals, Pesticides etc. as well as all its parameter like pH, Electrical Conductivity, Calcium, Magnesium, Total Hardness, Carbonate, Bicarbonate, Chloride, Total Dissolved Solid, Alkalinity, Sodium, Potassium, Nitrate, DO should be within a permissible limit. To treat water in order to bring in a permissible limit, various treatment methods are adopted to raise the quality of drinking water.

Water plays an indispensable role in sustenance of life and it is a key pillar of health determinant, since 80% of diseases in developing countries are due to lack of good quality water. Poor water quality continues to pose a major threat to human health. Diarrhoeal disease alone amounts to an estimated 4.1% of the total Disability-Adjusted Life Years (DALY) global burden of disease and is responsible for the deaths of 1.8 million people every year [9]. Consequently, water borne diseases such as cholera and typhoid often have their outbreak especially during dry season. High prevalence of diarrhea among children and infants can be due to the use of unsafe water and unhygienic practice. Thus, many infectious diseases are transmitted by water through fecal oral contamination. Diseases due to drinking of contaminated water leads to the death of five million children annually and make 1/6 of the world population sick [10].

Municipal water required for domestic uses, particularly the water required for drinking must be colorless, odorless and tasteless. It should be free from turbidity, and excessive or chemical compounds. Harmful microorganisms and radio activity must be absent. The quality of water for municipal supplies is therefore, generally controlled throughout the world, and even world health organization has laid down its standards for potable waters [7].

To monitor the water resource and ensure sustainability, national and international criteria and guidelines established for water quality standards are being used [12, 13]. The chemistry of water is very dynamic, largely controlled and modified by its medium of contact. Since the chemistry of water directly hints the quality of water for various purposes, its monitoring and assessment gained substantial importance in the present century. A tremendous increase in the population increased the stress on both surface and the groundwater [8].

This study is very helpful for Nekemte town residents. Depending on the findings of the study suitable water treatment methods will be proposed so that the community will get safe and clean water.

2. Material and Methods

2.1. Study Area

Nekemte is located western of Ethiopia in East Wollega Zone at 328km from Addis Ababa, the capital city of Ethiopia. Its water supply source is surface source of water retained by maqa dam around Diga and constructed under supervision of Desta Horecha general Consultant.

Pre- work

In data collection, before lab analysis the following were followed:

Previous works were revised, literature review related to water quality analysis and other related study was reviewed.

The feasibility reports of the area were reviewed to get insight about the problem and to show the direction of the work.

Necessary equipment's were acquired for laboratory work.

2.2. Materials Required for Laboratory Work

The following were list of materials and chemicals required for the laboratory work:

Turbidity meter

pH meter

Conductivity meter

Electronic balance

Sampling bottles

Digital camera

Filter paper

Nutrient agar and chemicals for microorganism determination

Sample holding bag

Coagulants- aluminum sulfate, and

Materials required for biological examination are some of the basic equipment.

Note the above materials are some of the materials required for the laboratory work. In addition to the above tests, water hardness, fluoride content, nitrate content, chloride, alkalinities, potassium content were examined.

Sampling Work

Water sample were collected from house connection at different times and at different sampling points. For Sample handling purpose, collected sample were kept in plastic bottles and taken to the laboratory for analytical purpose.

Laboratory test

The parameters used to determine the water characteristics such as turbidity, microorganism, pH, Fluoride (F^-), Electrical Conductivity (EC), Total Dissolved Solid (TDS), Calcium (Ca), Magnesium (Mg), Total Hardness (TH), Chloride (Cl^-), Carbonate (CO_3^{-2}), Bicarbonate (HCO_3^-), Alkalinity, Sodium (Na^+), Potassium (K^+) and Nitrate (NO_3^-) were determined.

