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Physicochemical Analysis of Stagnant Surface Water Used for Drinking Purposes for Livestock's in Jarar Zone Somali Regional State of Ethiopia

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Abstract

This research was carried out to investigate the physicochemical parameters of livestock drinking water samples collected from Falfal, Degehabur and Bulale areas in Somali regional state of Ethiopia. The objective of this research was to analyze the physicochemical parameters of water ponds used for livestock drink. The result was recorded that, the pH, Temperature, Total Dissolved Solid and Total hardness was 7.17°C ± 0.03°C, 22.51°C ± 0.18°C, 17.50 ± 2.60 mg/L and 825.22 ± 92.18 mg/L, respectively. The mean concentration of Chloride ion, Magnesium ion and calcium ion was 422.09 ± 64.05 mg/L, 61.37 ± 6.56 mg/L, and 200.70 13.23 mg/L, respectively. The mean Chemical Oxygen Demand and Biological Oxygen Demand were also recorded which was 12.67 0.54 mg/L and 7.47 0.67 mg/L, respectively.

The obtained results were also compared to the national and international standards to determine the quality of livestock drinking water. Accordingly, the measured pH was in agreement with World health organization and Ethiopian standards agency standards, which was 6.5 to 8.5. The Temperature, Total hardness and chloride ion concentration was above the standard limit set by World health organization and Ethiopian standards agency. The concentration of Total Dissolved Solid, Mg^{2+} and Ca^{2+} was in agreement with World health organization and Ethiopian standards agency standards. The standards for Chemical Oxygen Demand and Biological Oxygen Demand were not available both from World health organization and Ethiopian standards agency.

Keywords: Surface water • Physicochemical analysis • Livestock • Drinking water • Water quality

Introduction

Water is an essential nutrient for livestock which should meet the nutritional needs of the animal. An adequate and safe water supply is crucial for the production of healthy livestock. Poor water quality adversely affects the growth, reproduction or productivity of livestock and poultry.

Regardless of its advantage and necessity, water is the most affected commodity by pollution. Fresh water has become a scarce commodity due to over exploitation and pollution of water. It can be contaminated by various means, chemically or biologically. This includes rapid industrialization, indiscriminate use of chemical fertilizers and pesticides in agriculture and man-made activities are causing heavy and varied pollution in aquatic environment leading to deterioration of water quality and depletion of aquatic biota which may become inappropriate for drinking and other uses. Ensuring of good quality drinking water is a basic factor in guaranteeing public and livestock health, the protection of the environment and sustainable development.

Water of good drinking quality is of basic importance to human physiology and man's continued existence depends very much on its availability.

The provision of potable water to rural and urban population is necessary to prevent health hazards associated with poor drinking water. A significant proportion of the world's population use potable water for drinking, cooking, personal and home hygiene.

The healthy aquatic ecosystem depended on the physicochemical and biological characteristics. The quality of water in any ecosystem provides significant information about the available resources for supporting life in that ecosystem. Good quality of water resources is controlled and determined by physicochemical parameters and biological characteristics. These characteristics can identify certain condition of the ecology of living organisms and suggest appropriate conservation and management strategies.

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Water can be obtained from a number of sources, among which are streams, lakes, rivers, ponds, rain, springs and wells. Unfortunately, clean, pure and safe water only exists briefly in nature and is immediately polluted by prevailing environmental factors and human activities.

Water from most sources is therefore unfit for immediate consumption without some sort of treatment. In Somali regional state of Ethiopia, there are different water points that are used for livestock drinking purposes. The quality and safety of these water sources are determinant for the wellbeing of the livestock.

Livestock are the major components of the livelihoods of both pastoralists in the arid and semi-arid lowlands of the country. Access to water during the major part of the year is variable and both human and livestock suffer from its shortage. In many parts of the country, animals are trekked to distant watering points once in two or three days. Watering animals is a major occupation for pastoralists and shortage of water often leads to social conflict.

In most instances, the quality of available water is poor and is a major source of parasitic infestation to animals. Where both human and animals consume water from the same source as it happens in most cases - this poses a major risk for public health. Water requirement for animals in urban and semi-urban centers has never been considered in urban planning; and as a result, animals are often forced to consume wastewater with high health risks. This will have significant implications on product quality and public health.

