SURVEY OF *Salmonella spp* and *E. coli* IN DRINKING WATER OBTAINED FROM SOME SELECTED LOCAL GOVERNMENT AREAS IN ADAMAWA STATE, NIGERIA

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ABSTRACT

The aim of this research is to determine some bacteriological composition in drinking water (wells and bore-holes) at Mubi-north, Girei and Mayo-Belwa local government areas of Adamawa state, Nigeria. Various types of bacteria/viruses are categorized as pathogens, disease causing organisms that can be found in pretreated or inadequately treated water. Water, being dynamic, needs to be constantly analyzed to minimize contaminants that could be detrimental to the consumers. *E. coli* and fecal coliform are bacteria whose presence can indicate water contaminated by human or animal wastes, causing short-term health effects. When there is seepage of contaminant through well casing, cracks or holes in the well casing allow water that has not been filtered through the soil to enter the well. This seepage is common in the wells made of concrete, clay tile, or brick. These are the nature of wells commonly found across the study areas. Most of the bole holes are hand dug, shallow, located close to river banks where refuse and farming activities characterized by bush burning, application of fertilizers, animals and human defecation is the order day due to these reasons, water sources across the study areas are vulnerable to different kinds of contamination. Investigation into water quality is not a relatively new phenomenon but literature concerning the quality of drinking water from the study is sparse. 62 water Samples were collected at random from both well and boreholes at different location within the study areas using containers with earlier prepared nutrient broth. Three different media were prepared adhering strictly to the media manufacturer's instruction. For the determination of *E. coli,* 24g of EMB was used and SS agar was used for Salmonella species. Results shows that in well water during rainy season the mean concentration of salmonella spp. ranged from (153– 272 CFU/ml), Total coliforms, well water during rainy season mean concentration ranged from (418 – 624 CFU/ml), During dry season, values ranged from (81 – 126 CFU/ml), while for E.coli, in well water during rainy season, the mean values ranged from (33 – 71 CFU/ml),. During dry season ranged from (97. – 131 CFU/ml), conclusively, findings indicates significant higher bacteriological composition in well water during rainy season than dry season ($p<0.05$). Hence, calls further research and monitoring.

Keywords: Survey, pathogens, Salmonella ssp, Total Coliform, E. Coli and Count

INTRODUCTION

Humans have long recognized that water is vital to all life forms. The expected increase in the total production of human and animals feces (due to population growth and meat consumption), is bound to have a detrimental effect on microbial water quality in both coastal and inland waters because of lack of appropriate sanitary conditions.. Fecal pollution of water from a health point of view is the contamination of water with disease causing organisms (pathogens) that may inhabit the gastrointestinal tract of mammals, but with particular attention to human fecal sources as the most relevant source of human illnesses globally. Ingestion of water contaminated with feces is responsible for a variety of diseases important to humans via what is known as the fecal-oral route of transmission. Food, air, soil, and all types of surfaces can also be important in the transmission of fecal pathogens, and thereby implicated in disease outbreaks. Problems associated with fecal pollution of water are likely to worsen in coming decades if necessary steps are not taken it is reasonable to assume that fecal pollution of water is one of the most important and difficult challenges for future generations. Santo et al, (2008, 2018).

The most commonly used fecal indicators include total coliforms bacteria, *E. coli* and fecal enterococci bacteria found in both human and animal feces. (EPA, 2019). Agriculture, industry (including former industrial sites, brownfields, and abandoned industries), water pits, domestic septic tanks, slaughterhouses, animals, and various recreational uses of water by people are the primary sources of fecal water contamination. Humans, cows, agricultural poultry and wild geese can shed pathogens through their urine and feces. Bacterial disease like diarrhea is caused by drinking fecal contaminated untreated water. Fever, abdominal pain, nausea, and headache are the symptoms. Another bacterial disease, cholera can cause watery diarrhea and leads to dehydration and renal failure. Sharon (2015).