3. Result and Discussion

To check the acceptability of Nekemte town Water Supply for consumption purpose, selected water quality parameters were analyzed in water quality laboratory for randomly selected sites at different times. The concentration of different water quality parameters that exist in Nekemte Town Water Supply were analyzed with the help of spectrophotometer except few parameters that were analyzed with different instruments like turbidity by turbidity meter, conductivity by conductivity meter and pH by pH meter. A spectrophotometer is a device used to measure light at a specific wavelength. It consists of two parts: a spectrometer and a photometer. The spectrometer provides light at a specific wavelength. The photometer measures how intense the light is. By calculating the amount of light that a solution is able to absorb and applying Beer's Law, the spectrophotometer can determine the concentration of a colored solution. Accordingly the different water quality parameters were analyzed physically, chemically and biologically and the results are discussed in the following discussions.

3.1. Physical Water Quality Analysis

The physical analyses of water are very important as they are the first visibly noticeable factors. Ideally water should be colorless and odorless with a neutral pH. Presence of dissolved components like clay, silt, algal materials, etc. makes water turbid and a pH change can make it corrosive.

3.1.1. Turbidity

Turbidity is caused in natural waters by finely divided suspended particles of clay, silt, sand or by some organic materials and microscopic organisms. Turbidity meters are generally used to measure the turbidity of a given water sample. Turbidity is considered to be very important factor in drinking water due to aesthetic and psychological reasons, besides being a sign of pollution in some particular cases. In modern days, the turbidity measurements are made conveniently and easily through the use of photo meters. A beam of light from source, produced by a standardized electric bulb, is passed through a sample vial. The light that emerges from the sample is then directed to a photometer that measures the light absorbed. The read out is calibrated in terms of turbidity, usually measured in formazine turbidity unit (FTU). The FTU is based on a chemical, formazine that provides a more reproducible result, and hence has replaced silca standard unit. One FTU may be defined as the turbidity produced by 1 mg of formazine polymer in 1 liter of water.

A second method of measuring turbidity is by using the principle of scattering of light rather than the principle of absorption of light. In such an instrument, the sample "scatters" the light that impinges on it. The scattered light is then measured by putting the photometer at right angles to the original direction of the light generated by the light source. This measurement of light scattered at 90° angles is called a nephlometry; and the unity of turbidity in such an instrument is known as Nephlometric turbidity unit (NTU). These modern compact instruments are all calibrated and digitized, and can be easily used to measure turbidities of a given water sample in a short time in the laboratory. The permissible turbidity for drinking water is usually kept below 5 NTU according to World Health Organization, WHO, standard. From this research work it can be understood that the turbidity of water fluctuates from time to time and from sampling point to sampling point. The mean values of sample at different sampling time and at different sampling locations are indicated in the following table:

Table 1. *Turbidity measurement of water sample.*

Selected Parameter, NTU	WHO guide Value	Mean value of 1st round sampling	Remark for 1st round sampling	Mean value of 2nd round sampling	Remark for 2nd round sampling	Mean value of 3rd round sampling	Remark for 3nd round sampling
Turbidity, NTU	<5NTU	5.1	unacceptable	4.2	Acceptable	6.3	unacceptable

As it can be observed from the above table, turbidity of Nekemte Town Water Supply fluctuates from time to time and from sampling point to sampling point. This indicates that the water supplied for the community is not acceptable from healthy point of view as turbidity indicates presence of impurity in water in addition to aesthetics problem.

3.1.2. Odor

Odor in water is caused by the presence of algae, leaves, decaying vegetables, or contamination from sewage and industrial waste. The odor in a given water sample is determined at a temperature of 24 to 25°C. For Nekemte Water Supply, as we have observed from the samples collected at different times, the odor of water is not acceptable at different sampling times and from different sampling locations. Mostly, the odor of water is muddy.

