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Evaluation of drinking water quality for animals at MRCS&G farm, SKUAST-K

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Abstract
All living organisms require water for survival, food production, growth, and overall well-being. Water quality has become a worldwide concern as a result of overpopulation and development activities that have overused and polluted our available water resources. Water quality varies by location around the world. Water quality is determined by physical, chemical, and microbiological parameters, which are all interconnected. Many water borne diseases in livestock are also linked with polluted water. Moreover, poor quality water can lead to less productivity. Thus, the purpose of this study was to determine the water quality of the MRCS&G farm using physicochemical and biological parameters. The sampling took place during the winter season. The results showed that the pH, color, taste and odour conductivity, TDS, Cl, Ca, Mg, and other parameters were within the normal range specified by BIS, 2012. However, the water sample tested positive for coliforms, and there was a slight increase in turbidity and total hardness, indicating that the water was polluted. Livestock may be put at risk for illness if contaminated water is regularly used for drinking. It is essential to create a system for monitoring and maintaining the quality of drinking water on a regular basis. In this regard, procedures for sanitation and cleanliness should be improved on the farm.

Keywords: Water, quality, animals, health

1. Introduction
All living organisms depend on water for survival, food production, growth and general well-being (Beede, 2009) [5]. Despite being a crucial ingredient, water is frequently overlooked. It is a ubiquitous component of living things and necessary for intracellular metabolism. Depending on age, fat cover and physiological state, water makes up roughly 70-80% of a new-born animal's live weight and 65-70% of a mature animal's live weight. Nearly all bodily processes use water, including thermoregulation, lubrication, medium for chemical reactions, digestion, absorption, lactation, transport, support, cushion, mineral balance, and aiding other nutrients in their duties. Water is also used by the body for various other processes, such as support and cushioning (Lardner *et al*. 2005 and Hersom and Crawford, 2008) [19, 14]. Due to overpopulation and development activities that have overused and polluted the water resources that are accessible to us, water quality has become a global concern (Gupta *et al*., 2009) [13]. Depending on the environment and region, water quality varies across the globe from one place to another. The physical, chemical and microbiological parameters that determine the quality of the water are interrelated (Barik and Thorat, 2015) [3]. Good quality drinking water accelerates growth and boosts disease resilience (Bagley *et al*., 1997) [2]. Most of the livestock get their drinking water from dugouts, which are typically full of contaminants; drinking such water may cause slower development and performance issues. According to research, giving animals access to clean drinking water improves efficiency and increases disease resistance. Improved efficiency quickly offsets the expense of using clean water from any source after treatment (Brew *et al*., 2008) [7]. Poor quality water is not palatable; animals generally do not accept it readily; it results in low water and feed intake, low feed conversion ratio, ultimately decreased growth and production, poor performance, and susceptibility to non-specific disease conditions (Faries, 2007) [10]. Mountain Research Centre for Sheep and Goat-SKUAST-K has been witnessing various disease outbreaks, lamb mortalities and depressed production but so far, no research was under taken to evaluate water quality. Hence an attempt was made to study the various physical parameters of drinking water for livestock in the Mountain Research Centre for Sheep and Goat-SKUAST-K.

2. Materials and Methods
This study was designed to measure the quality of drinking water used at the Mountain Research Centre for Sheep and Goat-SKUAST-K. For analysis of different quality parameters like conductivity, pH, Total dissolved solids, coliform, etc. 5 liters of water were collected in a clean PET container and was transported to the laboratory on the same day for analysis. The analysis of water samples was done in duplicate.

Table 1: Physiochemical properties of water sample from MRCS & G farm

Parameter and Unit	Recorded value	Permissible level	Maximum tolerance level
Turbidity (N.T.U)	5.3± 0.1	1	5
Colour(Hazen)	4.9± 0.1	5	15
pH at 25 ºC	7.35± 0.15	6.5-8.5	8.5
Acidity (mg/L)	4.15 ± 0.15	N.A	N.A
Total Alkalinity (mg/L)	161.5±1.5	200	600
Total dissolved solids (mg/L)	194 ± 1.0	500	2000
Conductivity at 25 ºC (μs/cm)	385±1.00	N.A	N.A
Total Hardness (mg/L)	230.5± 0.5	200	600
Chlorides as C l(mg/L)	15.5±0.5	250	1000
Magnesium (mg/L)	21.5±0.5	30	150
Calcium (mg/L)	55±1.0	75	200
Fluorides (mg/L)	N.D	1	1.5
Sulphates (mg/L)	N.D	200	400
Iron (mg/L)	N.D	1	1
Phosphates (mg/L)	N.D	0.4	5
Nitrates (mg/L)	N.D	45	45
Nitrites (mg/L)	N.D	None	Traces
Taste and Odour	Unobjectionable	N.A	N.A
Residual Chlorine (mg/L)	Raw water	0.2	1
Coliforms	Positive	Negative	Negative

The table depicts Mean ±SE (mg/L) values recorded in the sample against the permissible level and maximum tolerance level as specified by BIS, 2012 [6].
N.D = Not detected.