Water resource is pertinent and vital for the existence and development of the livestock sector. It should be recognized that the multiple use of land and water resources lead to various conflicts that arise from the shared use of these limited resources.

It is noted that, of a whole variety of purposes of water resources development, which include inter alia, rain water harvest, irrigation, hydropower generation and water storage often relegate the fisheries and its ecosystem.

It should be stressed that planners and policy makers should be continuously made aware of the importance of livestock in the overall rural development schemes. The aim of this paper is to determine the physicochemical parameter of water points used for livestock drink in Somali Regional State of Ethiopia (SRSE).

Materials and Methods

This study was carried out in Jarar Zone, Somali Regional state of Ethiopia. Degehabur is the administrative town of Jarar Zone. It is located at 165 Km to the north of Jijiga town, the capital of the region and located at 8013'N43034'E, on the north of Fafan zone.

The zone has an elevation of 1,044m. Degehabur, Falfal and Bulale are found in Jarar Zone (Figure 1). There are different water ponds used for livestock drinking in the district.

Figure 1. Map of Zones in Somali Regional State of Ethiopia

A pilot survey was undertaken to inspect the aesthetic parameters of water ponds and the overall environment of livestock drinking water in the selected area, Jarar Zone. Degehabur, Bulale and Falfal areas were purposively selected for the high availability of livestock drinking water ponds and its convenience for sampling.

Three water ponds located in the study area were chosen randomly. Two water samples (from the edge and center of the pond) were taken from each water pond (Figure 2).

The sample was collected based on WHO guidelines for water sampling. Water samples were collected using a bottle of one liter capacity. The bottle was sterilized and then rinsed with water sample, before collection. Collections were made in between 8:00 AM to 12:00 PM throughout the study period. The collected water Sample was transported to laboratory and stored at 4oC for analysis of physicochemical parameters.

Figure 2. Degehabur water sampling site (ground water).

The instruments were calibrated before analysis for each parameter. All the stocks solutions were prepared with distilled water. The collected samples were analyzed for different physico-chemical parameters such Temperature, pH, Chloride (Cl^-), Dissolve Oxygen (DO), Chemical Oxygen Demand (COD), Calcium, Magnesium, total hardness and Total dissolved solids (TDS) as per the standard methods. PH of water was determined by using pH meter at the time and site of sampling. Electrical conductivity was measured using a conductivity meter. Total Hardness was estimated using EDTA (Ethylene Diamine Tetra Acetic Acid) as titrant with ammonium chloride and ammonium hydroxide buffer solution (pH-10) and Erichrome Black T as indicator.

The data was represented mainly in the form of descriptive tabular summaries and comparative explanations between experimental data and International as well as national standards maximum and minimum limit of the concentrations.

Results and Discussion

The aesthetic(physical) parameters, overall mean of the three areas and the mean values of physicochemical parameters of livestock drinking water sources from each area (Falfal, Degehabur and Bulale) are presented in Table 1, 2 and 3, respectively.

Characteristics	Result	Maximum permissible level(AES*)
Odour	Unobjectionable	Unobjectionable
Taste	Unobjectionable	Unobjectionable
Colour	Colourless	15 TCU
Turbidity	Clear	5 NTU
*Ethiopian standards agency		

Table 1. Physical characteristics of drinking water.

The overall pH of livestock drinking water was in a range of 7.04 to 7.30 being in acceptable range with national and international standards. As shown in Table 3, the mean value of pH value of Falfal, Degehabur and Bulale areas was 7.25, 7.18 and 7.09, respectively. A pH of 7.0 indicates a neutral solution. pH less than 7.0 shows acidic property whereas pH larger than 7.0 shows basic property. Water generally becomes more corrosive with decreasing pH (more acidic); however, excessively alkaline water can also be corrosive.

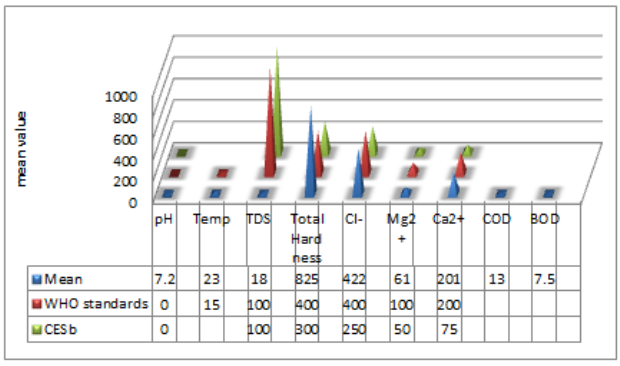


Figure 3. Overall mean value of the parameters in livestock drinking water in Degehabur Woreda.

