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Bacteriological Quality Assessment of Ground and Surface Water in Arba Minch University, South Ethiopia

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Abstract: **Drinking water is very indispensable substances to the human beings. We humans need safe water for our health. Therefore, the water we drink should be free from pathogenic bacteria and any pollution. In nature there are two major sources of water are there which is used for drinking water: These sources are ground water and surface water sources. This study was aimed to assess the bacteriological load of these two water sources; In case of Abaya campus (surface water sample) and Main campus (ground water sample) of Arba Minch University. The purposive sampling technique was used to collect samples of drinking water from Abaya campus and Main campus; surface water and ground water samples collected respectively, and transported to laboratory to assess the bacterial load of sampled waters by using standard procedures including colony counting of total and fecal coli forms with the help of nutrient agar and differential media; MacConkey agar respectively. The result revealed that average CFU/ml of bacteria counted on MacConkey agar were $7.6\times10^4$from surface water samples and 4.3×10^4 from ground water samples on morning and $3.5\times10^4$from surface water samples and 1.5×10^4 from ground water samples on afternoon respectively. In the same way the total average of CFU/ml of bacteria counted on nutrient agar were $2.93\times10^5$from surface water samples and 1.73×10^5 from ground water samples on morning and 7.3×10^4 from surface water samples and 4.6×10^4 from ground water samples on afternoon respectively. From this study we concluded that the drinking water is highly loaded by total coliforms. So, in order to reduce this bacterium and increase safety drinking water supplies: it is necessary to first assess the potential hazards in drinking water sources and storage materials.**

Keywords: **bacterial load, Ground water, surface water, colony count, water.**

1. INTRODUCTION

Water has a great function in the growth of microorganisms; such a key growth requirement is because of many roles it plays in living things. Perhaps most importantly water is able to dissolve tremendous verity of substances that serve as nutrients and to carry out critical cellular functions (Abebech Tiruneh and Getnet Melaku, 2006).

Water is a very important natural resource for the existence of all living organisms. Management of the quality of this precious resource is, therefore of special importance. People are increasingly concerned about safety of their drinking water. As improvements in analytical methods allow us to detect impurities at very low concentrations in water, water supplies once considered pure are found to have contaminants we cannot expect pure water , But we want safe water (Zaslow and Glenda,1996).

An adequate supply of safe drinking water is one of the major prerequisites for a healthy life. Drinking water is derived from two basic sources: surface water such as rivers and reservoirs and ground water (Fawell and Mark, 2003). Surface water provides a normal habitat for species of bacteria. The environmental conditions in a particular area will influence the microbial flora of water in that area (Volk and Brown, 1997).Ground water also contains a broad spectrum of

microbial types similar to those found in surface soils and waters. These microbes encompass bacteria and are representatives of most physiological types. On occasion pathogenic bacteria of gastrointestinal origin from domestic, agricultural and other anthropogenic activities may infiltrate through soils, sediments and rocks to the underlying ground water (Plazinska, 2000).

Ground water may appear at the surface in the form of springs, or it may be tapped by wells, ground water is often preferable because it tends to be less contaminated by wastes and organisms. Although ground water is less contaminated than surface water, pollutions of this major water supply have become an increasing concern in industrialized nations. In the United States many thousands of wells have been closed in the late 20^{th} century because of contamination by various toxic substances (Resiner and marc, 1993).

Most intestinal that contaminate environmental waters are not able to survive and multiply in this environment. Survival rates vary greatly among fecal bacteria introduced in to environmental waters. Pathogenic enteric bacteria and *E. coli* display low survival rates. The ability of fecal bacteria to survive in environmental waters generally increases as the temperature decreases. Other factors that influence the survival include dissolved organic carbon concentration, sun light intensity and the ability to enter the viable but non cultivable state (Joao and Cabral, 2010).

In its course ground water dissolves soluble mineral matter and often the surface waters of rivers and streams are polluted by the influx of sewage or industrial wastes. The quality of water from these sources varies greatly. Surface waters generally, contain larger quantities of turbidity and bacteria than ground waters, but ground water contains high concentrations of dissolved chemicals and some microscopic organisms as well. Because water quality does vary widely from source to source. The potential for bacteria present in human and animal wastes to contaminate water in nearby wells needs special attention. An important source of contamination of surface and ground waters is runoff water from agricultural and pasture lands and urban areas (Joao and Cabral, 2010).

