academicJournals

Vol. 12(3), pp. 106-114, March 2018
DOI: 10.5897/AJEST2017.2419
Article Number: C71880855964
ISSN 1996-0786

http://www.academicjournals.org/AJEST

African Journal of Environmental Science and Technology

Full Length Research Paper

Analysis of physical and chemical parameters in ground water consumed within Konso area, Southwestern Ethiopia

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Received 6 September, 2017; Accepted 30 October, 2017

To improve water quality, there should be a mechanism of keeping safe water source from chemical contaminants in an effective and protective way through the application of regular checkup and with interventions by taking exact measure periodically before it is supplied for usage. The intention of this research is aimed at determining the level of common cations, anions, heavy metals and physical parameters in drinking water supply system in, Konso and its surrounding area, Southwestern Ethiopia. Water samples were collected from 23 different locations in the area where there is a hand pump or motorized supply system that is used for drinking purpose. The collected samples were analyzed for physicochemical parameters including total alkalinity, temperature, pH, electrical conductivity, total dissolved solids, turbidity, alkalinity, total hardness and total suspended solid. Common cations (Li^+, K^+, Na^+, Ca^{2+} and Mg^{2+}), common anions (NO_3^-, SO_4^{2-}, PO_4^{2-}, F^- and Cl^-) and heavy metals (Pd, Ni, Mn, Pb, Co, Zn, and Cu) were analyzed. Accordingly, the results obtained show that most of the physical and some common ions and heavy metals were within the accepted range of the guideline recommended by WHO. However, some parameters are at alarming state as compared to the WHO standards for drinking purposes, thereby suggesting the need for treatment and precautionary measures for use of the particular ground water.

Key words: Ground water, physicochemical parameters, common cations, common anions, heavy metals.

INTRODUCTION

Water is one of the most important and most precious natural resources. It is vital to man's existence and without it, there would be no life on earth. The earth holds approximately 1.4 × 10^9 m^3 of water in the form of oceans, seas, rivers, lakes, ice, etc., but only 3% of the total available water resources are in the form of fresh

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water found in rivers, lakes, and groundwater. The fresh water that is needed for a clean water supply is limited and the demand far exceeds the available supply due to increasing population and industrialization (Muthulakshmi et al., 2013; APHA, 2012). A clean water supply is one of the key indicators for development in any country; however, the situation of most African countries is not encouraging because more than 300 million people in Africa live in water scarce environments (WHO, 2004a).

The availability of water resources and the amount of freshwater continue to decrease time to time in Africa. In sub-Saharan Africa, the water requirements for major domestic and industrial purposes are usually not met. The need to determine the quality of public water supply has been intensified as a result of an increase in water pollution on a global scale caused by increasing population, urbanization and industrialization (Omaka et al., 2015). All these major causes have rampantly deteriorated the quality of water worldwide. This has resulted in the decrease in the quality of drinking water available and has also caused the decline of resources from our marine sources as the runoff water from the land is ultimately destined for the seas (Nikunj et al., 2015).

Groundwater is an important source of drinking water for humankind. It contains over 90% of the fresh water resources and is an important reserve of good quality water (Kanmani and Gandhimathi, 2013) and it is also used for agricultural, industrial, household, recreational and environmental activities all over the world (Ackah et al., 2011). In the last few decades, the ground water potential and its quality level in major cities and urban center's is getting deteriorated due to the population explosion, urbanization, industrialization and also the failure of monsoon and improper management of rain water (Appelo and Postma, 2005). Public ignorance to environmental considerations, indiscriminate disposal of anthropogenic, agricultural and mining wastes, unplanned application of agrochemicals and fertilizers and overexploitation of groundwater resources caused excess accumulation of pollutants on the land and contamination of available surface and groundwater resource (Ashwani and Abhay, 2014).

The chemical composition of groundwater is a measure of its suitability as a source of water for human and animal consumption, irrigation, and for industrial and other purposes. The ground water quality is normally characterized by physical characteristics, chemical composition, and biological parameters. These quality parameters reflect inputs from natural sources including the atmosphere, soil and water rock weathering, as well as anthropogenic influences of various activities such as mining, land clearance, agriculture, acid precipitation, and domestic and industrial wastes. These parameters change widely due to the type of pollution, seasonal fluctuation, ground water extraction, etc. Monitoring of water quality levels is thus important to assess the levels of pollution, to assess its potability for human consumption, also to assess the potential risk to the environment and for the sustainable management of these resources (Appelo and Postma, 2005; Shittu, 2008).