3. Result and Discussion
3.1 Turbidity
Turbidity is defined or measured as the degree of cloudiness or muddiness of the water sample. It is a measurement of optical property that causes light to be scattered and absorbed by the water sample. The factors influencing turbidity in water include domestic pollution, stagnation for a long time, and algal bloom (Curran, 2014) [8]. Turbidity observed was 5.3±0.1 N.T.U (Table 1). The observed values of turbidity were exceeding as per the BIS, 2012 [6]. Slightly higher values may be due to various pollutants present in the sample. Turbidity in water leads to less palatability.

3.2 Color
The color of drinking water is of primary concern in water quality as far as the aesthetic aspect is concerned. The presence of color gives water the appearance of being unfit for consumption even though the water may be safe for drinking. Moreover, the presence of color can also indicate the presence of organic compounds or algae. As per the (BIS, 2012) [6] standards, colorless and clear water is ideal for drinking purposes. In the present study, the color of the water sample was within the permissible limits (Table 1).

3.3 pH
The concentration of hydrogen ion present in the solution is the measurement of the pH of that solution. The pH of drinking water should be between 6.5 and 8.5 as per (BIS, 2012) [6]. Very high and low pH has an impact on the health of livestock. Low or high pH was associated with decreased milk production associated, decreased average daily gain, increased susceptibility to infection, installation of some metabolic disorder and decreased fertility (Grant, 1993) [12]. Alkaline water with a pH greater than 8.5 increases the risk of metabolic alkalosis. And vitamin B deficiency. In the present study, the pH of the water was found to be 7.35± 0.15 (Table 1) which is in line with BIS standards and also within the range suggested by (Wright, 2007) [33] for livestock drinking water.

3.4 Total acidity and total alkalinity
Alkalinity is the measure of the capacity of unfiltered water to neutralize the acid. In almost all natural waters alkalinity is produced by the dissolved carbon dioxide species, bicarbonate and carbonate. Typically expressed as mg/L $CaCO_3$. The higher levels of acidity of alkalinity in water may be an indication of industrial or chemical pollution. Excess alkaline water can cause indigestion in cattle and increase the laxative effect (Parish *et al*., 2020) [24]. In the present study, the acidity and alkalinity of the water sample were noted to be 4.15 ± 0.15 mg/L and 161.5±1.5 mg/L (Table 1) respectively, falling within the specifications given by BIS, (2012) [6].

3.5 Total dissolved solids
In the present study TDS value observed in the water sample was 194 ± 1.0 mg/L (Table 1) which is within the desirable limits as per BIS, (2012) [6]. Therefore, drinking water is safe in terms of TDS. TDS levels in drinking water have been discovered to control how much water domestic animals consume. Animals ingest less water when the TDS level is low, as scientific evidence shows. As a result, it was determined that a decline in animal water and feed intake would result in poor growth and production (Giri *et al*., 2020) [11]. However, High TDS influences the other qualities of

water such as taste, hardness, and corrosion properties, influencing the osmoregulation of freshwater organisms (Prasad *et al*., 2019) [27] A study by (Kumaravelu & Divyalakshmi, 2022) [18] on the Evaluation of Physical Parameters of Drinking Water for Livestock reported TDS in tap water 413.20 ± 11.82 and 2681.76 ± 273.10 in well water which is again with the permissible limits.

3.6 Conductivity at 25 °C

Electrical conductivity (EC) is an indirect measure of total dissolved salts. The presence of these salts greatly affects the taste and acceptance of the water (Jain, 1998) [26] In the present study, the conductivity of the water sample was recorded to be 385±1.00 µs/cm which falls within the WHO standards that state that the value of conductivity should not exceed 400 µs/cm (Meride and Ayenew., 2016) [21].

3.7 Total hardness

Hardness is a measure of the calcium and magnesium ions present in the drinking water (Okoye *et al*., 2000) [23]. In the present study total hardness detected in the water sample was 230.5± 0.5 mg/L (Table 1). This value is in line with BIS (2012) [6] which states that the maximum hardness for potable water must be less than 600 mg/L. The high hardness can affect water palatability and often leads to formation of renal calculi, gastric disorders, chronic catarrh of the digestive mucosa and even methemoglobinemia (El-Mahdy C, 2013) [9].

3.8 Chloride (as Cl)

Chloride concentrations nationwide are mostly due to anthropogenic, or human-caused factors. The presence of a high concentration of chloride ions in the water sample is directly proportional mixing of sewage water in a water source. It indicates improper sewage disposal or dumping of animal and solid waste in nearby areas of a water source (Jha, 2000) [16]. Chlorides above 250 mg/dm^3 can imprint a salty taste to water which could result in reduced water intake and milk production. In the present study, the chloride content of water was recorded to be 15.5±0.5 mg/L (Table 1) which is very much within the permissible limits. (Bryan 2016) [31].

