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Drinking Water Quality Assessment from the Source to End User, the Case of Omo Kuraz Sugar Factory, Ethiopia

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Abstract: The aim of the study was to evaluate the water quality status from the source to end user in Omo Kuraz Sugar Factory -1. In the study, both primary and secondary sources of data were used to conduct the research. Stratified random sampling technique was adopted to select the sample needed for bacteriological analysis of the water quality. Samples were collected in rainy season for three times started from July 22 2019 to September 26 2019. Thirteen samples were collected at all representative sampling points at each time. The physicochemical parameters namely, pH, Temperature, Total dissolved solid, Electrical conductivity, Turbidity, Nitrate, Phosphate, Sulfate, Chloride, Total hardness, Calcium, Sodium, Potassium, Magnesium, Fluoride, Total alkalinity, Iron and Cupper. Total coliform as Bacteriological parameter was analyzed. The water quality index (WQI) - calculation was done using weighted arithmetic water quality index method. The result of physiochemical parameters, temperature (28.22°C), electrical conductivity (1331.37mg/l) and fluoride (1.89mg/l) were above the maximum permissible limit set by WHO and Ethiopian for drinking water. The results of remaining physiochemical parameters are fall within the desirable permissible limit for human consumption. The computed WQI values ranged 51.4 (source) to 69.6 (village-1) and all sampling points are ranked to poor water quality. The results of bacteriological analyses have shown that 50% of samples in the distribution systems were at medium risk, 16.7% of samples were at low risk and 33% of samples including the source were at zero risk. The study can conclude that the quality of drinking water source can be deteriorated in the water distribution system. Therefore, the current quality of water and distribution system needs to be improved or to be developed new better quality source in order to come up with current quality problem.

Keywords: Water Quality, Physiochemical, Bacteriological Parameters, Distribution System

1. Introduction

Water is a vital resource in the world to sustain life, and a satisfactory (adequate, safe and accessible) supply must be available to all. Improving access to safe drinking water can result in tangible benefits to health. Every effort should be made to achieve drinking- water that is as safe as practicable [1]. Water quality and the risk to waterborne diseases are critical public health concerns in many developing countries. Today, close to a billion people most living in the developing world do not have access to safe and adequate water [2].

Water quality of any specific area or specific source can be assessed using physical, chemical and biological parameters. The values of these parameters are unsafe for human health if they occurred more than defined limits [3]. Therefore, the suitability of water sources for human consumption has been described in terms of Water quality index (WQI), which is one of the most effective ways to describe the quality of water. Water contamination can happen from an identifiable source and unidentifiable source. Point sources of pollutant are those which have a direct injection into the water body from factories, waste water effluent, and oil spill of tankers. While, nonpoint sources of pollutant are those which arrive from different sources of origin and number of ways from different no identifiable sources [4].

While water quality can be compromised at any component, failure at the distribution level can be extremely serious because it is closest to the point of delivery. Water quality failures in distribution networks can generally be classified as:

intrusion of contaminants into the distribution system through system components; regrowth of microorganisms in the distribution network; injured microbes and residual chemicals and their byproducts from water treatment plant; leaching of chemicals and corrosion products from system components into the water; and permeation of organic compounds from the soil through system components into the water supplies [5].

Ethiopia's 81 million people have one of Africa's lowest rates of access to water supply, sanitation, and hygiene; even with abundant surface and groundwater resources [6]. Millions of people are exposed to unsafe concentrations of chemical contaminants in their drinking-water. This contamination may be linked to a lack of proper management of urban and industrial waste water or agricultural runoff water, with potentially long-term exposure to pollutants, resulting in a range of serious health implications [7].

The dwellers of Omo Kuraz Sugar Factory get their drinking water supply from ground water which is situated in the downstream side of main town. Water distribution system for villages is by using water truck that transports from Main Town to villages and stored in storage tankers. It is vital to identify whether the water obtained from the source, along its various stages until it reaches the consumers, is safe with regard to water quality parameters. Therefore, this research tries to assess the drinking water quality from the main existing drinking water scheme of Omo Kuraz Sugar Factory in terms of water quality parameters such as physicochemical and bacteriological.

Poor water quality and water borne diseases are serious public health that concerns in many developing countries. This is mainly due to lack proper research and subsequent monitoring of water quality parameters for most of the cities in Ethiopia.

In evaluating the quality of drinking-water, consumers rely principally upon their senses. Microbial, chemical and physical constituents of water may affect the appearance, odor or taste of the water and the consumer will evaluate the quality and acceptability of the water on the basis of these criteria [1].

The study is planned to conduct the determination of physicochemical and bacteriological quality of drinking water of Kuraz Sugar Factory. Before, there is no research that was studied about status of drinking water quality in the study area; therefore study is important for providing scientific evidences for users that help them to take care from being infected and for experts to make a decision.

2. Materials and Methods

2.1. Description of Study Area

The specific study area is delineated based on the outlet points of cross drainage structures and high way road culverts. The study area is shown in Figure 1. The research was carried out at Kuraz Sugar Factory which is located in Salamago district in South Omo Zone at a distance of 863 km away from the capital city of Addis Ababa in the south direction at 6° 0'0"–6° 15' 0" latitude and 36° 0' 0"–36° 10' 0" longitude. It is 27 km away from Hana town. The elevation in the current study area ranges between 370 and 500 m a.s.l. Thus, the area experiences typically a "tropical semi-arid climate (Kolla agro- climate). The mean maximum and minimum monthly temperature of the project area are 35.58°C to 22.39°C, respectively. The total mean annual rainfall is 974.34mm and the average annual relative humidity of the study area is 64.49%.