Metal contamination in groundwater is one of the most serious environmental concerns in the present world scenario, wherein metal contamination is a major problem due to its high toxicity, even at low concentration levels [34]. Groundwater usually contains dissolved mineral ions which can affect the water's usage depending on the type and concentrations of the ions involved. Major cations and anions found in groundwater include Calcium, Manganese, Chromium, Cadmium, Copper, Cobalt, Zinc, Lithium, Sodium, Potassium, Nitrate, Sulfate, Bicarbonate, and Chloride. Non-ionic constituents such as oxides, phenols, synthetic detergents, dissolved O_2 and CO_2 are also found in groundwater. These constituents determine the quality of ground water in terms of cations and anions. If it is present in excessive amounts above permissible limits of concentration, it may cause serious health hazards due to contamination and, the water may need to be treated before use (Blais et al., 1993; Radhey et al., 2010). The quality of water is more important compared to quantity in any water supply planning, especially for drinking purposes. Water quality standards are the foundation for the quality based control program and required for the treatment process. These standards support efforts to achieve and maintain protective water quality conditions (Omaka et al., 2014; AlSuhaimi et al., 2017).

The water used for drinking purposes should be free from toxic elements, living organisms and an excessive amount of minerals that may be harmful to health. The water supply in Konso and its surrounding villages for cooking, drinking, and other domestic purposes is often directly sourced from ground water without biochemical treatment and the level of pollution has become a cause for major concern. There is no any documented work that reveals the chemical composition of drinking water around Konso area. This will have a negative implication on the health condition of the society living around that area. The major aim of this research is to investigate the levels of cations, anions and trace metals in the ground water of Konso and its surrounding villages and thereafter compare results obtained with the standards set for water quality by the WHO and give direction for further intervention by the concerned body.

METHODOLOGY

General description of the study area

The study was conducted in Konso woreda and its surrounding villages and covers 23 different kebeles that have functional hand pump and motorized water supply system. Konso (also known as

Karat) is an administrative center of Konso Woreda of the Southern Nations, Nationalities, and Peoples Regional State which located at 595 km far away from Addis Ababa, Capital City of Ethiopia and 90 km far away from Arba Minch town. The total area of the study place is estimated about 2,273.79 km^2 and it lies at an altitude of 1650 m above sea level, its average temperature is 27°C (Konso special woreda, 2017). The specific sampling areas were identified by the help of the Konso wereda water resource bureau documentation and local names were used for identifying samples.

Chemicals and reagents

All the chemicals and reagents used for the analyses were in the analytical grade unless otherwise stated.

Sample collection and preparation

Samples were collected during March to May, 2016 from 23 sampling sites of Konso regions. Ground water samples from hand-dug wells were collected in polyethylene bottles that were soaked overnight in 15% nitric acid. The soaked polyethylene containers were washed with deionized water and dried at room temperature. Afterward, the containers were rinsed several times with the water source to ensure sufficient flushing before collection. These water samples are collected after pumping the water for 10 min. All samples were brought to the laboratory in an icebox jar to avoid unusual change in water quality and stored in a refrigerator (4°C) before analysis. The method of collection, preparation and preservation were similar to those reported in previous studies (Barati et al., 2010; Birke et al., 2010; Reimann et al., 2003; Brima, 2017) and Standard methods were followed that listed by American Public Health Association (APHA) (APHA, 2005; APHA, 1992; APHA, 2012).

Physiochemical determination

The water samples were analyzed for various physicochemical parameters using standards methods recommended by APHA (2012, 2005, 1992). On site sampling, five parameters, that is, temperature (°C), turbidity, pH and electrical conductivity (EC) of ground water were determined at the site with the help of digital portable water analyzer kit and other parameters were analyzed in the laboratory. Total hardness (TH) and calcium hardness are determined by complexometric EDTA titration methods using Eriochrome blackT (EBT) and murexide (ammonium purpurate) indicator, respectively. Magnesium concentration is calculated from total hardness and calcium hardness.

Total alkalinity (TA), carbonate and bicarbonate concentrations were estimated by titrimetric methods using phenolphthalein and methyl orange as indicator. To measure total dissolved solid (TDS), the filtered sample was evaporated in a hot oven at 180±2°C. After the whole sample was evaporated, the evaporated dish was cooled and the final weight was measured and computed with the initial weight measured. Estimation of heavy metals (Manganese, Lead, palladium, Nickel, Copper, Cobalt, and Zinc) carried by Flame Atomic Absorption Spectrometer (FAAS-210VGP). Estimation of cations (Na^+, K^+ and Li^+) was measured by single channel emission, Flame Photometer (JENWAY -PFP7).

Nitrate (NO_3^-), sulphate (SO_4^{2-}) and phosphate (PO_4^{-3}) were determined by a colorimetric method using a UV-Visible spectrophotometer type (JASCO V-530). For the analysis of chloride and fluoride ions, ion selective electrodes (Jenway-304 chloride and Jenway 924-305 fluoride) were used respectively. In this study, the precision of the results was evaluated by relative standard deviation of the results of triplicate measurements of each sample were used for the analysis of different parameter of ground water samples.

RESULTS AND DISCUSSION

The respective values of all water quality parameters (physicochemical properties, cation and anion content and trace metal content) of the groundwater samples are presented in Tables 1, 2 and 3, respectively. All the results are compared with standard's permissible limit recommended by the World Health Organization (1993, 2004) and American Public Health Association (APH) (1992, 2005, 2012).