Temperature of the water sample was in the range of 22.10°C to 23.30°C. The maximum Temperature was recorded in Bulale which was 23.23°C and minimum temperature, relatively in Degehabur which was 22.13 as illustrated in table 3 and fig. 7. Generally, water of uniformly low temperature is preferable for drinking. The Canadian Council of Minister for Environment, forwarded a standard temperature of water to be 15°C. In this case, the Temperature recorded from the three study areas was found to be higher than the standards. This may result due to hot nature of the region as a general.

The concentration of Total dissolved solid was in a range of 8.00 to 24.00 mg/L. The minimum average concentration of Total dissolved solid was recorded in Degehabour, which was 8.67 mg/L, whereas the maximum was recorded in Bulale which was 23.00 mg/L. The observed Concentration of Total dissolved solid was smaller than the maximum tolerable limit (1000 mg/L) stated,. According to, there is no health based limit for TDS in drinking water, as TDS occurs in drinking water at concentrations well below toxic effects may occur, but the palatability of water with TDS level of less than 500 mg/L is generally considered to be good. Drinking water becomes significantly and increasingly unpalatable at TDS Levels greater than about 1000 mg/L.

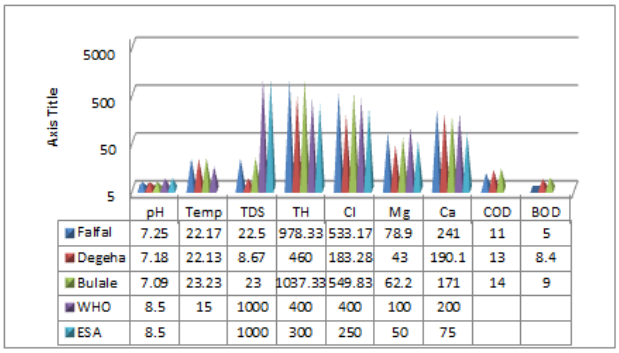
The concentration of total hardness was in the range of 455 to 1100 mg/L. The maximum concentration of total hardness was recorded in Bulale (1037.33 mg/L) and the minimum total hardness was in Degehabur which was 460 mg/L. The maximum standard concentration of total hardness was determined to be 400 mg/L by and 300 mg/L by Ethiopian standards. Accordingly, the observed total hardness was larger than the standards. Hardness is classified as soft (0-60mg/l), moderately hard (61-121mg/l), hard (121-180mg/l) and very hard (>180mg/l).

The concentration of Chloride ion in the collected water sample was in the range of 149.95 to 649.80 mg/L in which the mean was 422.09 (Table 3).

Area	pH	Temp (°C)	TDS (mg/L)	Total Hardness (mg/L)	Cl- (mg/L)	Mg++ (mg/L)	Ca++ (mg/L)	COD (mg/L)	BOD (mg/L)
Falfal	7.25	22.17	22.5	978.33	533.17	78.9	241	11	5
Degeha	7.18	22.13	8.67	460	183.28	43	190.1	13	8.4
Bulale	7.09	23.23	23	1037.33	549.83	62.2	171	14	9
WHOa	6.5-8.5	15CCME	1000	400	400	100	200	-	-
ESAb	6.5-8.5	-	1000	300	250	50	75	-	-

Table 3. The Mean values of physicochemical parameters of the three areas.

The Chloride ion concentration of each study area, Falfal, Degehabur and Bulale was 533.17, 183.28 and 549.83, respectively. The water sample from Bulale kebele was observed to have higher chloride ion concentration and the minimum in Degehabur kebele. According to (WHO, 2008), the upper limit concentration of water was determined to be 400 mg/L and the Compulsory Ethiopian standards (CES) set 250 mg/L as Compulsory standards. The water sample collected from Degehabur was within the standard range of and , whereas the water collected from Falfal and Bulale areas larger than the maximum value set by and standards. Large concentrations of chloride ion increase the corrosiveness of water and, in combination with sodium, give water a salty taste.