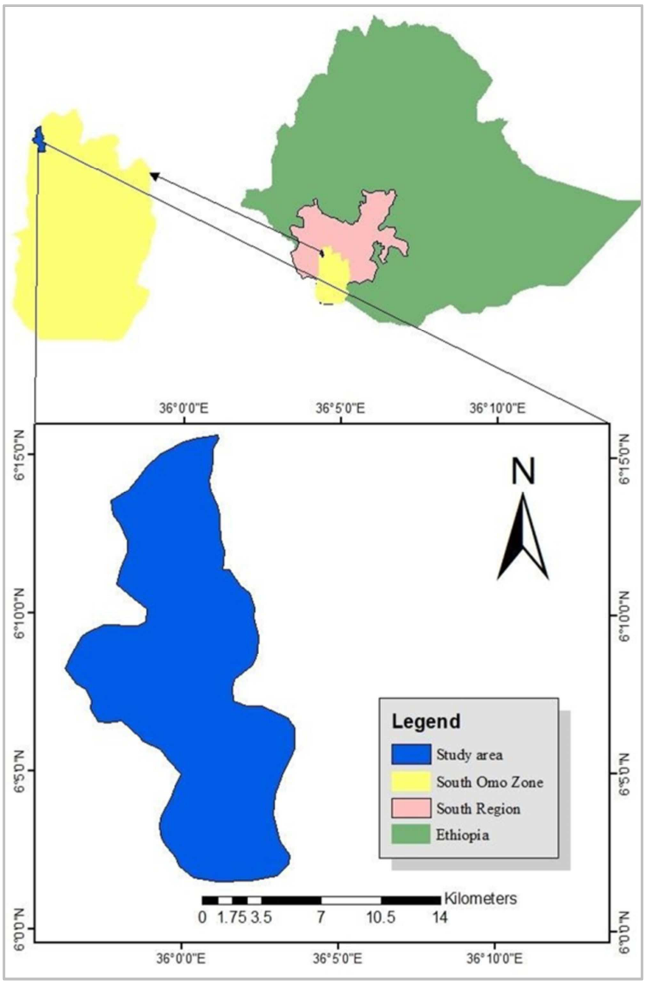

Figure 1. *Location Map of the study area.*

2.2. Sources of Data

Primary sources of data were collected from the site water source well, distribution system of Main Town and village's storage tanker as presented in figure 2. Secondary sources of data were collected from different literatures that are study about portable water supply and drinking water quality, feasibility study and progress reports in the study area to review the overall drinking water quality and distribution system in the study area. Data bases of health centre in the site presented incidents of water quality related disease are used for study.

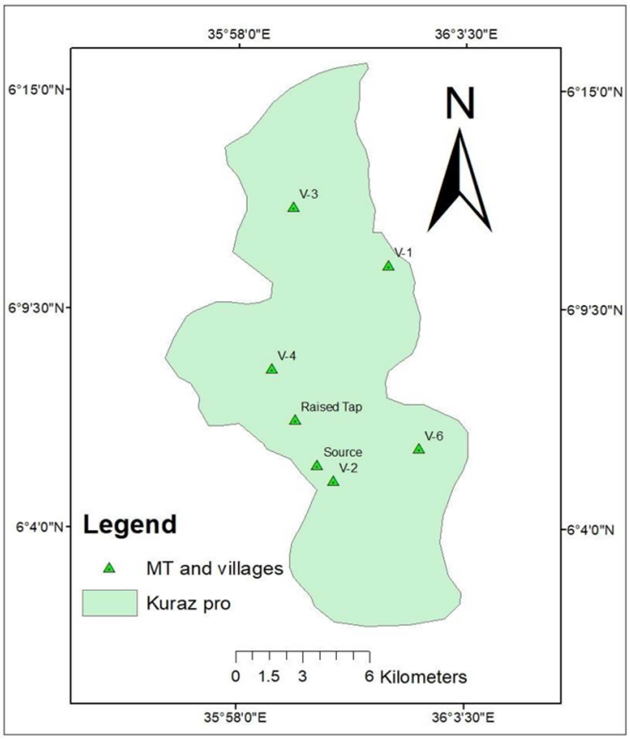

Figure 2. *Map of Main Town and Villages from where sample were taken.*

2.3. Sample Size and Sampling Method

Samples were collected in rainy season for three times started from July 22 2019 to September 26 2019. The total number of sample size was thirty-nine; thirteen samples were collected at all representative sampling points at each time for physicochemical and bacteriological analysis. A stratified random sampling technique was adopted to select the sample needed for bacteriological analysis.

2.4. Laboratory Test Method

For the analysis of water quality, the main water quality indicator parameters were perceived from the laboratory including physicochemical and bacteriological quality. The physicochemical parameters include: electrical conductivity (EC), pH, TDS, turbidity and iron are an important indicator of water quality. Total coliform analysis was carried out by membrane filtration technique and analysed within 24 h of sample collection. The cultures were incubated at 37°C for 24 hours for total coliforms determination.

Water samples were collected from selected locations in properly washed and cleaned appropriate sampling bottles. Samples were analysed for eighteen physico-chemical parameters namely, pH, Temperature, TDS, EC, Turbidity, Nitrate, Phosphate, Sulphate, Chloride, Total hardness, Calcium, Sodium, Potassium, Magnesium, Fluoride, Total alkalinity, Iron and Copper.

The physical analysis was carried out at the laboratory of Factory three that located near to study area immediately after the sample was collected by using the "Wagtech''products. Digital conductivity meter, pH meter and thermometer model no. of "Wag –WT3020'' used to analysed Electrical Conductivity, pH and Temperature respectively. The physiochemical tests like Nitrate, sulphate and phosphate were performed using DR/2800 spectrophotometer. Stannous chloride method was used to determine Phosphate and sodium salicylate method used for determination of nitrate.