3.1.3. Color

Dissolved organic matter from decaying vegetation, or some inorganic matter such as colored soils may impart color to water. The excessive growth of algae and aquatic microorganisms may also impart color to water. The presence of color in water is not objectionable from health point of view, but may spoil the color of the clothes if washed in such waters. Colors in water are also objectionable from aesthetic and psychological point of view, since people do not like to drink colored waters. In case of Nekemte town Water Supply, we have observed water sample collected from different area and the color of water observed at different area was found to be reddish in color. This indicates that the water contains either mud or materials related to soil.

3.2. Chemical Water Quality Analysis

Ideally pure water should be non-reactive; however presence of some chemicals can alter this property and adversely affect health. Though tap water supplied is chlorinated, excessive chlorine generates chloroform which is carcinogenic. Also nitrates can impair oxygen transport in the body causing brain death, while fluoride can cause dental fluorosis and affect skeletal tissues. Sulfide causes diarrhea, while anionic detergents if ingested, change the pH of blood and can also burn the tissues.

3.2.1. PH of Water

The pH value of water is defined as the log of reciprocal of hydrogen ions present in water. A pure water is, in fact, a balanced combination of positively charged hydrogen ions and negatively charged hydroxyl ions; both ions being equal. The pH value of such pure water is 7. If pH of water is found to be less than 7, the water is acidic in nature and if its pH is found to be more than 7, the water will be alkaline in nature. The pH value of raw water in fact must be taken into account, while deciding the various treatment processes like coagulation, disinfection, water softening, etc. The pH value also becomes important in corrosion control, since lower pH values may cause tuberculation and corrosion of the pipes and treatment tanks, etc. Higher pH values on the other hand, produce incrustation, sediment deposit, difficulty in chlorination, besides producing certain psychological effects on human system, if such alkaline waters are consumed. The permissible pH values for public supplies range between 6.5 to 8.5. In case of Nekemte Town Water Supply, the pH of the water at different sampling time and at different randomly selected sites was analyzed and the mean values of the pH of water sample were presented below.

Table 2. *pH measurement of water sample.*

Selected parameter	WHO guide Value	Mean value of 1st around sampling	Remark For 1st round sampling	Mean value of 2nd round sampling	Remark For 2nd round sampling	Mean value of 3rd round sampling	Remark For 3rd round sampling
pH	6.5-8.5	7.007	Acceptable	7	Acceptable	6.4	Unacceptable

As it can be observed from the above table, the pH of water does not remain at neutral pH. It sometimes falls below neutral pH at some sampling locations and above the neutral pH at another sampling location at different sampling times. This fluctuations show also that there is a problem with respect to pH. As it is known, a lower pH values are associated with acidic waters where as higher pH values are properties of alkaline waters. Acidic waters are more likely to cause corrosion problem in pipe lines and metallic taste to drinking water. Beside this, acidic waters are not recommended to drink from healthy point of view. On the other hand, alkaline waters cause deposition of scales ($CaCO_3$) in pipe lines and incrustation of water supply pipes.

3.2.2. Electrical Conductivity

Electrical conductivity shows concentrations of dissolved minerals that exist in water body. If concentration of dissolved mineral that exist in water sample is more the electrical conductivity of the water will be more. On the other hand, if concentration of dissolved minerals that exist in water sample is low, electrical conductivity of the water will be small. According to world Health Organization for a water to be used for consumption purpose, conductivity of water should fall within 0 to 800 µs/cm. For Nekemte town water supply project, water samples were collected at different time and at different sampling locations and the mean values of electrical conductivities of the sample were indicated in the following table:

Table 3. *Electrical conductivity measurement of water sample.*

Selected parameter	WHO guide Value, µs/cm	Mean value of 1st round sampling, µs/cm	Remark for 1st round sampling	Mean value of 2nd round sampling, µs/cm	Remark for 2nd round sampling	Mean value of 3rd round sampling, µs/cm	Remark for 3rd round sampling
EC	**0-400**	99.333	Acceptable	66.667	Acceptable	110.241	Acceptable

As it can be seen from the result analysis for Nekemte town water supply, the conductivity of the water sample is within acceptable range of WHO guideline.