Determination of physical parameters

The data in Table 1 reveals that there were considerable variations in the examined samples from different sources with respect to their physical characteristics and this indicates that the quality of water considerably varies from location to location. Determination of pH is very important because it influences the other physicochemical parameters and the availability of metal ion in the water and waste water. In addition, all the biochemical reactions are sensitive to the variation in pH and it is one of the most important operational water quality parameters (Reda, 2016). In this study, pH ranges between 6.55 (kolbeto) which is slightly acidic and 8.2 (Gersale) which is slightly alkaline. WHO acceptable pH value is 6.5 to 8.5. Hence, all the samples are in the recommended range by WHO and no effect on health with respect to pH.

The temperature of water and wastewater is one of the most important characteristics that determines, to a considerable extent, the trends and tendencies of changes in the river water quality. Increased water temperature decreases the solubility of dissolved oxygen and water temperatures ab''/over 27°C is "unsuitable" for public use. At above 32°C, it would be considered "unfit" for public use (Reda, 2016). In the present study, all measured sample temperatures were presented in permissive threshold value.

Turbidity in water arises from the presence of very finely divided solids which are not filterable by routine methods. The existence of turbidity in water will affect its acceptability to consumers. There is a risk that pathogenic organisms could be shielded by the turbidity particles and hence escapes the action of the disinfectant (Istifanus et al., 2013). Water samples from Misako, Alatayto, Moriteta, Chiro, and Delbela have high turbidity value, greater than 8 NTU that is above a threshold value that is recommended by WHO, this indicates that it is necessary to treat water from this sampling area before

Table 1. Results of physical parameters of the water samples.

Sampling area	Total alkalinity (mg/L)	Conductivity (µs/cm)	T (°C)	pH	Turbidity (NTU)	TDS (mg/L)	TSS (mg/L)	Total hardness (mg/L)
Kolbete	97.6	0.685	22.4	6.55	3.5	776.67	233.33	206.67
Misako	329.4	1.244	21.9	7.11	8.5	1463.33	270.00	477.78
Gera	234.24	0.703	22.0	7.24	1.7	406.67	256.67	340.00
Orbahe	175.68	0.966	22.0	7.44	7.3	793.33	406.66	442.22
Arfa	278.16	0.803	22.0	7.33	1.1	773.33	23.33	406.67
Arfa-1	200.08	0.581	22	7.23	7.5	1086.67	173.33	420.00
Docatu	297.68	1.766	22.1	7.23	2.0	353.3	76.66	817.78
Alatayto1	292.8	1.038	22.3	7.64	8.0	660	20	335.56
Alatayte2	283.04	1.050	22.4	7.74	2.3	1130	156.67	315.56
Moriteta	483.12	1.531	21.7	7.55	8.2	1756.67	336.67	297.78
Kadadeshe	112.24	0.838	22.2	7.64	2.5	873.33	196.67	368.89
Orshale	375.76	1.574	22.6	7.63	3.9	640	36.67	457.78
Airport	200.08	0.743	22.2	7.46	4.0	726.67	6.67	126.67
KonsoTown	283.04	1.051	22.4	7.41	7.9	1030	60.00	604.44
Fasha Town	112.24	0.396	22.3	7.91	1.8	626.67	2666.67	164.44
Chiro	204.96	0.579	22.4	7.95	8.3	396.67	106.67	275.56
Gersale	244	1.055	22.6	7.98	1.0	653.33	143.33	382.22
Fuchucha	229.36	0.600	22.3	8.02	7.8	536.67	153.33	173.33
Bahile	253.76	0.821	22.4	7.78	1.5	676.67	206.67	455.56
Sorobo	395.28	1.179	22.2	7.70	7.6	940	330.00	482.22
Sahayto	458.72	1.554	22.2	7.09	2.2	1310	220.00	666.67
Delbela	229.36	0.784	22.2	7.99	8.1	390	96.67	382.22
Dolbena	244	0.803	22.3	7.87	2.4	516.67	120.00	597.78

use. Electrical conductance is a measure of the ability of an aqueous solution to carry an electric current that depends on the presence and total concentration of ions, their mobility and valance and on the temperature. It is valuable to measure a number of ions dissolved in wastewater and water. It is a useful tool to assess the purity of water (Amanial, 2015). The WHO permissible limit for electrical conductivity (EC) of water is 300 µS/cm and the values of EC in all sampling points were ranged from 0.396 to 1.554 µS/cm. These values are below the WHO permissible limit.