Intestinal bacterial pathogens are widely distributed throughout the world. They include strain of *salmonella, shigella, enterotoxigenic E. coli, and vibrocholerae*. These organisms may cause diseases that vary from mild gastro enterits to severe and sometime fatal dysentery. These organisms differ in their infective dozes. The infective doze of cholera is high 10^6-10^8 organisms can cause painless diarrhea, salmonella have infective doze possibly below ten organisms which cause fever, aches and sometimes abdominal pain and diarrhea accompanied by vomiting which can lead to dehydration. They cause disease in healthy adults with fewer than 200 organisms. *Escherchia coli* cause dehydrating diarrhea in children as well as fever and mucoid diarrhea with infective doze of 10^8 organisms (Hunter, 1997). These groups of bacteria have also the ability to ferment lactose at 35-37^{0}c with the production of gas, acid and aldehyde with in 24-48 hours. They belong to the genera *Escherichia, Citrobacter, Enterobacter* and *Klebsiella* it includes lactose fermenting bacteria such as *Enterobacter cloacea* and *Citrobacter freundii* that can be found both in feces and the environment like nutrient rich water, decaying plant material soil. They are also found in drinking water with relatively high concentration of nutrients (Abebech Tiruneh and Getnet Melaku, 2006).

In our country we have many fresh water resources, but these resources have not been effectively used. Research indicates that only three percent of the total population has access to qualify potable water supply within a radius of 3.15km; water that fit for drinking that is free from harmful and un pleasant substances is said to be potable (Bitew Mulualem, 1998). Since water is one of the basic biological molecules for all living organisms; it should be free from unnecessary contaminants. Therefore to obtain safe and healthy drinking water it is important to evaluate the quality of drinking water (FDRE and MoWR, 2002).

Statement of the problem:

Water is a valued natural resource for all living organisms. Water provides a normal habitat for species of bacteria. A variety of bacteria and other microorganisms are found in water; including pathogenic and non pathogenic that may cause taste and odor problems with water supplies, which can influence whether people use the water for consumption, but the principle concern for microbiological quality is contamination by pathogenic species found in drinking water including species of bacteria (Dagnew Tadesse, 2007). In Arba Minch University little researches are conducted on bacteriological quality of potable water. So, as to fulfill this gap we were tried to evaluate the bacteriological load of surface water and ground water. In general, ground water is less vulnerable to pollution than surface waters (Fawell and Mark, 2003).So, this study was tried to assess bacteriological load of drinking water of Abaya campus and Maim campus, Arba Minch University.

Significance of the study:

Few, if any, substance is crucial to our daily living as water. We need to drink water every day and we use water for many purpose such as bathing, cooking and cleaning. Unfortunately, water is subject to contamination with injurious materials including harmful chemical and bacteria's (Volk and Jay, 1997). Therefore, the importance of this study was to provide the base line information for bacteriological quality of drinking water in the University in terms of colony forming unity per milliliter of water from two different sources (Surface and ground water

Objectives:

General objective:

The overall aim of this study was to evaluate the bacteriological quality of surface water (from Abaya campus water sample) and ground water (water samples from main campus).

Specific Objectives:

- To evaluate bacteriological quality of ground water
- To evaluate bacteriological quality of surface water
- To compare bacteriological quality of surface and ground water

2. MATERIALS AND METHODS

Description of the study Area:

Arba Minch university; main campus is located 5Km away from North of town and at west of Arba Minch Addis Ababa high way. Lake Abaya is 3Km away from the campus to the east. The campus has an average elevation of 1200 meters above sea level. Climatic condition is semi hot with an average temperature of 28^0c annual rainfall 900ml per year (Muridu, 2004).

Study Design:

A cross sectional study was conducted to investigate bacteriological quality of ground and surface water in case of main campus and Abaya campus respectively.

Sampling technique and sample size:

Purposive sampling technique was used to collect water sample from selected source. These samples were surface water and ground water from Abaya campus and Main campus respectively. Sample size was determined a convenience a total of 12 samples were collected (that was 6 samples from each site).