3.9 Calcium and Magnesium

Magnesium is the 8th most abundant element on earth and one of the natural constituents of water. It is quite essential for the normal metabolic functioning of living organisms. The magnesium content of water in the present study was 21.5±0.5 mg/L which is per BIS standards. Calcium is also naturally present in water and is essential for bone development. The permissible level of calcium in drinking water as per WHO (2011) AND BIS (2012) [6] is 75 mg/L. In the present study, the level of calcium in water was noted to be 55±1.0mg/L (Table 1). The hardness of water is largely dependent on calcium and magnesium content. Excess calcium interacts with iron, zinc, magnesium, and phosphorus thereby reducing the absorption of these minerals. Similarly, excess magnesium has been linked with decreased feed intake, renal insufficiency, lethargy, lameness, and laxative effects (ANZECC, 2000) [1].

3.10 Sulfates and Fluorides

In the present study sulfates and fluorides were not detected (Table 1) in the water sample. Sulfates are known to alter physiological parameters, deplete hepatic storage of Cu, Se, and Zn and give water an unpleasant taste. (Bagley *et al*., 1997, Kristula *et al*., 1994) [2, 17]. Water rich in sulfates influence reproduction negatively and lower weight gain potential (Patterson *et al*., 2004) [25]. Fluoride is naturally present in water and its presence in optimal concentrations is known to prevent caries by deposition of calcium fluoride crystals (Somasundaram *et al*., 2015) [29]. As per BIS, 2012 [6], the permissible level of fluoride in drinking water is 1 mg/L.

3.11 Total Iron

Iron in the given sample was not detected (Table 1). It has been observed that excess Iron in drinking water can bind other minerals in the diet e.g. (Cu) inducing mineral deficiencies, it also reduces feed intake and feed conversion efficiency (Man C, 2002) [22].

3.12 Phosphates

Phosphates are essential nutrients present in freshwater environments at low concentrations. Their high content is an indication of pollution because of runoff from agricultural and domestic activities. The high content of phosphates leads to the rapid growth of algae that can in extreme cases lead to eutrophication (Richardson *et al*., 2021) [28]. In the present study, the phosphates were not detected in the water sample (Table 1).

3.13 Nitrites and Nitrate

Nitrites and Nitrate were not detected in the water sample (Table 1). Many workers have reported that Nitrates are ingested by ruminants via the oral route, where they are converted into nitrites. Because nitrates are absorbed into the bloodstream and eventually affect the ability of red blood cells (RBCs) to transport oxygen, suffocation as a result of a lack of oxygen transport is the cause of death in these situations (Hersom & Crawford, 2008, Schutz, 2012 and Hubbard *et al*., 2004) [14, 30, 15]. The permissible level for nitrates is 45mg/L while as nitrites should not be present in drinking water as per BIS, 2012 [6].

3.14 Taste and Odour

The organic materials discharged directly into water such as leaves, runoff, soil, etc are sources of taste and odor-producing compounds that are released into the water by biodegradation. The taste and odor of the water sample in the present study were found to be unobjectionable. As per (BIS 2012) [6], potable water must be odourless.

3.15 Residual chlorine

Chlorination of drinking water in these areas is used usually for decontamination and has several advantages as a disinfectant, including its comparative cheapness, effectiveness, and ease of management, both in laboratories and in the field (Batabyal & Chakraborty, 2015) [4]. The residual chlorine was not detected in the sample. Animals show detestation for high chlorine content in water.

3.16 Coliform

Poor environmental sanitation and water quality play an important role in spreading infectious diseases which are presently emerging and creating major public health concerns. Total coliforms and fecal coliforms are indicators of the presence of pathogenic microorganisms in drinking water. Their presence renders water unfit for consumption. If a large number of coliforms are present in the water there is a high probability that other pathogenic bacteria responsible for waterborne illness will also be present in the water. In the present study, the water sample tested positive for the presence of coliforms indicating low microbiological quality. The presence of coliform in the sample may be because of its source as well as the lack of necessary treatments before use for livestock drinking. The presence of Coliform might result in outbreaks of pathogenic microorganisms such as *E. coli*, *Klebsiella*, and *E. aerogenes*. All these pathogenic microbes can lead to diarrhea, urinary tract infections, mastitis, and other related infections (Le Jeune *et al*., 2001 Brew *et al*., 2008) [20, 7].

4. Conclusion

The study provides us with valuable information about the overall water quality status of the MRCSG farm. The majority of the parameters evaluated were within the suggested limits set by the Bureau of Indian Standards (BIS, 2012) [6]. However, the main element that has affected the water quality on the farm is presence of coliforms. Livestock may be put at risk for illness if contaminated water is regularly used for drinking. It is essential to create a system for monitoring and maintaining the quality of drinking water on a regular basis. In this regard procedures for sanitation and cleanliness should be improved on the farm. It has been observed that poor storage facilities often lead to bacterial infection. Despite having a high-quality water source, water storage locations frequently have high amounts of microbial contamination. The likelihood of microbial contamination will be significantly reduced with an improved Point of Use technique for potable water on the farm.

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