3.2.3. Copper in Drinking Water

The major source of copper in drinking water is corrosion of household plumbing, faucets, and water fixtures. Water absorbs copper as it leaches from plumbing materials such as pipes, fittings, and brass faucets. The amount of copper in water depends on the types and amounts of minerals in the water, how long water stays in the pipes, the water temperature and acidity.

Copper from plumbing corrosion can accumulate overnight. Running cold water from the tap for about one minute can reduce copper that accumulates when household plumbing is not in use. Use cold water for drinking and cooking. Because hot water dissolves more copper than cold water, limit consumption of water from the hot water tap.

Sample collected from Nekemte Town water Supply was examined in laboratory and the result is here presented in the following table. As it can be seen from the table, the concentration of copper in drinking water satisfies World Health Organization guideline and it is acceptable.

Table 4. *Copper concentration in water sample.*

Selected parameter	WHO guide Value, mg/L	Mean value of 1st around sampling, mg/L	Remark on 1st round sampling	Mean value of 2nd round sampling, mg/L	Remark on 2nd round sampling	Mean value of 3rd round sampling, mg/L	Remark on 3rd round sampling
Copper	1	0.01	Acceptable	0.257	Acceptable	0.03	Acceptable

3.2.4. Zinc in Drinking Water

Zinc imparts an undesirable astringent taste to water. Tests indicate that 5% of a population could distinguish between zinc-free water and water containing zinc at a level of 4 mg/L (as zinc sulfate). The detection levels for other zinc salts were somewhat higher. Water containing zinc at concentrations in the range 3–5 mg/L also tends to appear opalescent and develops a greasy film when boiled. Atomic absorption spectrophotometry is the most widely used method for the determination of zinc. For determination of zinc concentration in Nekemte water supply project, water quality examination was carried out and the result is present in the table:

Table 5. *Zinc concentration in water sample.*

Selected Metals, mg/L	WHO guide Value, mg/L	Mean value of 1st around sampling, mg/L	Remark for 1st round sampling	Mean value of 2nd round sampling, mg/L	Remark for 2nd round sampling	Mean value of 3rd round sampling, mg/L	Remark for 3rd round sampling
Zinc, Zn	3	0.47	Acceptable	0.817	Acceptable	1.132	Acceptable

As it can be seen from the table, concentration of Zinc in Nekemte Town water supply project is within acceptable guide value of World Health Organization, WHO.

3.2.5. Chlorine Residual

The presence of chlorine residual in drinking water indicates that sufficient amount of chlorine was added initially to the water to inactivate the bacteria and some viruses that cause diarrheal disease and the water is protected from recontamination during storage. The presence of free residual chlorine in drinking water is correlated with the absence of disease-causing organisms, and thus is a measure of the portability of water.

A residual concentration of free chlorine of greater than or equal to 0.5 mg/L after at least 30 minutes contact time at pH less than 8.0 is desirable. This definition is only appropriate when users drink water directly from the flowing tap. A free chlorine level of 0.5 mg/Liter of free chlorine will be enough residual to maintain the quality of water through the distribution network, but it is most likely not adequate to maintain the quality of the water when this water is stored in the home in a bucket or jerry can for 24 hours.

Thus the following recommendations can be made:

At 30 minutes after the addition of sodium hypochlorite there should be no more than 2.0 mg/L of free chlorine residual present (this ensures the water does not have an unpleasant taste or odor).

At 24 hours after the addition of sodium hypochlorite to containers that are used by families to store water there should be a minimum of 0.2 mg/L of free chlorine residual present (this ensures microbiologically clean water).

Water samples collected from different sampling points and different sampling times are indicated in the following table for Nekemte town water supply.