Sample collection and transportation:

Both surface and ground water sample were collected for consecutive three days per week and twice per a day. (That is morning between 8AM to 9AM and afternoon 2PM to 3PM).Because bacterial growth is varied based on variable temperature. This might be helps to determine bacterial colonies variation at different time interval. Both water samples were collected by using sterilized 250ml flasks to reduce further addition of microbial contamination and the samples of drinking water were transported to microbiology laboratory for bacteriological analysis.

Laboratory Procedure:

The experiment were conducted in microbiology laboratory by using pure culture method; particularly, serial dilution. Serial dilution is the multiple tube method and referred to as the most probable number (MPN),because unlike the membrane filtration method it is based on an indirect assessment of bacterial density in the water sample by reference to statistical tables to determine the most probable number of bacterial present in the original sample. It is essential for highly turbid samples that cannot be analyzed by membrane filtration. The technique is used extensively for drinking water analysis. In this method the original inoculums is subjected to serial dilution successively, So that the concentrations of the bacteria (in a fixed quantity of the liquid), gradually become less and less. When these serial dilutions are plated, colonies were appears discrete and far removed from one another. Then the colony was counted with the help of colony counter.

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Bacterial Load Determination:

For enumeration of bacterial load present in sample after 3 fold serial dilution of each water sample was made and 0.1ml of 10^{-3}dilution was pipetteed in to sterilized petridishe that contain Macconkey agar(for gram negative bacteria) and nutrient agar (for total colony forming) by swirling(rotating) for to allow even distribution. Then colonies were counted by using colony counter machine after 24 hours, incubation at 37^0c.The colonies counted were reported as colony forming unit per milliliter of the water sample (Cfu/ml) by the following formula.

$$\text{CFU/ml} = \frac{number\ of\ colony}{dilution\ factor \times volumeplated}$$

Data Analysis:

All the data collected from the experiment were determined and analyzed by using descriptive statistical methods.

3. RESULTS

Table 1: Bacteria load (Cfu/0.1) for surface water sample, In case of Abaya campus

		Time							
		Morning				Afternoon			
		MacConkey agar		Nutrient agar		MacConkey agar		Nutrient agar	
Dilution (D)	Date of experiment	NC	CFU/0.1ml	NC	CFU/ml	NC	CFU/ml	NC	CFU/ml
1×10^{-3}	Day 1	8	8×10^4	32	3.2×10^5	3	3×10^4	9	9×10^4
	Day 2	7	7×10^4	26	2.6×10^5	_	_	8	8×10^4
	Day 3	8	8×10^4	30	3.0×10^5	4	4×10^4	5	5×10^4
	Average	**7.6**	**7.6×10^4**	**29.3**	**2.93×10^5**	**3.5**	**3.5×10^4**	**7.3**	**7.3×10^4**

The bacterial load found were ranged from 8×10^4 to 7×10^4 and 3.2×10^5 to 2.6×10^5 at morning samples on both media (MacConkey agar and nutrient agar) respectively, and 4×10^4 to3×10^4 and 9×10^4 to 5×10^4 at afternoon samples on both media respectively. The average colony forming unity observed at morning was 7.6×10^4 and 2.93×10^5 on MacConkey and nutrient agar respectively, while 3.5×10^4 and 7.3×10^4 colony forming unity on MacConkey and nutrient agar at afternoon respectively (table 1 above).