TDS values depend on climate, the host rock, and the residence time of the groundwater in the geological matrix. Thus, it tends to be higher in arid/desert areas than in tropical areas that receive abundant rainfall. It also enhanced in agricultural arid areas due to cyclic salting process, in which salts are concentrated and precipitated in the soil zone from irrigated water due to high evaporation rates, and then leached from the soil zone by either irrigation or rainwater and percolated, hence reaching the groundwater (AlSuhaimi et al., 2017). The TDS was found to be in an acceptable range for the water samples collected from the Delbela, Gera, Docatu and Chiro. The possibilities of dissolution of rockery minerals are very low. However, the rest of water samples were found to possess high TDS value when compared with the tolerance limit of 100 to 500 mg/L of WHO. Since Konso and its surrounding villages found low altitude and there are farms, this can have possibilities to increase TDS of ground water in the sampling sites.

Regarding the values of TSS, all the water samples showed the excess presence of contaminants, and samples from Arfa, Alatayto and Airport TSS measured values were within the permissible limits of WHO (≤30 mg/L). However, other samples were above a threshold value set by WHO. The result indicates sample which has high TSS value may have high contamination and this may introduce different diseases which affect all living things.

Total alkalinity is a measure of the ability of water to neutralize acids. The alkalinity of groundwater is mainly due to carbonates and bicarbonates (Reda, 2016). Alkalinity in terms of HCO_3^- of all these water samples ranged from 97.6 to 483.12 mg/L, respectively. The acceptable limit of alkalinity is 200 mg/L and in the absence of alternate water source, alkalinity up to 600 mg/L is acceptable for drinking. In the present study, the

Table 2. Results of common and heavy metals.

Sampling area	Concentration (mean ± SD) of heavy and light metals (mg/L)										
	Cu	Mn	Zn	Co	Pb	Na	K	Li	Ca	Mg	Pd	Ni
Kolbete	0.176±0.029	0.074±0.000	ND	0.281± 0.013	0.003±0.00	5.312	1.229	ND	161.0	145.7	ND	ND
Misako	0.013±0.010	ND	ND	0.257±0.018	0.276±0.008	5.479	1.337	ND	219.3	258.4	ND	ND
Gera	0.063±0.010	ND	0.049±0.003	0.247±0.036	0.076±0.008	2.688	1.373	ND	168.0	172.0	ND	ND
Orbahe	ND	ND	ND	ND	ND	2.188	1.626	ND	221.7	220.6	ND	ND
Arfa	0.012±0.001	0.002±0.001	ND	0.257±0.017	ND	1.020	1.446	ND	172.7	234.0	ND	ND
Arfa-1	0.182±0.022	0.074±0.013	0.074±0.005	0.288±0.017	ND	0.521	1.554	ND	154.0	266.0	ND	ND
Docatu	0.208±0.001	0.078±0.007	0.107±0.001	0.281±0.016	ND	0.937	1.808	ND	289.3	528.4	ND	ND
Alatayto1	0.076±0.032	0.034±0.000	0.409±0.005	0.268±0.000	ND	1.104	2.460	ND	112.0	223.6	ND	ND
Alatayte2	0.013±0.028	ND	ND	1.355±0.963	ND	1.645	2.786	ND	74.7	240.9	ND	ND
Moriteta	ND	ND	ND	ND	ND	0.646	1.699	ND	46.7	251.1	ND	ND
Kadadesh	0.069±0.010	ND	0.040±0.002	0.247±0.017	ND	ND	1.482	ND	109.7	259.2	ND	ND
Orshale	ND	ND	ND	ND	ND	0.521	1.735	ND	144.7	313.1	ND	ND
Airport	0.132±0.019	ND	0.039±0.000	0.268±0.030	0.027±0.001	0.063	1.880	ND	42.0	84.7	ND	ND
KonsoTown	0.0189±0.018	ND	0.036±0.000	0.257±0.047	0.003±0.000	0.146	1.554	ND	186.67	417.8	ND	ND
Fasha Town	ND	ND	1.054±0.032	0.247±0.018	ND	ND	1.336	ND	86.3	78.1	ND	ND
Chiro	0.139±0.010	ND	0.162±0.009	0.289±0.018	ND	ND	1.590	ND	126.0	149.6	ND	ND
Gersale	0.038±0.022	ND	ND	0.247±0.018	ND	ND	2.422	ND	79.3	302.9	ND	ND
Fuchucha	0.063±0.063	ND	0.067±0.004	0.278±0.036	ND	ND	1.228	ND	56.0	117.3	ND	ND
Bahile	0.094±0.019	ND	ND	0.247±0.018	ND	ND	1.446	ND	193.7	261.9	ND	ND
Sorobo	0.038±0.019	ND	0.458±0.009	0.278±0.017	0.057±0.000	0.009	1.663	ND	235.7	246.6	ND	ND
Sahayto	0.032±0.010	ND	ND	0.257±0.064	ND	ND	1.699	ND	221.7	445.0	ND	ND
Delbela	0.025±0.021	ND	ND	0.278±0.047	ND	ND	2.207	ND	135.3	246.9	ND	ND
Dobena	ND	ND	ND	0.237±0.00	ND	ND	2.170	ND	179.7	418.1	ND	ND

ND: Not detected.

value of total alkalinity content in all sampling sites has been found under permissible alkalinity level.