HACH Model-2100AN turbid meter and (HACH model 41100-21) ampule method were used to determine turbidity and fluoride respectively. Hardness and Alkalinity were analysed by using titrimetric method as the recommendation given by the standard method. Chloride was analysed by argentometric method is a type of titration. Potassium and sodium were analysed by using Cole- Parmer model 2655-10 dual channel flame photometer measurement method. And a flame photometer measures the concentration of the element itself in the sample solution. And Water samples were analysed for presence of heavy metals (iron and cupper) using Atomic Absorption Spectrometer (AAS).

2.5. Calculation of Water Quality Index

The WQI calculation was done using weighted arithmetic water quality index which was originally proposed by [8, 9]. The weighted arithmetic water quality index (WQI) is in the following form:

$$\text{QWI}=\sum_{i=0}^{n} QiWi \Big/ \sum_{i=0}^{n} Wi \quad (1)$$

Where n is the number of parameters, Qi is the water quality rating of the i^{th} parameter and Wi is the relative weight of the i^{th} parameter Water quality rating Qi is calculated using the following equation:

$$\text{Qi}=\frac{Vi-Vo}{Si-Vo} * 100 \quad (2)$$

Where, Vi is estimated concentration of i^{th} parameter in the analysed water, Vo is the ideal value of this parameter in pure water Vo = 0 (except pH =7.0 and DO = 14.6 mg/l) and Si is recommended standard value of each parameter. The unit weight (Wi) was computed by using the next equation,

$$\text{Qi}={K}/{Si} \quad (3)$$

Where K = proportionality constant and can also be calculated by using equation-4

$$\text{K}=1 \,/\, \sum_{i=0}^{n}({1}/{Si}) \quad (4)$$

The rating of water quality according to the weighted arithmetic water quality index method mentioned below in Table 1.

Table 1. *Water Quality Rating as per Weight Arithmetic Water Quality Index Method [3].*

WQI Value	Rating of Water Quality	Grading
0-25	Excellent water quality	A
26-50	Good water quality	B

WQI Value	Rating of Water Quality	Grading
51-75	Poor water quality	C
76-100	Very Poor water quality	D
Above 100	Unsuitable for drinking	E

3. Method of Data Analyses

Data were analysed using Microsoft excel, GIS and SPSS statistical software. Results of physico-chemical analysis and bacteriological analysis of the investigated water samples were compared with the set standards of WHO guide lines and Ethiopian recommended values for drinking water quality and interpreted as acceptable or unacceptable.

Table 2. *WHO and Ethiopian guide line value.*

No	Parameters	WHO standards	Ethiopian guide line
1	Electrical Conductivity	400.00	_
2	pH	6.5-8.5	6.5-8.5
3	Turbidity	4.00	5.00
4	Temperature	12-25	_
5	TDS	1000.00	1000.00
6	Total Hardness	200.00	300.00
7	Calcium	100.00	75.00
8	Magnesium	50.00	50.00
9	Sodium	200.00	200.00
10	Potassium	_	_
11	Nitrate	50.00	3.00
12	Sulfate	250.00	250.00
13	Phosphate	_	_
14	Chloride	250.00	250.00
15	Fluoride	1.50	1.50
16	Total alkalinity	300.00	300.00
17	Iron	0.30	0.30
18	Copper	2.00	2.00
19	Total coliform	0.00	0.00

4. Results and Discussion

1). Physicochemical analysis

PH: As figure 3 shows the pH value was ranged between 7.48 and 8.11 and the mean value of pH was 7.96. As the result indications drinking water in Omo Kuraz Sugar Factory has moderately alkaline character (pH >7). The mean value of pH in the study area lies in the range of permissible limit of WHO and Ethiopian standard. The pH value in the study area was somewhat increase in the distribution system. The pH is determined by the amount of dissolved carbon dioxide (CO_2), which forms carbonic acid in water.

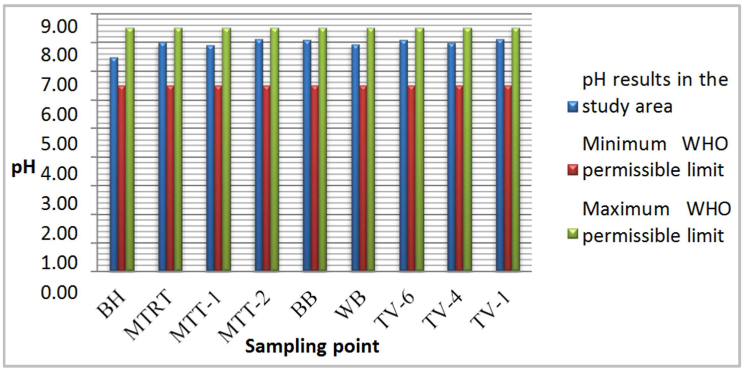

Figure 3. *pH Lab-Result Compare with WHO Maximum Permissible Limit.*

Temperature: The temperature laboratory results in Omo Kuraz Sugar Factory are shown in Figure 4. The average temperature value of water samples in the study area was 28.22°C and the maximum and minimum values of temperature were 29.33 and 25.33°C, respectively. Temperature in this study was found above the WHO permissible limit. The higher values are recorded at villages' storage tanker. This is because of the study area has high air temperature and all of storages have not shelter to protect the water from environmental effect especially from sunlight.

