# Mineral Profiles of Water Used by Livestock in Selected Sites in Central Highlands of Ethiopia

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## Abstract

*The study was conducted to evaluate the status of pH and mineral concentration of livestock water sampled from Holetta, Akaki and Ambo areas in central highlands of Ethiopia. Water samples were analyzed for macro minerals (Na, Ca, K, Mg) and micro minerals (Fe, Zn, Cu, Mn) using Atomic Absorption Spectrophotometer (AAS). The variation in pH among Akaki (6.77 ± 0.43), Holetta (7.46 ± 0.43) and Ambo (7.75 ± 0.43) was not significant. Calcium (69.02 ± 9.77 ppm), potassium (31.82 ± 9.77 ppm) and sodium (9.35 ± 9.77ppm) were found in higher concentration in Akaki, Ambo and Holetta, respectively. Iron (89.95 ± 9.77ppm), manganese (9.20 ± 9.77ppm) and manganese (0.83 ± 9.77 ppm) were the micro minerals found in higher concentration in Akaki, Ambo and Holetta, respectively. The concentration of calcium, magnesium, sodium, zinc and copper in water samples collected from the study locations were found within acceptable range. However, the concentration of potassium in Akaki (26.91 ± 9.77 ppm) and Ambo (31.82 ± 9.77 ppm); iron in Akaki (89.95 ± 9.77 ppm), Ambo (5.5 ± 9.77 ppm) and Holetta (0.33 ± 9.77 ppm); manganese in Akaki (20.76 ± 9.77ppm), Ambo (9.20 ± 9.77 ppm) and Holetta (0.83 ± 9.77 ppm) respectively were greater than the acceptable limit. Therefore, any intervention in mineral supplementation of livestock should take into account the mineral concentration of water used by livestock. To overcome the excessive concentration of iron, potassium and manganese in water, an adjustment, targeting to the problematic mineral element is required during feed formulation.*

***Keywords***: *Cattle, Consumption, pH, quality, macro, micro*

## Introduction

Water is a basic requirement for numerous functions of life. It is the most important nutrient next to oxygen to sustain life (Beede, 2006). Water is involved in regulation of body temperature and other physiological processes in livestock species (NRC, 1996, Matt and Sonja, 2012). It is required for milk production and accounts for about 87% of the milk in dairy cows. A cow's body weight is composed of 56-81% water and can faces fatal conditions when 20% of the water weight is lost (Lejune et al, 2001). Both the quantity and quality of water are important aspects for achieving better livestock performances. Since water is one of the reservoirs of minerals, there is an interest to study its quality (Patra et al, 2008). The quality of water is evaluated in terms of its concentration of minerals which may be vary depending on the locations they exist (Qiang et al., 2009). Macro minerals such as calcium, potassium, sodium and magnesium are necessary for many physiological processes such as fluid balance, maintenance of bones and teeth, muscle contractions and nervous system functions. Micro minerals such as copper, iron, manganese, zinc are essential for immune system functions, energy metabolism and protection of antioxidants (Qiang et al., 2009; Tekleyohannes and Agrawal, 2003). Evaluating the concentration of minerals is vital because limitations could result to deficiency diseases and their presence in excess could provoke toxicity. For example, deficiency of calcium and phosphorus can lead to poor reproductive performance and low content of fat in milk (Rekhis et al., 2002). Iron content greater than 0.3 ppm is considered a concern for poor performance and health of dairy cattle. Presence of higher concentrations of calcium, sodium and magnesium in water can reduce water intake and higher concentrations of trace elements in water such as copper, zinc and manganese are toxic (Salinity management handbook, 2013). Moreover, the presence of minerals in excess can leave residues in animal products which can adversely affect product sales and transfer health risks to humans (Dave, 2008; Lili, 2009; Khan et al., 2012). There is an acceptable limit of the concentration of mineral elements in water at which no adverse effects can occur (Breede, 2006; Dawd, 2010; MOH, 2004).

The quality of water can also be evaluated in terms of PH (Jane, 2009). Highly acidic pH in livestock water leads to acidosis and reduced feed intake, while highly alkaline water causes digestive upsets, diarrhea, reduced water intake, lower feed intake and lower feed conversion efficiency (Jane, 2009).