To determine whether drinking water is safe, it is monitored for what Long called "indicator organisms" that are highly associated with the pathogen sources. These indicators include total coliform bacteria, thermo tolerant (fecal) coliforms, *E. coli*, fecal streptococci/enterococci and bacteriophages. An investigative study was carried out by Bello *et al.* (2013) to determine the bacteriological and physiochemical qualities of borehole and well water samples in Ijebu-Ode, Southwestern Nigeria. Ten water samples each of borehole and well water sources were collected within the geographical location. The total bacterial count was determined by pour plate technique and total coliform determined using 3-3-3 regimen. Identifications of isolates were done using standard methods. Total bacterial count in borehole and well water sampled ranged from zero to 2.5 x 102 cfu/ml and zero to 8.1 x 102 cfu/ml, respectively.

In another study carried out by Emmanuel *et al.* (2015) to determine the bacteriological quality of some well water in Samaru, Zaria located in Northern Nigeria, Five sampling sites were randomly selected for this study. Samples were analyzed using presumptive multiple tube fermentation and confirmatory tests for total and fecal coliforms. The well water samples were also cultured for *Salmonella*, *Shigella*, and *Vibrio chole*. The total coliform count for all the samples analyzed was >180+/100 ml. All the well water samples from the study locations were contaminated with one or more bacterial pathogens. (Anake *et al.*, 2013). Lydia *et al.* (2018), determine the microbiological quality of 41 brands of sachet water sampled in 16 districts across 5 regions in Ghana. The samples were analyzed for the presence of total and fecal coliform (*Escherichia coli*) using the Colilert*- 18 Test Kit. Results showed that majority of the samples (56.09%) were excellent, 4.87% satisfactory and 14.63% suspicious. Ten samples (24.4%) were unsatisfactory. For the degree of fecal contamination, (85.56%) were satisfactory, four (9.76%) were suspicious, and two others (4.88%) were unsatisfactory. The contaminations observed could be attributed to poor sanitary conditions (during and/or after production) and failure of some production facilities to adhere to standard manufacturing practices.

When there is seepage of contaminant through well casing cracks or holes in the well casing allow water that has not been filtered through the soil to enter the well and this is a good avenue for pathogens and related pollutants to flow into different water bodies locally meant for water consumption. This seepage is common in the wells made of concrete, clay tile, or brick. These are the nature of wells we have across the study areas. Most of the bole holes are hand dug, shallow constructions located close to river banks where refuse and farming activities characterized by bush burning, animals and human defecation as a result, water sources across the study areas are susceptible to different kinds of contamination especially pathogenic pollutants. This stimulated this research work. which is to determine some bacteriological composition in drinking water (wells and bore-holes) in Mubi-north, Girei and Mayo-Belwa local government areas of Adamawa state.

MATERIALS AND METHODS

Study Areas

The study areas for this research covered the following local government areas in Adamawa state: Mubi-North, Girie and Mayo-Belwa located in the north eastern part of Nigeria and lies between latitude 7^{O} and 11^{O}, north of the equator and between longitude 11^{O} and 14^{O}east of the Greenwich meridian (Sanusi, 2017 cited Adebayo, 1999). Mubi-North north local government area, well1 is located at Shuwari Garden city (Sabon -layi) on latitude N100.16.045'and longitude E13.16.716, well 2 on latitude N100.16.591' and longitude E13.16.174', well 3 at Anguwan Qarkeje on latitude N100.16.162 and longitude E 13. 15. 667. Bole-hole point 1 is located at Shuware Qura'anic memorization school on latitude100.16.311' and longitude E100.16 623' and longitude130.16.311'.bore-hole 2 in Shuware primary school located onN100.16.667' and longitude E130.15, 119', bore-hole 3 at Coke-cola deport, Shagari low cost on latitude N100.16.162 and longitude E130. 15.661. In Girie local government area, well 1 is located in Bajabure, Latitude N 90 18. 340' and longitude E120 27.859', well 2 is located Latitude 90 18.278 and longitude 120 27.859, well 3 is located on latitude No90.18.161' and longitude E120 27.922', bore-water 1 is located Samunaka Bajabure on latitude No90 18. 027' and longitude E0120.28.087', bore-hole 2 is located on latitude N9018.152 and longitude E0120.27.885', bore-hole 3 is on latitude 90.18.320' and E12027.829. Mayo-belwa local government area well 1 location is Labbare on latitude N9 0.06, 566 and120.04.617', well 2 is located at Anguwan fada on latitude N90.03.663' and E120.03.138'well 3 at Labbare 11 on latitude N90.06.639' and longitude E120 04.671, bore-hole 1 at Masagamare Sabonlayi on latitude N90.05.402' and longitude E120.04.436', bore-hole 2 at kofar fada on latitude N90 03.738' and E120 03.249', bore-hole 3 at Wakili Buba ward on latitude N90 03.420' and E120 03.391