Table 6. *Residual chlorine concentration in water sample.*

Selected parameter, Mg/L	WHO guide Value, mg/L	Mean value of 1st around sampling, mg/L	Remark for 1st round sampling	Mean value of 2nd round sampling, mg/L	Remark for 2nd round sampling	Mean value of 3rd round sampling, mg/L	Remark for 3rd round sampling
FCR, mg/L	**0.3-0.5**	0.307	Acceptable	0.173	unacceptable	0.213	unacceptable

As it can be seen from the table, the residual chlorine that exists in water is not acceptable since most of the concentration of residual chlorine is out of WHO guide value. This means that, the residual chlorine is not sufficient enough to prevent water from cross contamination and kill any pathogen that may exist in water supply pipeline.

3.2.6. Sulfate in Drinking Water

Sulfates are discharged into water from mines and smelters and from kraft pulp and paper mills, textile mills and tanneries. Sodium, potassium and magnesium sulfates are all highly soluble in water, whereas calcium and barium sulfates and many heavy metal sulfates are less soluble. Atmospheric sulfur dioxide, formed by the combustion of fossil fuels and in metallurgical roasting processes, may contribute to the sulfate content of surface waters. Sulfur trioxide, produced by the photolytic or catalytic oxidation of sulfur dioxide, combines with water vapor to form dilute sulfuric acid, which falls as “acid rain” [3]. Sulfate in aqueous solutions may be determined by a gravimetric method in which sulfate is precipitated as barium sulfate; the method is suitable for sulfate concentrations above 10 mg/L. But for Nekemte Town Water Supply project we used spectrophotometry which measures the concentration of sulfate in drinking water. Accordingly, the analyzed water quality parameter verses it’s WHO standards are indicated in the following table:

Table 7. *Sulfate concentration in water sample.*

Selected parameter	WHO guide Value, mg/L	Mean value of 1st around sampling, Mg/L	Remark for 1st round sampling	Mean value of 2nd round sampling, Mg/L	Remark for 2nd round sampling	Mean value of 3rd round sampling, Mg/L	Remark for 3rd round sampling
Sulfates, SO^-_4	250	17.667	Acceptable	12	Acceptable	21.612	Acceptable

From laboratory work, it was investigated that the sulfate concentration in Nekemte Town Water Supply is less than the WHO guideline. Therefore, there is no water quality deviation from WHO guide value with respect to sulfate concentration.

3.2.7. Iron and Manganese in Drinking Water

Iron and Manganese are natural constituents of soil and rocks.

Usually natural waters have an iron content which is greater than manganese content.

Waters are seldom found to have iron levels greater than 10 mg/l or manganese levels greater than 2 mg/l.

Iron exists in the +2 or +3; oxidation states, whereas manganese exists in the +2, +3, +4, +6, or +7 oxidation states. However, iron (III) and manganese (IV) are the only stable oxidation states found in waters containing oxygen.

The presence of significant amounts of either or both of these metals in a water supply can create several problems for the consumers. The problems caused by the presence of iron including: Large concentration of iron impart a metallic taste to the water.

Industrial products such as paper, textiles, or leather may be discolored

Household fixtures such as porcelain basins, bathtubs, glassware, and dishes are stained.

Clothes may stain a yellow or brown-yellow color.

Iron precipitates clog pipes and promote the growth of gelatinous masses of iron bacteria. These bacteria slough off and create "red water".

Iron bacteria may cause odor and taste problems, particularly, when the flow in pipes is low.

The problems caused by the presence of manganese are similar to those of iron: High concentrations of manganese may produce taste problems.

Manganese may cause a discoloration of industrial products similar to that caused by iron.

Household fixtures may be stained a brown or black color.

Clothes may be stained and become dingy or grayish.

Iron (Fe) and manganese (Mn) can be present in water in one of three basic forms: 1. Dissolved: ferrous (Fe^{2+}) and manganous (Mn^{2+}) states.

Particulate: ferric (Fe^{3+}) and manganic (Mn^{4+}) states.