Some research activities have been conducted on mineral status of feed stuffs (Lemma Gizachew and Smit, G.N 2005). However, information is lucking on concentration of mineral elements in livestock water under Ethiopian condition. Therefore, this study was conducted with the following objectives:

- To determine the pH status of livestock water across different locations
- To assess the concentration of selected macro and micro minerals in livestock water and its contribution to the daily requirements of cattle
- To compare the concentration of macro and micro minerals against the Official Standard of acceptable limits

## Materials and methods

### Description of the study locations

The study was carried out in three locations of the central highlands of Ethiopia: Akaki, Holetta and Ambo. Akaki is located in central Ethiopia along the Western margin of the Main Ethiopian Rift. The catchment is located between 8°46´–9°14´N and38°34´–39°04´E

Holetta is located at 38° 30`E, 9° 3`N and 30 km west of Addis Ababa and lies 2400 m above sea level. The annual rainfall is 1066 mm with bimodal distribution, over 70% of which occurs during the main rainy season (June to September) and 30% during the small rainy season (February to April). The average annual minimum and maximum temperatures were 6° and 22°C, respectively. The area is also characterized by occasional frost that occurs in the months of October to December, where temperatures below zero are recorded for few days during these months (Fekede et al., 2004).

Ambo is located in Western Shewa Zone of the Oromia Regional state in central Ethiopia. It is situated 115 km West of Addis Ababa. The area is located at a longitude of $37^0$ 32' to $38^0$ 3' E, and a latitude of $8^0$ 47' to $9^0$ 20' N. The altitude of the area ranges from 1900-2275m above sea level. The broad agro-ecological classification of the area is 23% highland, 60% mid altitude, and 17% lowland. It has an annual rainfall and temperature ranging from 800-1000 mm and 20-29°C, respectively. The rainfall is bi-modal with short rainy season from February to May and long rainy season from June to September. Agriculture is the main occupation of the population. Agricultural activities are mainly mixed type with cattle rearing and crop production under taken side by side. Ambo is known for its mineral water, which is bottled outside of town which is reportedly the most popular brand in Ethiopia.

### Sampling sites, sampling methods and laboratory analysis

Water samples were collected from ten water points in each study locations. Theses water points serve as a source of drinking water for different livestock species in the respective location. In this particular study these water points were used as a replication of water samples for each study location. Accordingly, ten water samples were collected from each water point under each study location. The water points from which water samples were collected is described in Table 1.

Plastic bottles with capacity of 0.5 liter were used for collecting water samples. The containers were cleaned by rinsing with distilled water and labeled with the location and the water point. The sample bottles were filled and capped tightly. Water samples were checked for physical appearances like color, turbidity and odor prior to laboratory analysis. The samples were then analyzed for pH, macro and micro minerals at Debrezeit soil and plant laboratory. The pH of the samples was measured by pH/ion-meter, WTW, Inolab (Germany). The concentrations of macro minerals (Na, K, Ca, Mg) and micro minerals (Cu, Zn, Fe, Mn) were determined using the standard procedures of Atomic Absorption Spectrophotometer (AAS).

Table 1. Study locations and their respective water points (sampling sites)

| Akaki | Holetta | Ambo |
|---|---|---|
| Laga Dukem 1 | Kui 1 | Boji wenz 1 |
| Tulu Dimitu 1 | Kui 2 | Boji wenz 2 |
| Tach Dengora1 | Weserve 1 | Huluka 1 |
| Lay Dengora 1 | Weserve 2 | Huluka 2 |
| Fanta Wenz 1 | Holetta wenz 1 | Umuga 1 |
| Tulu Dimitu 2 | Holetta wenz 2 | Umuga 2 |
| Tach Dengora 2 | Ureni 1 | Cholu 1 |
| Lay Dengora 2 | Ureni 2 | Cholu 2 |
| Fanta Wenz 2 | Korejela 1 | Chancho 1 |
| Laga Dukem 2 | Korejela 2 | Chancho 2 |

**Experimental design and Statistical analysis**

The experimental design was Completely Randomized Design (CRD) and the statistical model is indicated below.