Hardness is one of the very important properties of ground water from a utility point of view for different purposes. In groundwater, hardness is mainly contributed by bicarbonates, carbonates, sulphates and chlorides of calcium and magnesium. So, the principal hardness causing ions are calcium and magnesium (Reda, 2016). WHO standards given for hardness include 100 mg/L (highest desirable) and 50 0mg/L (maximum permissible). The samples, Sahayto, Dolbena, Konso town and Docatuhave very high hardness value, which is beyond the maximum permissible limit. But Airport and Fasha town and gets moderate hardness, and all the remaining samples are characterized by hard water though they are in the recommended range.

Determination of light and heavy metals

The mean (average) values for light and heavy metals determined in the ground water samples

Table 3. Results of common anions.

Sampling area	Concentration (mean ± SD) of metals (mg/L)				
	NO_3^-	PO_4^{-3}	SO_4^{-2}	Cl^-	F^-
Kolbete	2.03±0.050	0.411±0.000	1187±0.000	23.67±0.244	0.480±0.67
Misako	7.13±0.013	0.578±0.004	732±0.000	72.97±0.489	0.355±0.67
Gera	6.10±0.013	0.107±0.004	52±0.000	19.72±0.244	0.277±0.67
Orbaye	72.65±0.013	ND	174±0.000	60.15±0.044	0.247±1.11
Arfa	16.00±0.249	0.068±0.004	140±0.000	24.66±0.156	0.174±0.66
Arfa-1(upper)	17.75±0.013	0.066±0.004	137±0.000	21.69±0.089	0.138±0.44
Dokatu	23.12±0.000	0.167±0.004	196±0.000	114.39±0.177	0.173±0.67
Alatoyte-1	2.48±0.000	0.580±0.004	256±0.577	61.12±0.044	0.205±0.67
Alatoyte-2	2.10±0.000	0.059±0.004	99±0.000	91.71±0.200	0.186±0.44
Moriteta	11.38±0.000	ND	88±0.577	54.24±0.044	0.217±0.44
Kadadish	31.05±0.240	0.053±0.008	72±0.577	30.57±0.044	0.188±0.67
Orshale	22.88±0.249	ND	111±0.173	193.28±0.155	0.146±0.67
Airport	2.45±0.249	2.046±0.079	146±0.000	36.48±0.155	0.108±0.67
Konso Town	65.33±0.000	ND	64±0.577	55.22±0.044	0.123±0.67
Fasha Town	31.45±0.015	0.566±0.040	52±0.000	21.89±0.312	0.144±0.11
Chiro	4.28±000	ND	51±0.000	21.45±0.162	0.111±0.44
Gersal	58.53±0.000	0.162±0.004	65±0.000	101.56±0.444	0.105±0.44
Fuchucha	2.75±0.125	ND	127±0.000	14.79±0	0.178±0.44
Bahile	24.63±0.294	0.158±0.007	71±0.000	25.63±0.111	0.101±0.44
Sorobo	4.15±0.429	0.018±0.014	70±0.000	82.09±0.175	0.123±0.67
Sahayto	62.80±0.113	0.066±0.010	238±0.100	100.58±0.133	0.146±0.67
Delbela	2.80±0.132	2.470±1.961	198±0.100	46.34±0.05	0.088±0.67
Dolbena	2.60±0.011	0.438±0.007	204±0.000	52.26±0.089	0.775±0.67

are shown in Table 2.

The major sources of copper in water bodies are agricultural activities and municipal solid wastes, pesticides, batteries charging and blue color for consumer products. Ingesting high levels of copper can cause nausea, vomiting, and diarrhea. Very-high doses of copper can cause damage to your liver and kidneys, and can even cause death (Ediagbonya et al., 2015). Copper is one of essential dietary requirement, However, astringent tastes in water can be caused by levels above 1 mg/L Cu. At levels above 2.5 mg/L, copper imparts an undesirable bitter taste to water; at higher levels, the color of the water is also impacted (World Health Organisation (WHO), (2004a). As is indicated in Table 2, the average concentrations of copper in all water samples are below the threshold value, (2 mg/L), as set by WHO and all the samples are within safe permissible limits.

Zinc levels in surface water and groundwater normally do not exceed 0.01 and 0.05 mg/L, respectively, concentrations in tap water can be much higher as a result of the dissolution of zinc from pipes. Zinc is found naturally at low concentrations in my rocks and soils principally as sulphide ores and to a lesser degree as carbonates. Most zinc is introduced into water by artificial pathways such as byproducts of steel production or coal-fired power station or from the burning of waste materials, from fertilizer that may leach into groundwater. Zinc is considered an essential trace metal which functions as a catalyst for enzymatic activity in human bodies. Drinking water contains this trace metal in very small quantities which may reduce the possibility of its deficiency in the diet. However, its accumulation in the human body causes harmful effects such as stomach cramps, nausea, vomiting, decrease good cholesterol and acceleration of anemic conditions (Quinn and Sherlock, 1990; Ediagbonya et al., 2015). The maximum permissible limit for Zn in drinking water is 0.01 g/ml as recommended by WHO. The mean concentration for Zinc (Zn) (Table 2) in this study varied from 0.036 to 1.054 mg/L; with the highest measured at Fasha town and the lowest was at Konso town. However, in some samples, Zinc concentration is not detected by instrument indicating too little concentration. Detected too much zinc concentration is above a threshold value that needs immediate intervention to improve the quality of water around sampling area.