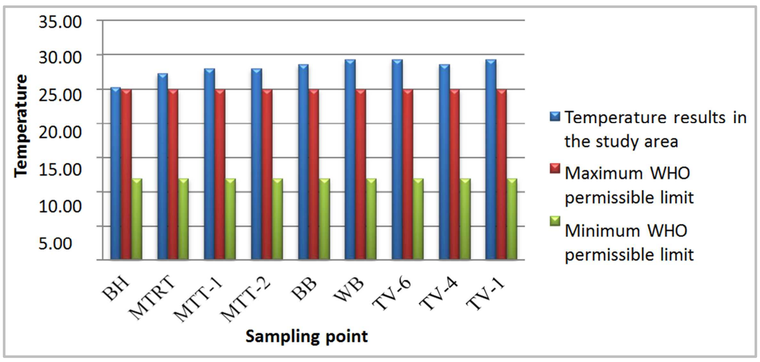

Figure 4. *Temperature Lab-Result Compare With WHO Maximum Permissible Limit.*

Turbidity: It is caused by particles of soil, fine organic and inorganic matters, algae and other microscopic organisms. As the results in the study area shows below in the figure 5, the turbidity of the study area range from 0.1 to 1.8 NTU and the average value of turbidity 0.63 which is below the WHO Maximum Permissible limit. The maximum value recorded which is at sample location of main town raised tap.

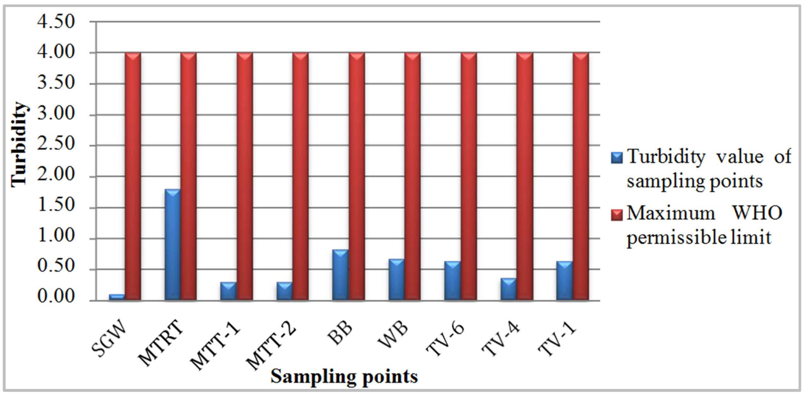

Figure 5. *Turbidity Lab-Result Compare With WHO Maximum Permissible Limit.*

Electrical Conductivity (EC): Electric conductivity value in drinking water should not exceed 400 µS/cm as stated on standard [10]. The results clearly indicate that water in the study area is highly ionized and has the high level of ionic concentration due to having high concentration of dissolved solids. According to the result, there is somewhat change through the distribution system and the mean EC value was above the WHO maximum permissible limits. The electrical conductivity value in the study area mentioned below in the figure 6.

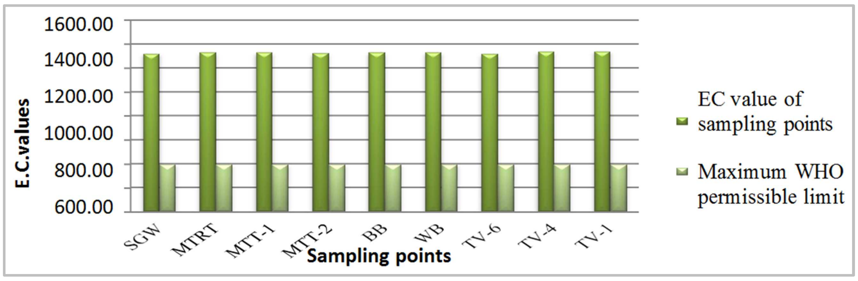

Figure 6. *E. C Lab-Result Compare With WHO Maximum Permissible Limit.*

Total Dissolved Solids (TDS): The concentration of TDS in the study area was from 649.67 to 664.33 mg/l. The mean total dissolved solids concentration in Omo Kuraz Sugar Factory was found to be 656 mg/l, and it is lower than maximum permissible limit of WHO standards and Ethiopian recommended value (1000mg/l). Similar value (406-694mg/l) was reported as cited in [11]. High values of TDS in ground water are generally not harmful to human beings, but high concentration of TDS in drinking water may affect persons who are suffering from kidney and heart diseases [12]. In the study area, as the result shows below the figure 7, all of sampling points have the TDS value above 500 mg/l and it may affect for users those are suffering from kidney and heart diseases. And there is slight change through the distribution system.

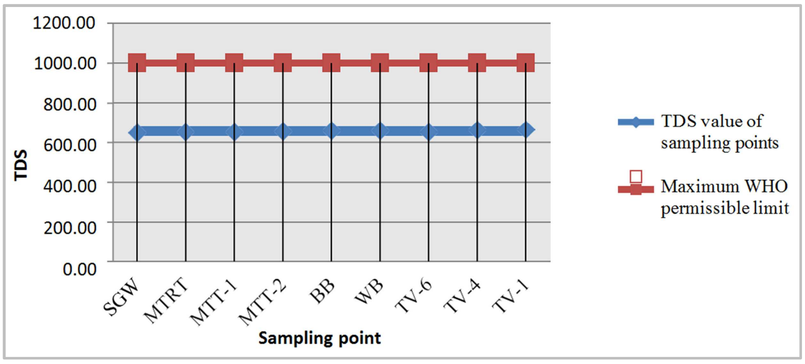

Figure 7. *TDS Lab-Result Compare With WHO Maximum Permissible Limit.*

Total hardness: Hardness in Omo Kuraz Sugar Factory was range from 177.73 to 188.67mg/l as shown below the Figure 8 and the mean value of total hardness in the study area was 182.9mg/l. The maximum value is recorded from village-1 and the minimum value recorded from the source. All results categorized as hard water according to discussed in literature review and all are within WHO permissible limit and Ethiopian standard (300mg/l). There is some difference in the value of total hardness between samples in the distribution system.