$Y_i = \mu + Li + ei$ Where,

$Y_i$ = the concentration of mineral elements

$\mu$ = the overall mean

Li = the effect of $i^{th}$ location

ei = the error term

Due to the wide variation observed among concentration of mineral elements ranging from 0 – 262 ppm, the standard deviation (root MSE) of some elements was found greater than the respective means. When the data was tested for assumptions of normality, it could not fulfill trend of normal distribution. To make data set fulfilling normal distribution, we were forced to transform the data using the square root transformation and we have got the transformed data. Both the transformed and untransformed data were subjected to Analysis of variance. The General Linear Model Procedures (GLM) of Statistical Analysis System (SAS, 2002) was used for data analysis based on one way analysis of variance. Ls-means of both the transformed and untransformed data were presented on the result and least square means of the transformed data is reported in parenthesis.

**Intake of minerals from drinking water and its contribution to mineral requirement**

For estimation of macro and micro minerals, maintenance requirement for the different minerals found from literature was taken into consideration. To estimate the maintenance requirement of calcium for non-lactating mature cattle, the absorbed calcium required was 0.0154 g/kg body weight (Hansard et al., 1957). This requirement should be added to the total inevitable losses in the form of urine and faeces that is 0.015 g/kg body weight per day (Gueguen et al. 1989).To estimate the maintenance requirement of sodium, the absorbed sodium for lactating cows was set at 0.038 g/kg of body weight per day. This requirement needs to be added to the total inevitable losses in the form of urine and faces that is 0.015 g/kg body weight per day (NRC 2001). In addition, at environmental temperatures between 25 and 30°C, an additional 0.10 g sodium per 100 kg body weight is lost in the form of sweat which is considered to be part of maintenance requirement (ARC, 1980).The maintenance requirement for absorbed potassium of lactating cows was set at 0.038 g/kg body weight (endogenous urinary loss) plus 6.1 g/kg of dietary dry matter (endogenous fecal loss) (Sanchez et al., 1994a). At environmental temperatures between 25°C and 30°C, an additional 0.04 g potassium/100 kg body weight was considered part of maintenance requirement. The maintenance requirement for absorbed magnesium is 0.33 g/day (Lyford and Huber, 1988). On top of this, the fecal loss of endogenous Mg is 3 mg/kg body weight for adult cattle and heifers in 100 kg body weight (NRC 1996). Obligate urinary loss of magnesium is negligible. The daily copper requirement for 300kg body weight cattle is 72mg/day (NRC, 2000). The iron requirement of mature lactating cow is 24 mg /kg DM feed (Henry and Miller 1995). The daily Manganese requirement of cattle is 40 mg/kg DM feed (NRC, 1989b). The maintenance requirement of zinc is the sum total of the absorbed zinc requirement of 0.045 mg/kg body weight plus the daily endogenous fecal loss which is approximately 0.033 mg zinc/kg body weight and the obligate urinary loss of zinc is estimated at 0.012 mg zinc/kg body weight (Hansard et al., 1968).

## Results and Discussions

The pH of livestock water across the study locations and sampling sites are presented in Table 2. Extreme pH values beyond the acceptable range were recorded in Akaki (3.93 - 9.95). Some sites/water points in Akaki including Lagadukem 1 (pH=9.95) and Lagadukem 2 (pH=9.87) had higher pH values than the acceptable range. In Akaki, lower pH values were also recorded in sites like Tach Dengora 1 (3.93), Tach Dengora 2 (4.1), Lay Dengora 1 (5.28) and Lay Dengora 2 (4.04). As compared to Holetta and Ambo, the pH of water across Akaki sampling sites has a wide range of variation. The pH value in Ambo and Holetta was 7.37 - 8.45 and 7.21 - 8.01 respectively which was within the acceptable limit. However, no significant differences were observed in mean pH values among Akaki (6.77 ± 0.43), Holetta (7.46 ± 0.43) and Ambo (7.75 ± 0.43). The acceptable limit of pH in livestock water was reported to be 6.5–8.5 (Peterson, 1999).
Water pH is used to describe the acidity or alkalinity and the concentration of hydrogen ion. Water pH lower than 5.5 can lead to acidosis and reduced feed intake in cattle (Jane, 2009). On the other hand, pH greater than 9.0 may result in chronic or mild alkalosis (Adams and Sharpe, 1995). Water pH also determines the effectiveness of water treatments. For example, chlorination efficiency is reduced at a higher pH. Lower pH may cause precipitation of some antibacterial agents in a water system (MOA, 1999). For example, sulphonamides are a particular concern as precipitated medication may leak back into the water after treatment has ended, contributing to potential sulpha residues in carcasses (Karen, 1999). The value of pH in water is a measure of quality which can cause low water intake in livestock species. Anti-quality factors

(elements existing in excess or unwanted compounds) present in water may affect pH value and consequently influence the normal physiological functions of animals (Beed, 2006).