Colloidal: very small particles (difficult to settle and filter).

The predominance of one form another is dependent on the pH, redox potential, and temperature of the water. Knowledge of the forms or states of iron and manganese can help fine-tune a given treatment practice for these metals.

Depending on laboratory work, Nekemte Town Water Supply was sampled and analyzed at different time at different randomly selected sites and the results determined verses WHO guide values were presented in the following table:

Table 8. *Iron and Manganese concentration in water sample.*

Selected parameter	**WHO guide Value, mg/L**	**Mean value of 1st around sampling, Mg/L**	**Remark for 1st round sampling**	**Mean value of 2nd round sampling, Mg/L**	**Remark for 2nd round sampling**	**Mean value of 3rd round sampling, Mg/L**	**Remark for 3rd round sampling**
Iron, Fe	0.3	0.547	unacceptable	0.403	unacceptable	0.556	unacceptable
Manganese, Mn	0.1	0.4	unacceptable	0.867	unacceptable	0.46	Unacceptable

From laboratory work it was verified that Nekemte Town Water Supply is high in concentration of both iron and manganese than the one stated by world Health Organization guide line. Since the two minerals exceed the maximum limit, the two minerals create problem to users.

3.2.8. Fluorine in Drinking Water

Fluorine is widely found in ground water than in surface water. In Ethiopia large concentration of fluorine is found in Rift Valley Regions like Adama, Awasa and similar areas. If present in optimal amount, fluorine will be useful for human beings. Fluorine up to 1.2 p.p.m will prevent dental caries of children. Excess concentrations (more than 1.5 p.p.m) can cause dental fluorosis or mottled enable in children, [4]. In case of Nekemte town, fluorine concentration in drinking water is found at low concentration. As a result of this there is no healthy problem with regard to fluoride.

Table 9. *Fluoride concentration in water sample.*

Selected parameter	**WHO guide Value, mg/L**	**Mean value of 1st around sampling, Mg/L**	**Remark for 1st round sampling**	**Mean value of 2nd round sampling, Mg/L**	**Remark for 2nd round sampling**	**Mean value of 3rd round sampling, Mg/L**	**Remark for 3rd round sampling**
Fluoride, F^-	1.5	BDL	Acceptable	BDL	Acceptable	BDL	Acceptable

BDL=below detectable limit

3.2.9. Chromium and Potassium in Drinking Water

Chromium, when inhaled can cause cancer in man, though the results of ingestion are unknown. The likely sources of hexavalent chromium in water could be pollution by wastes from chromium plating shops. Depending on laboratory work, Nekemte Town Water Supply was sampled and analyzed at different time, at different randomly selected sites and the mean results of chromium verses WHO guide values were presented in the following table:

Table 10. *Chromium concentration in water.*

Selected parameter,	**WHO guide Value, mg/L**	**Mean value of 1st around sampling, Mg/L**	**Remark for 1st round sampling**	**Mean value of 2nd round sampling, Mg/L**	**Remark for 2nd round sampling**	**Mean value of 3rd round sampling, Mg/L**	**Remark for 3rd round sampling**
Chromium, Cr^{+6}	0.05	0.043	Acceptable	0.043	Acceptable	0.04	Acceptable

As can be verified from laboratory work, the concentration of chromium in Nekemte town water supply is within WHO guide value and there is no problem expected as can be observed from the laboratory result.

Potassium is an essential element in humans and is seldom, if ever, found in drinking water at levels that could be a concern for healthy humans. It occurs widely in the environment, including all natural waters. It can also occur in drinking-water as a consequence of the use of potassium permanganate as an oxidant in water treatment. In some countries, potassium chloride is being used in ion exchange for household water softening in place of, or mixed with, sodium chloride, so potassium ions would exchange with calcium and magnesium ions.