The major sources of manganese are fertilizer, steel production, ores, rocks, pesticides, and batteries charging. It has not been particular toxicological to be too much harmful and poisonous, but the concentration of it in a particular spot may vary the taste and yet causes turbidity (WHO, 2004a). The health based standard guideline given by WHO for Manganese is 0.5 mg/L, hence in all samples the concentrations were found to be less than the threshold value. Exceptionally, sample from Kolbete Arfa, Arfa-1 and Docatu, their concentrations are very low to be detected by the instrument.

Lead is a cumulative general poison for the fetus and pregnant women. Infants and children up to 6 years of age are the most susceptible to its adverse health effects. Its effects on the central nervous system can be particularly serious. The almost universal use of lead is plumbing fittings and as solder in water distribution systems. Lead pipes may be used in old distribution systems and plumbing. Corrosion of plumbing systems is an important source of excessive lead in drinking-water, so lead levels in water should be measured at the tap, rather than at the drinking-water source, when estimating human exposure (WHO, 2004a). Samples from Misako, Gera, Airport, and Sorobo were above the permissive level recommended by WHO>0.01 mg/L, hence need a special attention. However, for other rest of the samples, the levels of lead are low and undetected by the instrument. This may suggest that the environment is free of lead contamination and hence ground water samples from these sampling areas are safe for human consumption and their animals.

The trace element Cobalt is detected in all samples that range from least concentration 0.237 mg/L (Dobena) to 1.355 mg/L (Alatayte2). The result for the analysis of light metal ions: sodium, potassium and lithium, shows the very less average concentration of the corresponding ions are present, and most of them are in the recommended range. When the result of sodium concentration compared with the standard given by WHO based on aesthetic quality, there is no maximum contaminant level set for sodium, but 200 mg/L was fixed based on taste. For potassium and lithium, there are no specific standards in drinking water given by WHO.

Calcium has no effect on human health in water, but it can cause hardness problem risk and directly related to hardness (Welch et al., 2000). Except for sample area from Alatayte2, Moriteta, Airport, Fasha town, Gersale and Fuchucha, rest of the samples' concentrations of calcium are above permissive standard limit prescribed by WHO. This indicated that in terms of the calcium content, the water is not safe for drinking and other domestic purposes for this area. Mg^{2+} is the most abundant elements in nature and it is a significant member in water hardness, it gives an unpleasant taste to water (Konso special woreda, 2017). In all of the samples, the content of magnesium level was above standard limit sated by WHO. This indicated that in terms of the magnesium content, the water is not safe for drinking and other domestic purposes for this area.

In most of the water samples, the concentration of Ni, Li and Pd is very low to be detected by the instrument. None of this element was detected in all samples which show that the water samples contain very less amounts of Ni, Li and Pd, that is less than the detection limit of the instrument. Therefore, ground water around Konso area has very less level of these ions; hence, the water is safe for drinking with respect to these ions. Lithium (in all samples), zinc, sodium, and manganese were below the detection limits in some samples and are reported as not detected (ND).

Determination of common anions

Chloride and fluoride are very common in water systems as they are added to drinking water for various health and sanitary purposes. However, chloride and fluoride levels can be increased by contamination of fertilizers, road salt, and industrial pollution as well as human and animal waste. The contaminants can cause dramatic increases in chloride and fluoride concentrations, which should be closely monitored (Jason and Christina, 2012). The concentration of chloride is the indicator of sewage pollution and also imparts laxative effect. Atmospheric sources or sea water contamination is the reason for the bulk of the chloride concentration in groundwater which may exceed due to base-exchange phenomena, high temperature, domestic effluents, septic tanks and low rainfall. Porosity soil and permeability also plays a key role in building up the chlorides concentration (Reda, 2016). According to WHO recommendation (1993), the permissible value is 250 mg/L. As shown in Table 3, the current analysis result reveals that all the samples of water from different areas of Konso have low values of chloride ranging from 0.34 to 4.45 mg/L which is in the permissible range for drinking.