Table 2. pH range of livestock water across sampling sites

| Akaki | | Holetta | | Ambo | |
|---|---|---|---|---|---|
| Sampling sites | pH | Sampling sites | pH | Sampling sites | pH |
| Laga Dukem 1 | 9.95 | Kui 1 | 7.41 | Boji wenz 1 | 7.68 |
| Tulu Dimitu 1 | 7.34 | Kui 2 | 7.21 | Boji wenz 2 | 7.67 |
| Tach Dengora1 | 3.93 | Weserve 1 | 7.46 | Huluka 1 | 8.45 |
| Lay Dengora 1 | 5.28 | Weserve 2 | 8.01 | Huluka 2 | 7.82 |
| Fanta Wenz 1 | 8.08 | Holetta wenz 1 | 7.39 | Umuga 1 | 7.40 |
| Tulu Dimitu 2 | 7.38 | Holetta wenz 2 | 7.37 | Umuga 2 | 7.96 |
| Tach Dengora 2 | 4.1 | Ureni 1 | 7.31 | Cholu 1 | 7.91 |
| Lay Dengora 2 | 4.04 | Ureni 2 | 7.40 | Cholu 2 | 7.72 |
| Fanta Wenz 2 | 7.43 | Korejela 1 | 7.48 | Chancho 1 | 7.48 |
| Laga Dukem 2 | 9.87 | Korejela 2 | 7.54 | Chancho 2 | 7.37 |
| Minimum | 3.93 | | 7.21 | | 7.37 |
| Maximum | 9.95 | | 8.01 | | 8.45 |
| Mean | 6.77 ± 0.43 | | 7.46 ± 0.43 | | 7.75 ± 0.43 |

The concentration of macro and micro minerals is presented in Table 3. Their concentrations has varied in the order of calcium (26.43 ppm) > sodium (24.68 ppm) > potassium (19.84 ppm) > magnesium (6.59 ppm). No significance difference ($p>0.05$) was observed among the concentration of sodium, calcium and potassium. However, significance difference ($p<0.05$) was observed between magnesium (6.59 ppm) and the other macro minerals vis. sodium (24.68 ppm), calcium (26.43 ppm) and potassium (19.84 ppm).

Table 3. Concentration of macro and micro minerals in livestock water (LS-means ± SE)

| Mineral element | Concentration (ppm) | |
|---|---|---|
| *Macro minerals* | | |
| Na | $24.68 \pm 6.13^{a}$ | $(4.70 \pm 0.44)^{a}$ |
| Ca | $26.43 \pm 6.13^{a}$ | $(3.67 \pm 0.44)^{a}$ |
| K | $19.84 \pm 6.13^{a}$ | $(3.58 \pm 0.44)^{ab}$ |
| Mg | $6.59 \pm 6.13^{b}$ | $(2.37 \pm 0.44)^{c}$ |
| *Micro minerals* | | |
| Cu | $0.13 \pm 6.13^{b}$ | $(0.36 \pm 0.44)^{b}$ |
| Zn | $0.29 \pm 6.13^{b}$ | $(0.50 \pm 0.44)^{e}$ |
| Fe | $31.93 \pm 6.13^{a}$ | $(2.75 \pm 0.44)^{fcd}$ |
| Mn | $10.26 \pm 6.13^{ab}$ | $(1.77 \pm 0.44)^{dc}$ |

*LS-means with different superscripts within columns are significantly different.*
*Figures indicated in parenthesis are the transformed Ls-means.*

With respect to micro minerals the concentration has varied in the order of iron (31.93 ppm) > manganese (10.26 ppm) > zinc (0.29 ppm) > copper (0.13 ppm). No significance difference (p>0.05) was observed between copper (0.13 ppm) and zinc (0.29 ppm); iron (31.93 ppm) and manganese (10.26 ppm). However, significance difference (p<0.05) was observed between copper (0.13 ppm) and iron (31.93 ppm); zinc (0.29 ppm) and iron (31.93 ppm); zinc (0.29 ppm) and manganese (10.26 ppm).