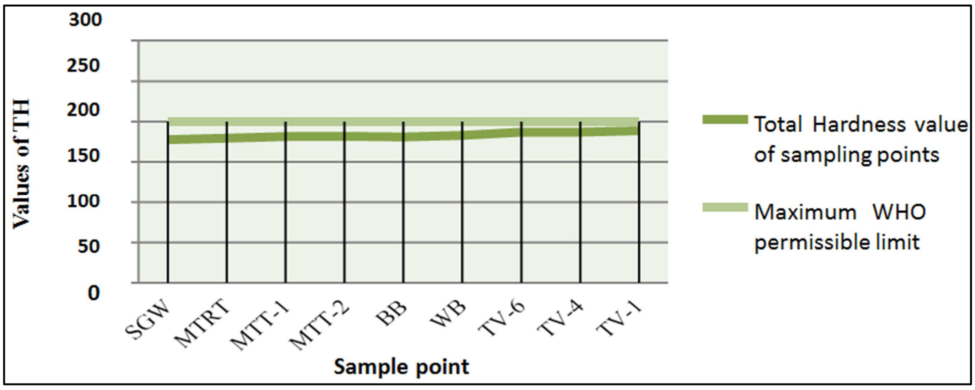

Figure 8. *Total Hardness Lab-Result Compare With WHO Maximum Permissible Limit.*

Calcium: According to WHO standards, its permissible limit in drinking water is 100 mg/l. In the study areas, laboratory results, concentration of calcium ranges from 28.87 to 32.37 mg/l and the mean value of Calcium in the study area was 30.64mg/l. Results in Omo Kuraz Sugar Factory were within WHO permissible limit and Ethiopian standard.

Magnesium: According to WHO standards the permissible range of magnesium in water should be 50 mg/l. In the study areas magnesium was ranges from 25.12 to 26.98mg/l and the mean value of magnesium in water was 25.76mg/l. The concentration of magnesium in study areas was with in the limit of WHO standard and Ethiopian recommended value.

Total Alkalinity: The Alkalinity is a measure of the capacity of water to neutralize the acid. According to the portability of drinking Water set by WHO standard guideline, the maximum allowable limit should not be exceeded 300mg/l. The Total alkalinity con5centration of Omo Kuraz Sugar Factory shows in Figure 9, ranges from 55.05 to 58.59mg/l and the mean value of total alkalinity was 56.37mg/l. These results show that at all points of sample taken; the values of total alkalinity lay below the WHO maximum permissible limit and Ethiopian guide line value. Thus, there is no effect on human health and there is no significant difference between points of sample in the distribution system and source.

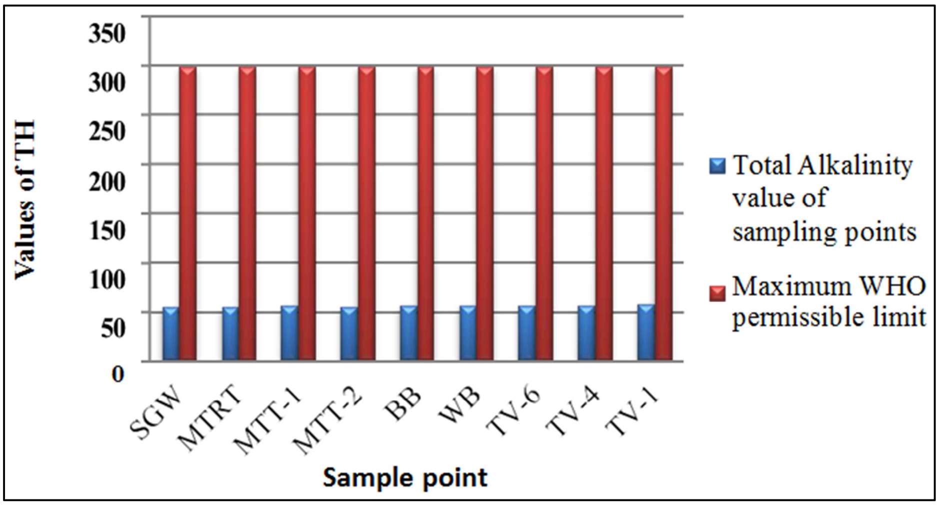

Figure 9. *Total Alkalinity Lab-Result Compare With WHO Maximum Permissible Limit.*

Chloride: No health-based guideline value is proposed for chloride in drinking-water. However, chloride concentrations in excess of about 250 mg/l can give rise to detectable taste in water as shown below the figure 10 the chloride value in the study ranges from 137.95 to 148.44 mg/l, and the mean value of this drinking water was

142.98 mg/l. the result shows that chloride in the study area was with in the WHO and Ethiopian guideline value.

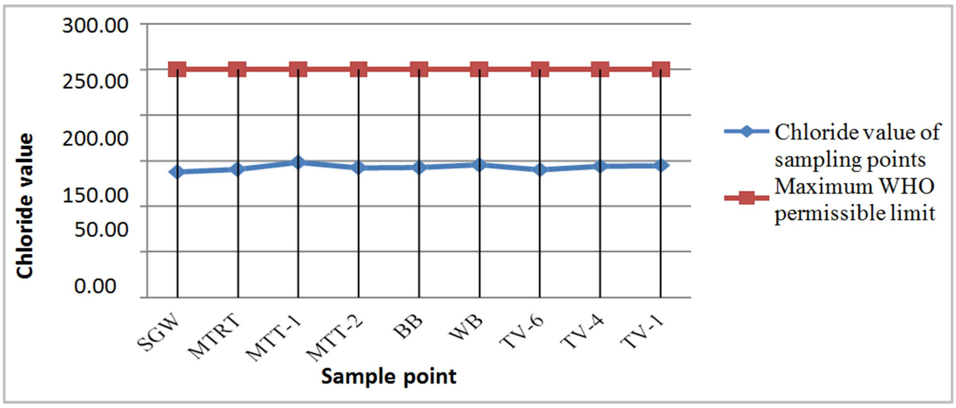

Figure 10. Chloride Lab-Result Compare With WHO Maximum Permissible Limit.