Most ground watersamples have low or acceptable concentrations of fluoride (<1.5 mg/L) according to the recommendation of WHO (1993). However, some large groundwater provinces have significant concentrations which cause prominent health problems. Presence of large amounts of fluoride is associated with dental and skeletal fluorosis (>1.5 mg/L) and inadequate amounts with dental caries (< 1 mg/L). From the result indicated in Table 3. All samples have average fluoride concentration below 1.5 mg/L, which is found between 0.088 and 0.775 mg/L. This shows the water is recommended for drinking purpose with respect to fluoride. On the other hand, this result reveals that the amount of fluoride concentration is very small in the range of 0.1 ppm, which is reflected by dental caries in some areas. This requires some remedial action to be done, that is, more supply of fluoride to the water or from other sources is required.

Nitrate is the highest oxidizable form of nitrogen and occurs in trace quantities in surface water, but may attain high levels in some ground water and is toxic when present in excessive amounts in drinking water. Mostly nitrate comes from industrial, agricultural chemicals and fertilizer application. The most common source of nitrate concentration is attributed to animals and human waste disposal practices and the use of agricultural fertilizer (Mohammed and Nur, 2013). The nitrate concentration measurements, for these water samples range between 2.03 and 65.33 mg/L. The recommended value of nitrate is 50 mg/L as expressed by WHO (1993). In this study, the experimental result listed in Table 3 shows sample from Orbaye, Konso town, Gersal, and Sahayto has above the maximum threshold value, so the water in these areas needs immediate attention/treatment to make water safe for drinking. Other samples are recommended for drinking purpose since they have concentration below a threshold value.

The sulfate concentration ranges from 1187 to 9.51 mg/L most samples falls below 500 mg/L threshold value that recommended by WHO (1993) guidelines for drinking water, however, samples Kolbete and Misako have a high amount of sulfate concentration. The sulphate concentration in the analyzed sample is probably derived from oxidation of sulphate in the igneous rocks. These shows it is above threshold value; it needs further treatment to make safe water for the drinking purpose. The remaining samples' analysis result shows that they are in the recommended range for drinking purpose, according to WHO.

Phosphates enter waterways from human and animals waste, phosphorus rich bedrock, laundry, cleaning, industrial effluents, and fertilizer runoff. Phosphates become detrimental when they over fertilize aquatic plant and cause step up eutrophication. Though, there is no clear guideline set for the phosphate ion concentration by WHO (1993), some research articles and guidelines suggest that concentration of 0.01 mg/L of phosphate is acceptable while 0.02 mg/L is excessive (Istifanus et al., 2013; Ediagbonya et al., 2015). The result obtained (Table 3) shows that no phosphate content is detected in some samples. This shows the concentration of phosphate in the samples is very small and below the detection limit of the instrument. In the remaining samples, a high level is detected that is above recommended limit, however, the high amount is exceptionally detected in airport area and it needs treatments to make it safe for drinking purpose.

Conclusion

Chemical constituents in water can cause a variety of problem in living things. To improve its quality it should be recognized that the most effective and protective way is through the application of regular checkup and taking exact measure with a specific period of time before it is supplied to living things. The ground water samples which were taken from the various places in Konso area were analyzed for different physicochemical parameters and most of the parameters are found to be below the maximum permissible limits of WHO. However, the following results are noted as exceptions to meet the standards of WHO. Dolbena, Sahayto, Konso town and Docatu have very high hardness value, which is beyond the maximum permissible limit. In terms of light metal ions, sodium, potassium and lithium, the result shows that the very less average concentration of the corresponding ions are present, and most of them are in the recommended range. Samples collected from Misako, Gera Airport and Sorobo areas, respectively, have more lead content than the threshold value. For a sample with above permissive value need immediate interventions and need a special attention to improve the quality of drinking water. Generally, most of the parameters in the waters samples were found to be within the limit of drinking water quality standards and are safe for dirking and other domestic purposes at the physicochemical level. However, it is also important to investigate other potential water contaminations such as chemicals, microbial and radiological materials for a longer period of time, in order to assess the overall water quality.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

American Public Health Association (APHA) (2012). American Water Works Association – Awwa; Water Pollution Control Federation - Wpcf. Standard methods for the examination of water and waste water. 22th ed. Washington DC.

American Public Health Association (APHA) (1992). Standard Methods for the Examination of Water and Wastewater. 18th ed., Greenberg, A.E.; Clesceri, L.S. & Eaton, A.D. (editors). APHA, WEF & AWWA, Washington D.C.

American Public Health Association (APHA) (2005). Standard methods for the examination of water and waste water. Washington, DC: American Public Health Association.

Ackah M, Agyemang O, Anim AK, Osei J, Bentil NO, Kpattah L, Gyamfi ET, Hanson JEK (2011). Assessment of groundwater quality for drinking and irrigation: the case study of Teiman-Oyarifa Community, Ga East Municipality, Ghana. Proc. Int. Acad. Ecol. Environ. Sci. 1(3-4):186-194.

Appelo CAJ, Postma D (2005). Geochemistry, Groundwater and Pollution. Taylor & Francis, P 251.

Amanial HR (2015). Assessment of Physicochemical Quality of Spring Water in Arbaminch, Ethiopia. J. Environ. Anal. Chem. 2(157):2380-2391.