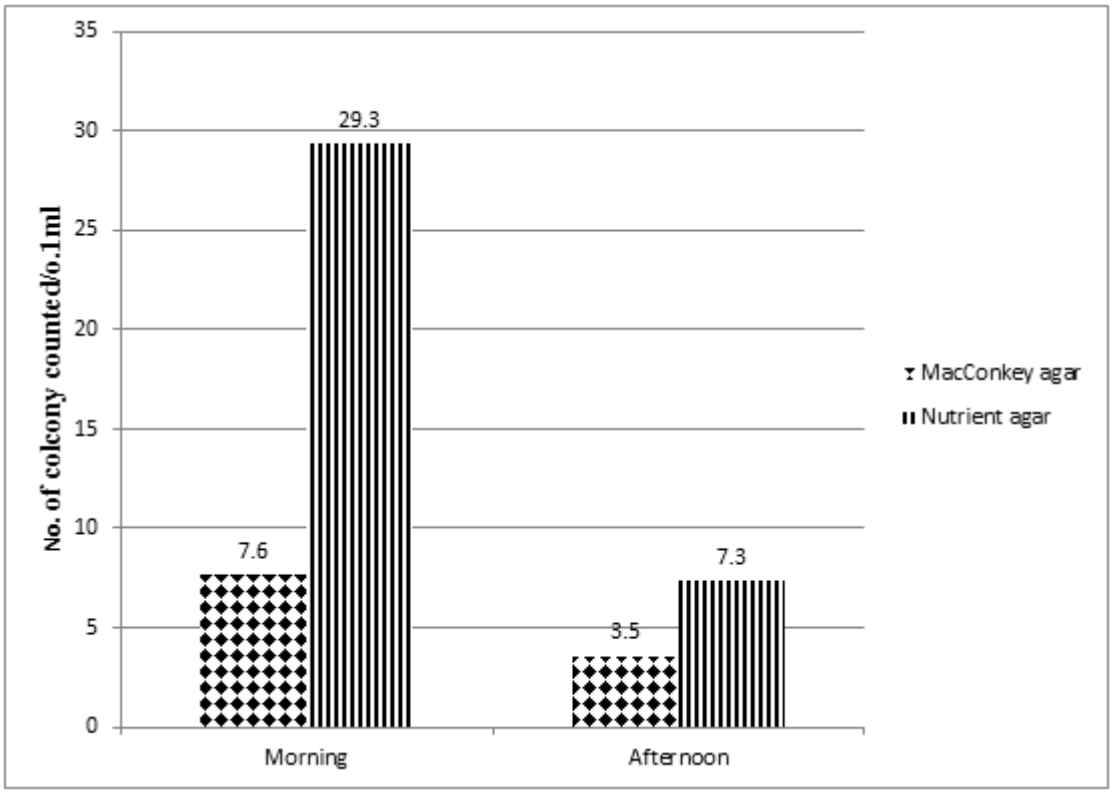

Fig 1: Average colony counted per 0.1ml of surface water sample at morning and afternoon on both media

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The above figure revealed that average conony of bacteria grown on MacConkey and nutrient agar from 0.1ml of surface water after 24hours incubation at morning and afternoon. 29.3 and 7.3 average colonies were grown on nutrient agar at morning and afternoon respectively, while only 7.6 and 3.5 average colonies were grown on MacConkey agar respctively from surface water samlpe, case of Abaya campus. More colonies were observed on both midia at morning than afternoon.

Tables 2: Bacteria load (Cfu/0.1) for ground water sample, In case of Main campus

		Time							
		Morning				**Afternoon**			
		MacC.		NA		MacC.		NA	
DF	Date of experiment	NC	CFU/0.1ml	NC	CFU/ml	NC	CFU/ml	NC	CFU/ml
1×10^{-3}	Day 1	5	5×10^{4}	18	18×10^{5}	1	1×10^{4}	4	4×10^{4}
	Day 2	3	3×10^{4}	14	14×10^{5}	_	_	7	7×10^{4}
	Day 3	5	5×10^{4}	20	20×10^{5}	2	2×10^{4}	3	3×10^{4}
	Average	**4.3**	**4.3×10^{4}**	**17.3**	**1.73×10^{5}**	**1.5**	**1.5×10^{4}**	**4.6**	**4.6×10^{4}**

The bacterial load (Cfu/0.1ml) was ranged from 3×10^{4} to 5×10^{4} and 1.8×10^{5} to 2.0×10^{5} at morning samples on both media respectively and 1×10^{4} to 2×10^{4} and 3×10^{4} to 7×10^{4} at afternoon samples on both media respectively. The average colony forming unity observed at afternoon was 4.3×10^{4} and 1.73×10^{5} on MacConkey and nutrient agar respectively, while 1.5×10^{4} and 4.6×10^{4} colony forming unity on MacConkey and nutrient agar at afternoon respectively.