The concentration of macro and micro minerals across the study locations is presented in Table 4. With respect to macro minerals in Akaki, calcium was the highest (69.02 ± 9.77 ppm) and the lowest was magnesium (9.77 ± 9.77 ppm). In Ambo, potassium was the highest (31.82 ± 9.77 ppm) and magnesium was the lowest (3.87 ± 9.77 ppm). In Holetta sodium had the highest concentration (9.35 ± 9.77 ppm) and potassium was lowest (0.79 ± 9.77 ppm). With regard to micro minerals, the highest concentration of iron was observed in Akaki (89.95 ± 9.77 ppm ) and the lowest one was copper (0.10 ± 9.77 ppm). However, in Ambo, manganese was the highest (9.20 ± 9.77 ppm) and the lowest was copper (0.13 ± 9.77 ppm). In Holetta, manganese was the highest (0.83± 9.77 ppm) and the lowest was copper (0.16 ± 9.77 ppm).

Table 4. Concentration (ppm) of macro and micro minerals in livestock water across locations (mean ± SE)

| Mineral element | Location | | |
|---|---|---|---|
| | Akaki | Ambo | Holetta |
| *Macro minerals* | | | |
| Sodium | 40.78 ± 9.77[a] (6.37± 0.7)[a] | 23.93 ± 9.77[ac] (4.69 ± 0.7)[a] | 9.35 ± 9.77[c] (3.04 ± 0.7)[c] |
| Calcium | 69.02 ± 9.77[a] (6.92 ± 0.7)[a] | 3.94 ± 9.77[bc] (1.63 ± 0.7)[bc] | 6.35 ± 9.77[c] (2.47 ± 0.7)[c] |
| Potassium | 26.91 ± 9.77[ac] (5.01± 0.7)[a] | 31.82 ± 9.77 (4.99 ± 0.7)[a] | 0.79 ± 9.77[ab] (0.73 ± 0.7)[c] |
| Magnesium | 9.77 ± 9.77[a] (2.94± 0.7)[a] | 3.87 ± 9.77[a] (1.70 ± 0.7)[a] | 6.12 ± 9.77[a] (2.47 ± 0.7)[a] |
| *Micro minerals* | | | |
| Copper | 0.10 ± 9.77[a] (0.31± 0.7)[a] | 0.13 ± 9.77[a] (0.36 ± 0.7)[a] | 0.16 ± 9.77[a] (0.39 ± 0.7)[a] |
| Zinc | 0.46 ± 9.77[a] (0.59 ± 0.7)[a] | 0.20 ± 9.77[a] (0.44 ± 0.7)[a] | 0.22 ± 9.77[a] (0.47 ± 0.7)[a] |
| Iron | 89.95 ± 9.77[a] (6.23 ± 0.7)[a] | 5.5 ± 9.77[bc] (1.62 ± 0.7)[bc] | 0.33 ± 9.77[c] (0.40 ± 0.7)[c] |
| Manganese | 20.76 ± 9.77[a] (3.67± 0.7)[a] | 9.20 ± 9.77[a] (1.36 ± 0.7)[bc] | 0.83 ± 9.77[a] (0.29 ± 0.7)[c] |

*LS-means with different superscripts among rows are significantly different.*
*Figures indicated in parenthesis are the transformed Ls-means.*

In general, the highest concentration of minerals was observed in Akaki which may be associated with the industrialization activities running around this area. Iron and manganese are very common pollutants that can occur naturally in ground water. Iron and manganese levels greater than 0.3 and 0.05 mg/L respectively was reported to bring unpleasant tastes in livestock water which may lead to reduced water intake and milk production. In the present study, the concentration of iron particularly in Akaki (89.95 ± 9.77 ppm) and Ambo (5.5 ± 9.77 ppm) were above the recommended limit. In addition, the concentration of manganese in Akaki, Ambo and Holetta were 20.76 ppm, 9.20 ppm and 0.83 ppm respectively which were above the recommended limit. Copper usually occurs in water from corrosion of metal plumbing components. It may also be elevated from treatment of ponds with copper sulfate algaecides. Copper levels above 1.0 mg/L may cause a metallic taste resulting in reduced water intake and milk production. High copper concentrations may also cause liver damage. In the present study however, the concentration of copper in water sampled from Akaki, Ambo and Holetta were 0.1 ppm, 0.13 ppm and 0.16 ppm, respectively which was below the recommended limit.