Ashwani K, Abhay K (2014). Hydrogeochemical Investigation and Groundwater Quality Assessment of Pratapgarh District, Uttar Pradesh. J. Geol. Soc. India 83:329-343.

Ashwani K, Marina D, Gianpiero A (2017). Evaluation of Metal Contamination in the Groundwater of the Aosta Valley Region, Italy. Int. J. Environ. Res. 11(3):291-300.

AlSuhaimi AO, AlMohaimidi KM, Momani KA (2017). Preliminary assessment for physicochemical quality parameters of groundwater in Oqdus Area, Saudi Arabia. J. Saudi Soc. Agric. Sci. http://dx.doi.org/10.1016/j.jssas.2016.12.002

Barati AH, Maleki A, Alasvan M (2010). Multi-trace elements level in drinking water and the prevalence of multi-chronic arsenical poisoning in residents in the west area of Iran. Sci. Total Environ. 408:23-1529.

Birke M, Reimann C, Demetriades A, Rauch U, Lorenz H, Harazim B, Glatte W (2010). Determination of major and trace elements in European bottled mineral water-Analytical methods. J. Geochem. Explor. 107:217-226.

Blais JF, Tyagi RD, Aucleir JC (1993). Bioleaching of metals and sewage sludge: Effect of temperature. Water Resour. 27(1):110-120.

Brima EI (2017). Physicochemical properties and the concentration of anions, major and trace elements in groundwater, treated drinking water and bottled drinking water in Najran area, KSA. Appl. Water Sci. 7:401-410.

Ediagbonya TF, Nmema E, Nwachukwu PC, Teniola OD (2015). Identification and Quantification of Heavy Metals, Coliforms and Anions in Water bodies using Enrichment Factors. J. Environ. Anal. Chem. 2(146):2380-2391.

Istifanus YC, Karu E, Ziyok I, Amanki ED (2013). Physicochemical analysis of ground water of selected areas of Dass and Ganjuwa local government areas, Bauchi State, Nigeria. World J. Analyt. Chem. 1(4):73-79.

Jason H, Christina L (2012). Determination of chloride, fluoride, and sulfate ions in various water samples using ion chromatography. Concordia College J. Anal. Chem. 3:24-28.

Kanmani S, Gandhimathi R (2013). Investigation of physicochemical characteristics and heavy metal distribution profile in groundwater system around the open dump site. Appl. Water Sci. 3:387-399.

Konso special woreda - Wikipedia, https://en.wikipedia.org/wiki/Konso_special_woreda. Accessed, august 2, 2017.

Reda AH (2016). Physico-chemical analysis of drinking water quality of Arbaminch Town. J. Environ. Anal. Toxicol. 6(2):1-5.

Reda AH (2016). Physico-chemical characterization of tannery effluent and its impact on the nearby river. J. Environ. Chem. Ecotoxicol. 8(6):44-50.

Mohammed AG, Nur A (2013). Physicochemical analysis of groundwater samples of gwoza town and environs, northeastern Nigeria. Int. J. Res. Earth Environ. Sci. 1(1):28-34.

Muthulakshmi L, Ramu A, Kannan N, Murugan A (2013). Application of Correlation and Regression Analysis in Assessing Ground Water Quality. Int. J. Chem. Technol. Res. 5(1):353-361.

Nikunj A, Parekh F, Suryanarayana TM (2015). Analysis of Physico-chemical properties of groundwater. Int. J. Innov. Res. Sci. Eng. Technol. 4(3):1094-1098.

Omaka ON, Offor IF, Onwe IM (2015). Hydrogeochemical attributes and ground water quality of Ngbo Community in Ohaukwu Area Council, Ebonyi State, Nigeria. Rev. Ambient Água 10(1):35-47.

Quinn MJ, Sherlock JC (1990). The correspondence between U.K. action levels for lead in blood and in water. Food Addit. Contam. 7:387-424.

Reimann C, Bjorvatn K, Frengstad B, Melaku Z, Tekle-Haimanot R, Siewers U (2003). Drinking water quality in the Ethiopian section of the East African Rift Valley I-data and health aspects. Sci. Total Environ. 311:65-80.

Shittu OB (2008). Physicochemical and Bacteriological Analyses of Water Used for Drinking and Swimming Purposes in Abeokuta, Nigeria. Afr. J. Biomed. Res. 11(3):285-290.

Welch P, David J, Clarke W, Trinidade A, Penner D, Bernstein S, McDougall L, Adesiyun AA (2000). Microbial quality of water in rural communities of Trinidad. Revista Panamericana de Salud Pública. 8(3):172-180.

World Health Organisation (WHO) (2004a). Guidelines for Drinking Water Quality. 3rd Edition. World Health Organisation, Geneva, Switzerland.

World Health Organisation (WHO) (1993). Guidelines for Drinking-water Quality Recommendations, WHO, Geneva. Vol. 1, 2nd Edition.