Fluoride: In the study areas, the concentration of fluoride ranges from 1.81 to 1.97mg/l and mean value of fluoride in Kuraz Sugar Factory was 1.89mg/l. The optimum fluoride level for a given community depends on climatic conditions because the amount of water (and consequently the amount of fluoride) consumed by children is primarily influenced by air temperature.

Nitrate: The WHO allows maximum permissible limit of nitrate is 50 mg/l in drinking water. In Omo Kuraz Sugar Factory, the concentration of nitrate ranges from 1.15 to 1.38 mg/l. the mean value of nitrate was 1.26 mg/l. The concentration of Nitrate in drinking water of study area was below the WHO maximum permissible limit and Ethiopian guideline value. It is not harmful for users' health and there is no significant change through the distribution system.

Phosphate: The quality criteria of phosphate in drinking waters are to check the unwanted algae growth. In the study area concentration of phosphate ranges from 0.00 to 0.15mg/l and the mean value of phosphate in Omo kuraz Sugar Factory was 0.05mg/l. Concentration of Phosphate in drinking water of the study area was very low. The figure 11 shows the result in the study area.

Sulfate: the laboratory results of study area at all points of sample location ranges from 11.33 to 13.29mg/l and the mean value of sulfate was 12.39mg/l. the values were very below the maximum permissible limit set by WHO and Ethiopian recommended value. There is no significant change in the distribution system.

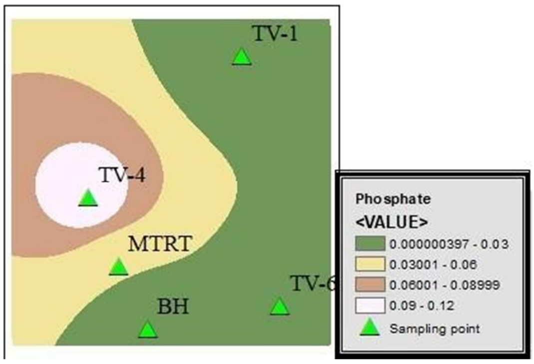

Figure 11. Map of Phosphate in Omo Kuraz Sugar Factory water supply scheme.

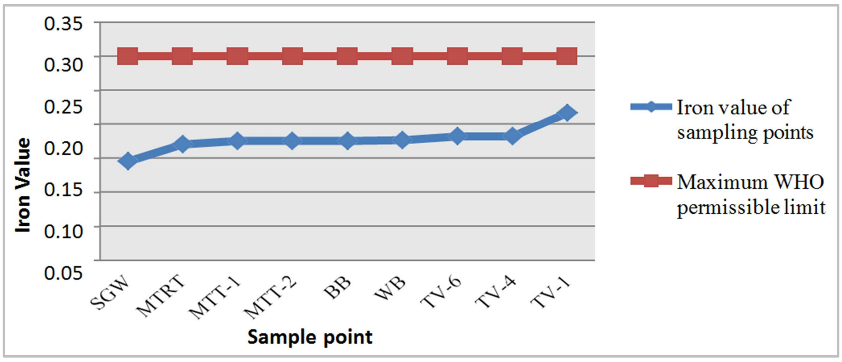

Figure 12. Iron Lab-Result Compare With WHO Maximum Permissible Limit.

Iron: In Omo Kuraz, the laboratory results at all points of sample location ranges from 0.15 to 0.22mg/l and the mean value of iron was 0.18mg/l. the maximum value recorded at village -1, this implies the storage material in the village is iron container and there is corrosion in the storage tanker. In general, as the result shown below the figure 12; the values of iron in the study area were somewhat below the maximum permissible limit that sets by WHO and Ethiopian guideline value. Therefore, the results in the study area indicate that there is no noticeable taste and to some extent there is change between sample locations in the distribution system.

Copper: The World Health Organization has established 2.0 mg/l of Cu as maximum permissible limit guidance level in drinking water supply. According to the laboratory results of the study area, the concentration of copper ranges from 0.04 to 0.06mg/l and mean value of copper in the study area were 0.05mg/l. The results of all samples in the areas, water supply system was lower than the maximum permissible limit of WHO standard. Therefore, there is no health effect regards to this parameters on the customers. Copper in the distribution system stated below in the figure 13.

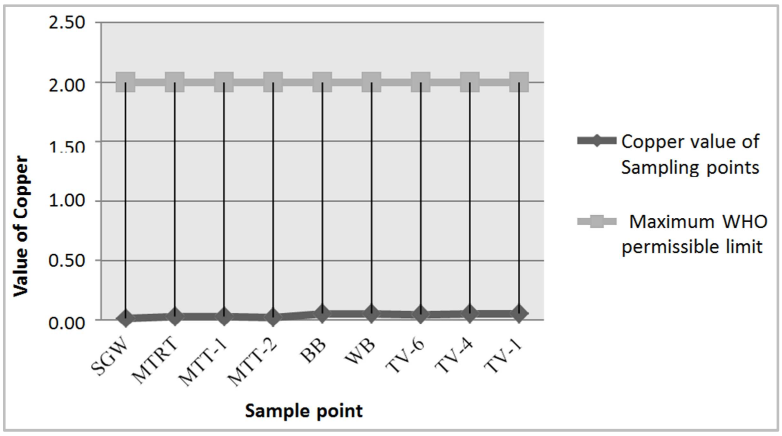

Figure 13. *Copper Lab-Result Compare With WHO Maximum Permissible Limit.*

Sodium: No health based guideline value is proposed. However, concentrations in excess of 200 mg/liter may give rise to unacceptable taste [1]. In the study area, the finding as shown below the figure 14; sodium concentration ranges from 157.9 to 168.91 mg/l with an average value of 164.53mg/l. According to the result the average value of sodium in the study area was below the WHO and Ethiopian recommended value.