	pH	Temp	TDS	TH	Cl	Mg	Ca	COD	BOD
Falfal	7.25	22.17	22.5	978.33	533.17	78.9	241	11	5
Degeha	7.18	22.13	8.67	460	183.28	43	190.1	13	8.4
Bulale	7.09	23.23	23	1037.33	549.83	62.2	171	14	9
WHO	8.5	15	1000	400	400	100	200		
ESA	8.5		1000	300	250	50	75		

Figure 5. Physicochemical parameters recorded from three areas

The level of Magnesium ion was in the range of 43.00 to 79.00 mg/L with a mean ± standard error of mean 61.376.56. The concentration of Magnesium ion in each sampling area, namely Falfal, Degehabur and Bulale was 78.90, 43.00 and 62.20 mg/L, respectively (Figure 5).

This value was in agreement with the World Health Organization standard which is 100 mg/L as upper level for safe drinking water. However, the Compulsory Ethiopian standards determined a maximum of 50 mg/L of Magnesium ion as safe for drinking water.

Accordingly, the level of Magnesium ion in Falfal and Bulale kebele was higher than the standards set by.

The overall concentration of Calcium ion was in the range of 171 to 242 mg/L having a mean value 200.70 gm/L. Explicitly, the level of Calcium ion in Falfal, Degehabur and Bulale was 241.00, 190.1 and 171.00 mg/L, respectively.

The overall mean concentration of Calcium ion in the three areas was coincide with the upper limit of safe drinking water set. The maximum concentration Calcium ion was recorded in Falfal area which was above the World health organization standards.

The water sample from Degehabur and Bulale area was in the range of WHO standards. The Ethiopian drinking water standard is lower than WHO standards and hence the concentration of Calcium in all the study area was higher than this value. Calcium has no effect on human health in water, but it can cause hardness to water.

The Chemical Oxygen Demand (COD) of the water sample was in the range of 10 to 14.5 mg/L in which the mean was 12.67 ± 0.54 mg/L. Specifically, the level of COD in Falfal, Degehabur and Bulale was 11.00, 13.00 and 14.00 mg/L respectively. Accordingly, minimum amount of COD was recorded in Falfal area.

COD is a measure of the capacity of water to consume oxygen during the decomposition of inorganic chemicals such as nitrate and ammonia. If the COD is higher it will considered containing greater number of microorganisms. Standard limit of COD was not given both. However, the lower concentration of COD determines the safe drinking water.

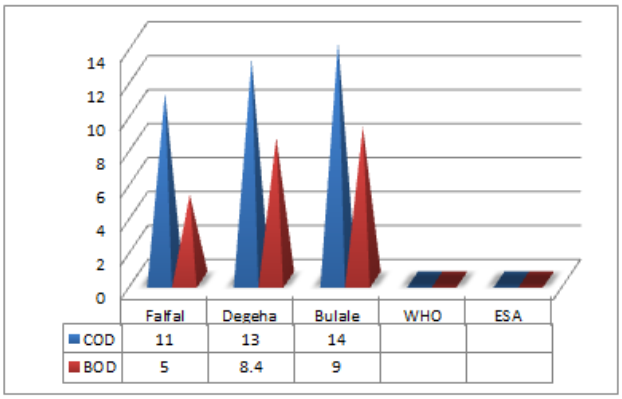


Figure 6. Chemical oxygen demand and Biological oxygen demand of water sample

Conclusion

According to the result obtained, the pH of the water sample collected from the three study area was nearly neutral and in agreement with the standards set by WHO and Ethiopian national standards. The temperature of the water was above the standards (15°C), which may be due to the hot nature of the study area. Normally, the increment in the temperature of water (in higher degree) may favor the production and activity of microbial. The Total Dissolved solid concentration obtained from the study area was also in the range of safe drinking water forwarded by World health organization and Ethiopian standard agency. The measured total hardness of water was above the upper limit of safe drinking water set both by World health organization and Ethiopian standard agency. The water in those areas was considered as hard water. The concentration of Chloride ion recorded from falfal and Bulale area was above the upper limit concentration set by World health organization and Ethiopian standard agency. However, the water sample collected from Degehabur area was lower than the others, and in agreement with the standards which make it safe for livestock drinking purpose. The concentration of Mg^{2+} and Ca^{2+} ions were in the safe level according to national and international standards.

Conflict of Interest

The authors declare that they have no competing interests.

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