Increased exposure to potassium could result in significant health effects in people with kidney disease or other conditions, such as heart disease, coronary artery disease, hypertension, diabetes, adrenal insufficiency, pre-existing hyperkalemia, older individuals who have reduced physiological reserves in their renal function and/or individuals who are taking medications that interfere with the normal handling of potassium in the body. Infants also have a limited renal reserve and immature kidney function and may therefore be more vulnerable.

Potassium and sodium maintain the normal osmotic pressure in cells. Potassium is a cofactor for many enzymes and is required for the secretion of insulin, creatinine phosphorylation, carbohydrate metabolism and protein synthesis. Excessive loss of salts, such as through severe diarrhea or intense and prolonged sweating, can result in a loss of potassium, which can result in hypokalaemia if the loss is sufficient. This can cause a range of effects, including cardiac arrhythmia, muscle weakness, nausea and vomiting, and low muscle tone in the gut. Longer-term hypokalaemia is believed to cause a predisposition to hypertension [5].

Adverse health effects due to potassium consumption from drinking-water are unlikely to occur in healthy individuals. Potassium intoxication by ingestion is rare, because potassium is rapidly excreted in the absence of pre-existing kidney damage and because large single doses usually induce vomiting [6].

Although potassium may cause some health effects in susceptible individuals, potassium intake from drinking-water is well below the level at which adverse health effects may occur.

Potassium is silver white alkali which is highly reactive with water. Potassium is necessary for living organism functioning hence found in all human and animal tissues particularly in plants cells. The total potassium amount in human body lies between 110 to 140 g. It is vital for human body functions like heart protection, regulation of blood pressure, protein dissolution, muscle contraction, nerve stimulus etc. Potassium is deficient in rare but may led to depression, muscle weakness, heart rhythm disorder etc. According to WHO standards the permissible limit of potassium is 12 mg/L [11].

For the case of Nekemte Town water Supply project, water samples were taken at different times from different randomly selected sites and the mean values of concentration of samples versus WHO guide values were compared in the following table:

Table 11. *Potassium concentration in water sample.*

Selected parameter	WHO guide Value, mg/L	Mean value of 1st around sampling, Mg/L	Remark for 1st round sampling	Mean value of 2nd round sampling, Mg/L	Remark for 2nd round sampling	Mean value of 3rd round sampling, Mg/L	Remark for 3rd round sampling
Potassium, K	12	3.3	Found at low concentration to cause health effect	2.567	Found at low concentration to cause health effect	4.5	Found at low concentration to cause health effect

In most natural waters, concentration of potassium is found at low concentration. As a result of this, there is no healthy problem with naturally occurring concentration of potassium in drinking water. Even from the total population, only small portions of the community with kidney problem are susceptible to it. For this reason, since there is no healthy problem with potassium concentration for healthy people, there is no WHO guide value set for concentration of potassium in drinking water.

3.2.10. Nitrite and Nitrate in Drinking Water

Nitrite, a stage in the nitrogen cycle, occurs in water as an intermediate in an oxidation or reduction process. In raw surface water supplies the trace amounts of nitrite indicates presence of pollution. For the case of Nekemte Town water Supply, water samples were taken at different times from randomly selected sites for nitrite determination and the mean values of the result versus WHO guide value of nitrite concentration were compared as in the following table:

Table 12. *Nitrite concentration in water sample.*

Selected parameter,	WHO guide Value, mg/L	Mean value of 1st around sampling, Mg/L	Remark for 1st round sampling	Mean value of 2nd round sampling, Mg/L	Remark for 2nd round sampling	Mean value of 3rd round sampling, Mg/L	Remark for 3rd round sampling
Nitrites, No^{-}_{2}	0.91	0.007	Acceptable	0.006	Acceptable	0.008	Acceptable

From the results obtained, concentration of nitrite in Nekemte Town water supply is found at low concentration than the guide value given by World Health Organization, WHO. So, there is no healthy problem concerned with nitrite concentration in Nekemte Town water supply.