The concentration of mineral elements in livestock water as compared to the recommended desired and maximum upper limits is presented in Table 5. Among the minerals studied, the concentration of calcium, magnesium, sodium, zinc and copper were safe from the risks related to the desired and maximum upper levels. Whereas the concentrations of potassium in Akaki and Ambo (31.82 and 26.91 ppm), iron in Akaki, Ambo and Holetta (89.95, 5.5 and 0.33 ppm) and manganese in Akaki, Ambo and Holetta (20.76, 3.87 and 0.83 ppm) respectively were higher than the desired and maximum upper levels.

Table 5. Concentration (ppm) of minerals in livestock water in comparison to recommended desired and maximum upper levels

| Mineral | Desired levels* | Maximum upper levels** | Concentration of minerals | | |
|---|---|---|---|---|---|
| | | | Akaki | Ambo | Holetta |
| Calcium | <100 | 200 | 69.02 | 3.94 | 6.35 |
| Iron | <0.2 | 0.4 | 89.95 | 5.5 | 0.33 |
| Magnesium | <50 | 100 | 9.77 | 3.87 | 6.12 |
| Manganese | <0.05 | 0.5 | 20.76 | 9.20 | 0.83 |
| Potassium | <20 | 20 | 26.91 | 31.82 | 0.79 |
| Sodium | <50 | 300 | 40.78 | 23.93 | 9.35 |
| Zinc | <5 | 25 | 0.46 | 0.20 | 0.22 |
| Copper | <0.2 | 0.5 | 0.10 | 0.13 | 0.16 |

Source: *Zinpro Water Analysis Program, Version 2.0, 2002.*

** Animals consuming water exceeding these limits may reduce performance*

*** The consumption of this water poses a potential animal health risk*

It is known that iron and manganese are very common pollutants that can occur naturally in ground water. They cause severe staining and a metallic taste to water and results to reduced water intake and lower milk production (Salinity management handbook, 2013). Iron levels above 0.1 mg/L have been reported to cause red meat in veal calves and cause oxidized flavor in milk. Iron levels above 0.3 mg/L was also reported to stain clothes and initiate the growth of iron bacteria, which could result in foul odors and plugging of water systems (Karen, 1999). Since iron and manganese are essential heavy metals, they are toxic when they exist in excessive concentrations (Florin et al, 2008). Manganese, at a level beyond the acceptable limit presents problems when the water is to be disinfected. It was also reported that manganese together with iron discolors fixtures. They can bring problems in restricted flow devices in drinking water lines where manganese precipitation may plug the line (Peterson, 1999). Manganese toxicity in ruminants is unlikely to occur, and there are few documented incidences with adverse effects limited to reduced feed intake and growth (Jenkins and Hidiroglou, 1991). The negative effects begin to appear when dietary manganese exceeded 1000 mg/kg feed as given by the NRC (1980). In this study potassium is the other mineral found in excessive concentration. Potassium is a soluble mineral in water and livestock species drink water at higher levels may suffer with physiological upset and can die when they exposed to excessive concentrations due to potassium toxicity (Florin et al, 2008).