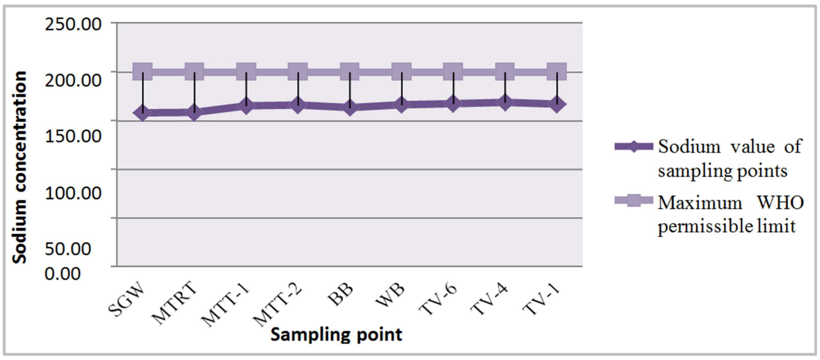

Figure 14. *Sodium Lab-Result Compare With WHO Maximum Permissible Limit.*

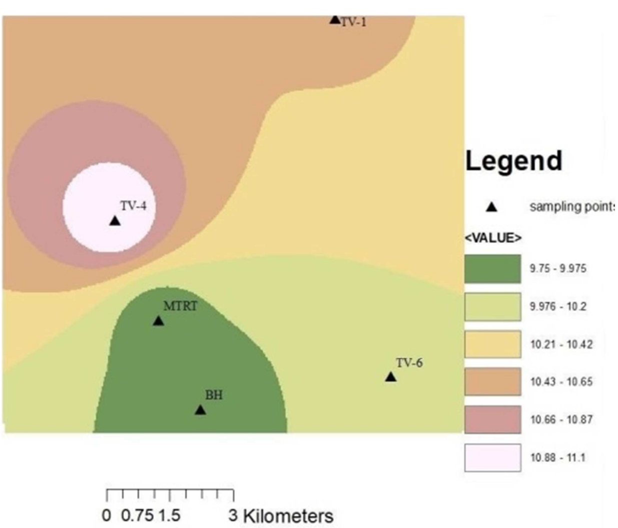

Figure 15. *Map of Potassium in the distribution system of Omo Kuraz Sugar Factory.*

Potassium: Potassium concentration as shown below the figure 15, ranges between 9.75 and 11.1mg/l. the mean value of potassium was 10.4mg/l. there is no significant difference between drinking water source and distribution system. Map of potassium in the distribution system stated below in the figure 15.

Correlations among Parameters: Result of correlation analysis indicated that electric conductivity was positively and significantly correlated with total dissolved solid ($r=0.9963^{**}$), sodium ($r=0.825^{**}$), chloride ($r=0.61^{**}$), total hardness ($r=0.593^{**}$) and calcium ($r=0.546^{**}$). On the other hand, electric conductivity was negatively and significantly correlated with nitrate ($r= -0.576^{**}$).

Total dissolved solid was positively and significantly correlated with total hardness ($r= 0.629^{**}$), calcium ($r= 0.561^{**}$), sodium ($r=0.860^{**}$), chloride ($r=0.526^{**}$), and total alkalinity ($r= 0.513^{**}$). And Potassium was positively and significantly correlated with nitrate ($r= 0.7^{**}$), sulfate ($r= 0.947^{**}$), and chloride ($r= 0.754^{**}$) (Table 3).

Table 3. *Correlation coefficient matrix of physico-chemical parameters in the study area.*

	E. C.	Ph	Turbidity	Temperature	TDS	T. H.	Calcium	Magnesium	Sodium
E. C.	1								
PH	0.185	1							
Turbidity	0.193	0.180	1						
Temperature	0.028	0.182	.122	1					
TDS	0.963**	0.254	0.153	0.011	1				
TH	0.593**	0.149	0.039	0.145	.629**	1			
Calcium	0.546**	0.227	0.101	0.378	0.56**	0.86**	1		
Magnesium	0.39*	0.110	0.050	0.219	0.39*	0.74**	.69**	1	
Sodium	0.82**	0.239	0.096	-0.195	0.860**	0.50**	0.437*	0.278	1
Potassium	-0.264	0.232	-0.267	-0.308	-0.179	0.49**	-0.55**	-.410*	-.032
Nitrate	-0.576**	0.115	-0.485*	-0.183	-0.557**	0.467*	-0.51**	-0.293	-0.425*
Sulfate	-0.265	0.228	-0.063	-0.316	-0.181	0.554**	-0.58**	-0.445*	-0.041
Phosphate	0.383*	0.192	0.011	0.206	0.38*	0.43*	0.41*	0.170	0.341
Chloride	0.61**	-0.087	0.147	0.363	0.53**	0.67**	0.71**	0.523**	0.4*
Fluoride	-0.081	-0.141	-0.331	-0.032	-0.050	0.135	-0.076	0.181	-0.084
TA	0.44*	0.191	-0.023	-0.28	0.51**	-0.066	-0.27	-0.224	0.47*
Iron	0.115	0.574**	0.322	0.04	0.103	0.260	0.25	0.136	-0.15
Copper	0.06	0.047	-0.04	0.43*	0.025	-0.085	0.08	0.067	-0.09