Nitrate contained in pure well waters derived from an extensive catchment is largely the result of biological activity in the surface layers of the soil, enhanced by cultivation and application of manures. When nitrate is in excessive amounts, it contributes to the illness known as infant methemoglobinemia. Under this research, water samples collected from randomly selected sites at different sampling times were analyzed in laboratory and compared against WHO guide value as in the following table:

Table 13. *Nitrate concentration in water sample.*

Selected parameter,	WHO guide Value, mg/L	Mean value of 1st around sampling, Mg/L	Remark on 1st round sampling	Mean value of 2nd round sampling, Mg/L	Remark on 2nd round sampling	Mean value of 3rd round sampling, Mg/L	Remark on 3rd round sampling
Nitrate, NO^-_3	11.3	1.333	Acceptable	4.8	Acceptable	3.6	Acceptable

Concentration of nitrate in Nekemte Town Water supply is small when we compare with WHO guide value. So there is no healthy problem expected in case of Nekemte Town Water Supply Project.

3.3. Biological Water Quality Analysis

Contaminated water may contain a host of microorganisms, due to which water borne diseases may spread if water is not properly treated before it is supplied for domestic use. As per World Healthy Organization, WHO, water to be supplied for a community for consumption purpose must be totally free from mass of microorganisms that cause disease. In case of Nekemte Town Water Supply project, since the residual chlorine is out of WHO guide line, it is totally too difficult to assume the water is free from pathogens. Even in the absence of laboratory work, people we have interviewed told us that the water is not free from pathogen. The reason why they gave us this idea is that most of the time when they consume water supply from this pipeline of Nekemte town water supply they experienced cholera and diarrhea. Also laboratory result indicates that the water is not totally free from contamination.

4. Conclusion and Recommendation

This study was carried out on Water quality Analysis of Nekemte town water Supply. The Water quality of the town was analyzed physically, chemically and biologically and the result was discussed in detail in the document. In the laboratory work, it was found out that the mean of water samples at different sampling seasons and different sampling locations were analyzed and at most of the places and seasons the water quality of Nekemte town Water Supply was found not to fit standard set by world health organization, WHO. Especially water quality of the town in terms of turbidity, color, odor, pH, Iron and Manganese, residual chlorine and microbiological examination were analyzed in water quality laboratory and the result was found not to fit the standard set by World Health Organization, WHO.

Some of the water quality parameters like chromium, sulfate, Electrical conductivity, potassium, fluoride, zinc, copper, nitrates, and nitrites were analyzed in the water quality laboratory and the mean of the water samples at different sampling locations and sampling times were found to agree with the standard set by world health organization, WHO.

As we have seen from the laboratory work, the water quality of Nekemte Town Water Supply was found not to be acceptable from Health point of view especially in terms of turbidity, pH, residual chlorine, microbiological examination, iron and Manganese, color, odor and similar water quality parameters when compared with the standards set by World Health Organization. Since the water quality of the town does not fit the standard set by World Health Organization, it requires further study to find the cause for water quality problem and find solution for water quality problem of the town and bring the water quality of the town to acceptable range.

During our research period, many of the people we have interviewed told us that they were suffering from diseases like diarrhea and cholera due to consumption of poor water quality. So, this problem needs further study in order to find the real cause of water quality problem and to solve it.

Also during the research period we have seen that Nekemte Town Water Supply Project has large concentration of divalent metallic cations like magnesium and iron. Since this minerals cause corrosion of water supply lines, affect color of water, stains plumbing fixtures and similar structures, the water should be aerated sufficiently in order to oxidize these cations to their solid states so that they will be removed. To solve this problem, construction of cascade aerator or other similar type of aerator is important which can remove the iron and manganese cation that exist in the water supply of the town.

To save the residents of Nekemte Town, the study suggests regular monitoring of water quality should be practiced by municipality of Nekemte town to provide safe drinking water.

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