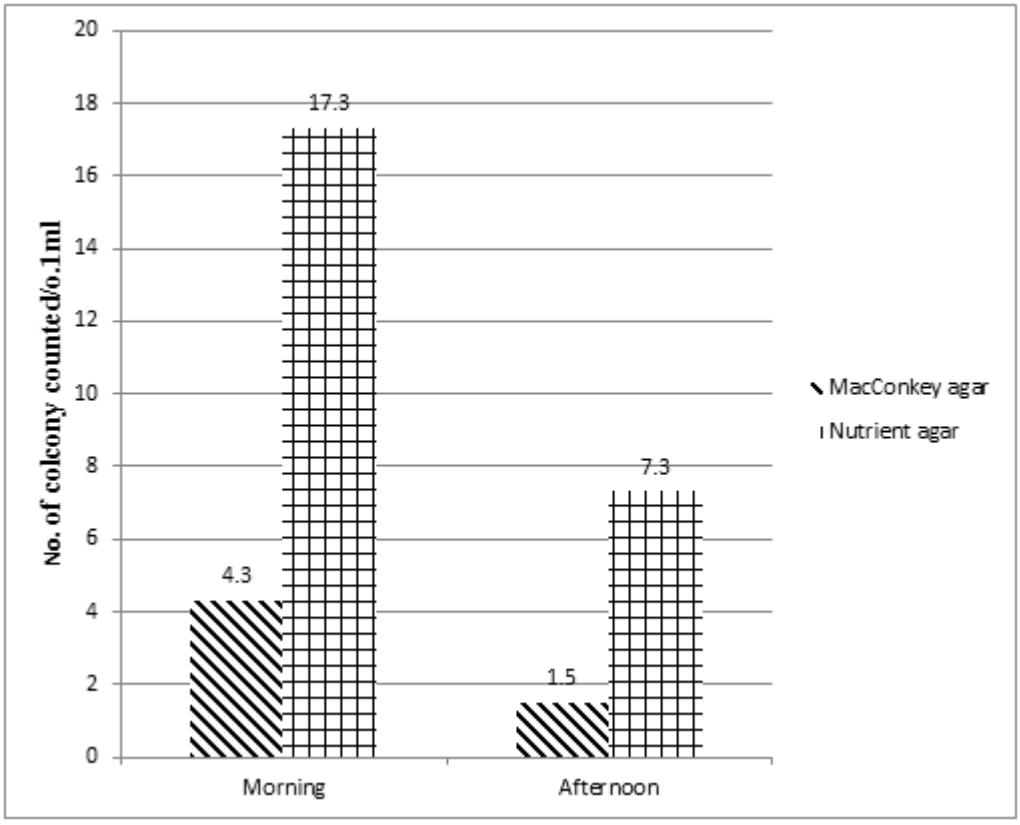

Fig 2: Average colony counted per 0.1ml of ground water sample at morning and afternoon on both midia

The above figure revealed that average conony of bacteria grown on MacConkey and nutrient agar from 0.1ml of surface water after 24hours incubation at morning and afternoon. 17.3 and 4.6 average colonies were grown on nutrient agar at morning and afternoon respectively, while only 4.3 and 1.5 average colonies were grown on MacConkey agar respctively from ground water samlpe, case of Main campus. More colonies were observed on both midia at morning than afternoon.

4. DISCUSSION

The current study which was under taken to assess the bacteriological quality of drinking water in Abaya and Main campus drinking water suppliers revealed that the sampled drinking water in this study were loaded with different bacterial colonies. The bacterial content of water was greatly varied with the source, season of the year and especially with the kind and quantity of pollution it has received.

Deep springs and well contain few microorganisms or may be entirely free from bacteria. On the other hand, surface wells and springs contain thousands or millions of bacteria. Running streams usually contain more bacteria than standing water, (Greaves and Ethelyn, 1986). Some what this idea have positively related with the current study which revealed that, more bacteria were grown on surface water samples than that of ground water samples.

In as much as counts do not give an exact measure of the purity of water, and it has been found impracticable and usually impossible to isolate the pathogens from them, but the most valuable and widely used bacteriological procedure is to determine the presence or absence of Bacterium coli *(Escherichia coli)* in the water.

This study was conducted to assess the bacteriological quality of surface water from Abaya campus and ground water from Main campus. The water samples taken from both sites were used to evaluate the quality of drinking water in both sites. However during the bacteriological analysis of samples taken from both sites, there was time variation; that means the sample was taken in morning and afternoon. According to this variation each samples that taken from both sites show different results. The variation of bacterial loads reported from both sites with regards to time variation indicates that, there were some factors that affect the growth of bacteria in the water. Based on the data taken from the experimental results of the study, 7.6×10^4 cfu/0.1ml bacteria were grown on MacConkey agar from morning sample and 3.5×10^4 cfu/ml bacteria were grown on the same media from afternoon sample. In similar way 2.93×10^5cfu/ml bacterial colonies were counted on nutrient agar from morning sample were higher than 7.3×10^4CFU/ml bacterial were grown on nutrient agar from afternoon sample.