The intake of minerals from water and its contribution to the daily mineral requirement is presented in table 6. With regard to macro minerals, calcium content of water in Akaki can satisfy 21% of the daily requirement of cattle, while water from Ambo and Holetta can contribute only 1.2% and 2% of the daily requirement, respectively. In similar study in Jijiga, livestock water could satisfy about 15% of the daily mineral requirement of calcium for camels (Temesgen and Mohammed, 2012). Sodium content of livestock water from Akaki, Ambo and Holetta can satisfy 7%, 4.2% and 1.6% of the daily mineral requirement of cattle respectively. Water from Akaki was observed to be a better source of sodium. In similar study in Jijiga, livestock water could contribute about 38.3% of the daily mineral requirement of sodium for camel (Temesgen and Mohammed, 2012). Magnesium content of livestock water from Akaki, Ambo and Holetta can satisfy 0.3%, 0.3% and 0.2% of the daily requirement of cattle respectively. Magnesium content in all the study locations was found to be very low. In similar study in Jijiga (Biya'ada and Golajo'o ) magnesium in water could contribute 1.8% and 1.3% to the daily requirement of camel respectively (Temesgen and Mohammed, 2012). Potassium content of livestock water in Akaki, Ambo and Holetta respectively can contribute 1%, 1.4% and 0.03% of the daily requirement of cattle. In Jijiga, potassium content of water had contributed 1.2-1.6% and < 0.001% to the daily requirement of camel in Biya'ada and Golajo sites respectively (Temesgen and Mohammed, 2012).

With regard to micro minerals in Akaki, the contribution of Iron to the daily mineral requirement of cattle was found to be extremely excess (1061%). In Ambo, the contribution of iron to the daily mineral requirement of cattle was also high (65%). The concentration of copper to the daily mineral requirement of cattle in Akaki, Ambo and Hoetta was 2.4%, 3.1% and 4.2% respectively. In similar study in Jijiga, copper content of water can contribute about 8% to the daily mineral requirement of camel (Temesgen and Mohammed, 2012). The contribution of Manganese from water to the daily mineral requirement of cattle was found to be very high, 147% . In similar study, the consumption of mineral water from Jiiga (Biya'ada) can contribute up to 18.5% of the daily requirements of Manganese for the camels. The contribution of Zn from water to the daily mineral requirement of cattle in Akaki was also high (50%) as compared to Ambo (21%) and Holetta (25%). In similar study in jijiga (Golajo'o) Zn content of water can contribute about 2.09% to the daily requirements of camels (Temesgen and Mohammed, 2012).

Table 6. Intake of minerals from water and its contribution to the daily mineral requirement of cattle

| | Mineral element | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Ca | Na | Mg | K | Fe | Cu | Mn | Zn |
| Requirement of cattle, mg/d | 5500 | 9680 | 59540 | 39872 | 144 | 72 | 240 | 16 |
| ***Akaki*** | | | | | | | | |
| Mineral concentration in water, mg/l | 69.0 | 40.8 | 9.8 | 26.9 | 90.0 | 0.1 | 20.8 | 147 |
| Mineral intake from water, mg/d | 1173 | 693 | 166 | 458 | 1529 | 1.7 | 353 | 7.8 |
| Contribution to the daily requirement, % | 21.0 | 7.0 | 0.3 | 1.0 | 1061 | 2.4 | 147 | 50.0 |
| ***Ambo*** | | | | | | | | |
| Mineral concentration in water, mg/l | 3.94 | 23.9 | 9.2 | 31.8 | 5.5 | 0.13 | 3.87 | 0.20 |
| Mineral intake from water, mg/d | 67 | 407 | 156 | 541 | 94 | 2.2 | 66 | 3.4 |
| Contribution to the daily requirement, % | 1.2 | 4.2 | 0.3 | 1.4 | 65.3 | 3.1 | 28 | 21.3 |
| ***Holetta*** | | | | | | | | |
| Mineral concentration in water, mg/l | 6.35 | 9.35 | 6.12 | 0.79 | 0.33 | 0.16 | 0.83 | 0.22 |
| Mineral intake from water, mg/d | 108 | 159 | 104 | 13 | 5.6 | 3 | 14 | 4 |
| Contribution to the daily requirement, % | 2.0 | 1.6 | 0.2 | 0.03 | 4 | 4.2 | 5.8 | 25 |

NB. Mineral intake of cattle is based on voluntary water intake of 17 lt/day/cattle for 0.7 TLU (180kg BW) of tropical indigenous cattle

## Conclusions

- Mineral concentration of livestock water varied from location to location with significantly high concentration in Akaki, whereas the pH values did not differ significantly.
- Depending upon level of concentration, drinking water can contribute to the daily mineral intake of livestock**.** Thus**,** the mineral concentration of water used for livestock drinking in a given location should be taken into account during feed formulation.
- The concentration of potassium in Akaki and Ambo; iron and manganese in Akaki, Ambo and Holetta were observed to be in excess of the requirement.

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