Table 3. *Continued.*

	Potassium	Nitrate	Sulfate	Phosphate	Chloride	Fluoride	Total alkalinity	Iron	Copper
E. C.									
PH									
Turbidity									
Temperature									
TDS									
TH									
Calcium									
Magnesium									
Sodium									
Potassium	1								
Nitrate	0.70**	1							
Sulfate	0.95**	0.576**	1						
Phosphate	-0.44*	-0.341	-0.52**	1					
Chloride	-0.7**	-0.60**	-0.79**	.561**	1				
Fluoride	0.254	0.310	0.116	-0.134	-0.006	1			
TA	0.53**	0.085	0.54**	-0.006	-0.230	0.074	1		
Iron	-0.108	-0.043	-0.046	-0.025	-0.014	-0.03	-0.025	1	
Copper	0.114	0.043	0.077	-0.060	-0.05	0.18	0.08	0.04	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

5. Bacteriological Analysis

Most pathogens that can contaminate water supplies come from the feces of humans or animals. If large numbers of coliforms are found in water, there is a high probability that other pathogenic bacteria or organisms exist. The WHO and Ethiopian drinking water guidelines require the absence of total coliform in public drinking water supplies. The results in the study area as shown in the table below, total coliform in the study area ranges between 0 to 52 count/100 ml. Drinking water in the Omo Kuraz was contaminated through water supply process. So as the result shown, it is moderately unsafe for the health of the users in the study area. The bacteriological laboratory results are discussed below the table 4.

Table 4. *Bacteriological laboratory analysis result.*

S. N.	Sampling points	Total coliform /100ml	risk level
1	SGW	0.0	no Risk
2	MTRT	35.0	Intermediate Risk
3	BB	15.0	Intermediate Risk
4	WB	20.0	Intermediate Risk
5	TV-1	0.0	no risk
6	TV-4	6.0	Low risk
7	TV-6	41.0	Intermediate Risk
8	MTT-1	0.0	no Risk
9	MTT-2	0.0	no Risk
10	HHDL-1	52.0	Intermediate Risk
11	HHDL-2	36.0	Intermediate Risk
12	HHMW-1	7.0	Low risk
13	HHMW-2	0.0	no Risk

Water Quality Index: The WQI value in the area ranges from 54.17 to 71.63 as listed the table 5. The WQI values for all the sampling location expresses that the drinking water in the study area ranked at poor quality. This has been largely caused by concentration of iron in drinking water. Due to storing of water in rusty metallic tanker of the study area of tanker village -1 (TV-1), that cause high value of iron concentration measured. The other parameter that has high contribution to enhance WQI is fluoride. Contamination occurs by high concentration of fluoride in drinking water relative to the WHO permissible level of (1.5mg/l), which has harm full effect to health of users especially for infant in the future. And also Total coliform has high contribution to enhance WQI in the system. In addition, some contamination occurs due to having the result of moderately high temperature and pH value since reduce drinking water quality in the study area.

Table 5. *Water quality index value and quality status.*

sample location	WQI value	water quality
SGW	54.17	Poor water quality
MTRT	69.03	Poor water quality
MTT1	62.39	Poor water quality
MTT2	61.47	Poor water quality
BB	65.84	Poor water quality
WB	66.82	Poor water quality
TV-6	71.13	Poor water quality
TV-4	64.68	Poor water quality
TV-1	71.63	Poor water quality

6. Conclusion and Recommendations

The thought of this research is drinking water quality failure in water supply schemes from the Source to point of use by assessing current water quality. About 9 representative water samples were collected from source to point in distribution system to analyzed physiochemical parameters. The physical and chemical water quality parameters analyzed in the laboratory were pH, Temperature, TDS, EC, Turbidity, Nitrate, Phosphate, Sulfate, Chloride, Total hardness, Calcium, Sodium, Potassium, Magnesium, Fluoride, Total alkalinity, Iron and Cupper. 13 samples were taken for bacteriological water quality analysis. Total coliforms were analyzed as Bacteriological tests in relation to the health prevalence of waterborne diseases.

The laboratory results have shown that three physico-chemical parameters, electrical conductivity (1331.37μS/Cm), fluoride (1.891mg/l) and Temperature (28.22°C) were beyond the WHO maximum permissible limit and Ethiopian recommended values. The rest of all parameters were found within the permissible limit of WHO guidelines and Ethiopian recommended values.

The results of bacteriological analyses have shown that 50% of samples in the distribution systems were at medium risk, 16.7% of samples were at low risk and 33% of samples including the source were at zero risk. According to the bacteriological test results, there is the contamination in the distribution system of drinking water. Due to these, most of the users are affected by water borne diseases.

The WQI value ranges from 51.4 to 69.6 and the drinking water quality status in the study area ranked at poor drinking water quality. The value of WQI raises as the distance from the source increases, it implies the quality of water decrease throughout the system.

Bacteriological and physicochemical parameters testing on time at source and household could be a good option to reduce water born disease [2]. In developed communities the preferred technology is a piped distribution system with indoor household taps [13].

To solve the current problems of water quality of Omo Kuraz Sugar Factory,

1) The current drinking water quality and distribution system need to be improved. Thus, water supply system will be a piped distribution system with inside household taps to reduce water contamination through transportation of water from village to village by water trucking.
2) Essential to develop new alternative water source having a better quality of drinking water and investigation must be done for other sources.
3) As an immediate solution for the existing problems, use the following appropriate recommendations in order to maintain the existing quality of water:
4) To prevent bacteriological contamination, chlorination must be needed to reduce occurrences of waterborne disease.
5) Maintenance and disinfection will be done for water supply schemes including water trucking and water storage at the villages.

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