In comparative study, as Chrost and Faust, 1997 reported; Bacterial production and growth in waters may be both directly inhibited and indirectly stimulated by solar radiation. Direct inhibition of the studied processes was observed during the day time, while indirect stimulation occurred during night time, when bacteria were able to recover from solar radiation stress. After Sunset, a bacterium recovered from UV stress, enhanced their metabolism, and markedly increases their growth rates and biomass production. They found in samples taken from the Lagoon and Lair in the early morning that bacterial production was on average 1.2$\pm$0.13 and 1.88$\pm$0.52 times higher than in the afternoon samples respectively (Chrost and Faust, 1997). In case of the current finding the average bacterial; colony counted in the morning (5.95×10^4cfu/ml on MacConkey and 2.33×10^5 on nutrient agar) from both sites (Abaya and Main campus respectively) were more than the afternoon (2×10^4 on MacConkey and 5.95×10^5 on nutrient agar). So, it is directly related the current finding.

Since Ethiopia is tropical country it has more penetration of the sun light. So in our study the cause of bacterial growth rate reduction shown in the afternoon samples might be the effect of solar radiation. In addition to this there was also different results of bacterial colonies were reported from both sites (Abaya and Main campus). The average numbers of bacterial colony counted from the surface water samples per 0.1ml (7.6, 3.5 and 29.3, 7.3 from MacC and NA agar at morning vs. afternoon respectively.) were higher than that of the ground water (4.3, 1.5 and 17.3, 4.6 from MacC. and NA respectively).

The presence of coli forming in the water was the most determinants of polluted water. Based on the standards set by WHO, 2008 and FDRE, MoWR, 2002, states that ranges of cloiform bacteria per 100ml of water sample from 1-10 cfu/ml was acceptable or a reasonable quality range, but zero colonies forming is safe water for drinking. The result of the study revealed that, growth of bacteria on MacConkey agar were indicates that, the bacteriological quality of water few in acceptable or reasonable water or it is in low risk with fecal contamination.

5. CONCLUSION AND RECOMMENDATIONS

Conclusion*:*

Drinking water samples from Abaya campus and Main campus; In case of Arba Minch University were too many bacterial loads. In this study the water samples taken from both sites were highly loaded by total coliforms. Based on the results under the study; 7.6 and 3.5 average bacterial colonies were counted on morning and afternoon respectively, on

MacConkey agar from surface water samples, and 29.3 and 7.3 average colonies were counted at the same time on nutrient agar media from surface water. In a similar way, 4.3 and 1.5 average bacterial colonies were counted on MacConkey agar at morning and afternoon samples respectively, which taken from ground water, and 17.3 and 4.6 average bacterial colonies were counted on morning and afternoon respectively, on nutrient agar medium. The study showed that the water was highly loaded by total coliforms. This indicated that the water might be contaminated with fecal matters, this might be shown there were some unsafe conditions such as; pollution of the sources with bacteria that comes from soils contaminated with feces and toilets by diffusion through the soil in to the sources.

Recommendations:

From the finding of the study, the following recommendations were given:

- During our project experiment, when we were collecting our sample we observed some drinking water tubes were damaged or broken and having small opening and the drinking water flow through this opening and may be results in entrance of contaminants which may leads pollution in drinking water. So, drinking water supplying materials; such as water tanks and water pipes should protected from contamination by subsequent handling, processing (chlorination) and treatment in which one should sure they are bacteriological safe.
- During our project experiment we have took our samples from students' cafeteria only, Therefore, we have recommended that it is better to test the quality of students' dormitory and others water supply tanks and pipes for further test of drinking water in AMU.
- When were performs our experiment; there were rainy season which makes the water sources easy to contaminates by feces and other environmental wastes. But in our case we have no idea about dry season; so we have suggested that, it is better to check the quality of the drinking water in dry season to see the variation of bacterial loads with in different seasons in AMU.
- Finally, further studies have to be conducted to isolate and characterize bacteria to their species level.

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