Samples for Bacteriological Components Study

Samples were collected as follows; 13.0 g of nutrient broth was dissolved in 1000 ml of distilled water in conical flask. The solution was gently heated to dissolve completely to a clear solution. Sterilization was carried out by autoclaving at 121^{0}c for 15 minutes using autoclave after which the solution was allowed to cool to room temperature. 9ml of the solution was then injected into already sterilized sample bottles and taken to the sampling sites. At the sites, 1 ml of was injected into each 9ml sample bottled and properly labeled for onward transportation to the laboratory (Sulaiman et al. 2013).

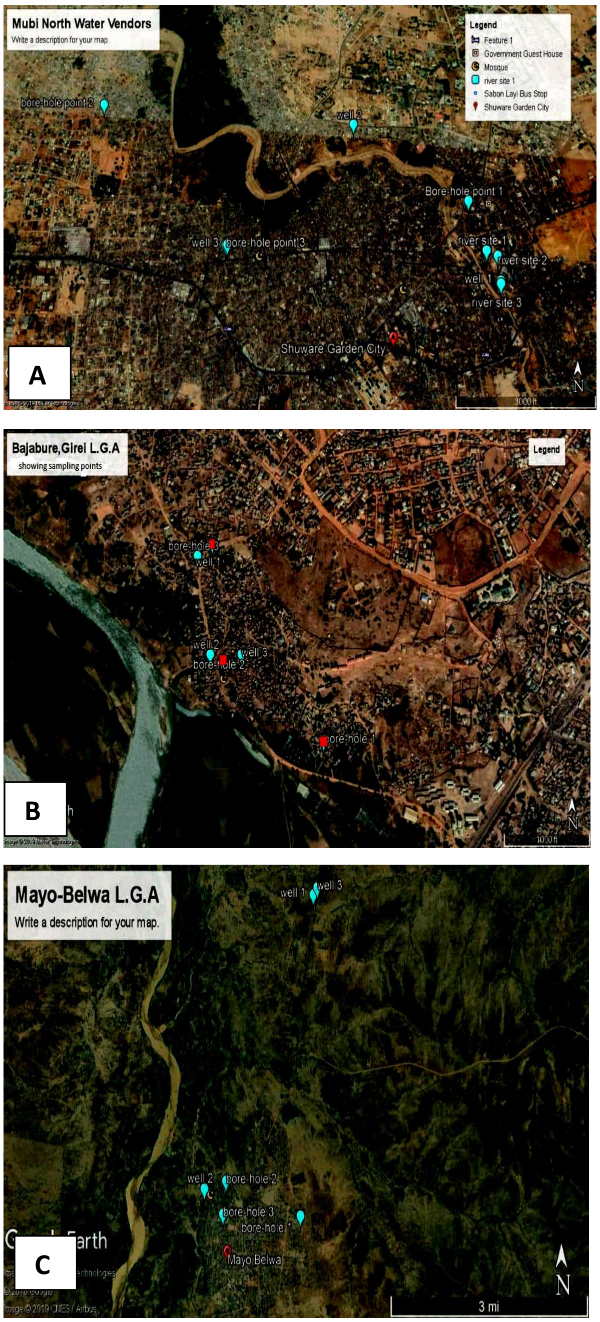

Figure 1: Map of Mubi-North, Girei and Mayo-Belwa local governments area showing the coordinates sampling points.

Media Preparation and Determination of Bacteria in Water Samples

Three different media were prepared adhering strictly to the media manufacturer's instruction. For the determination of *E. coli*, 24g of EMB was weighed, transferred into 500ml flask and dissolved in 380ml of distilled water, properly swirled until a homogenous mixture was obtained. This was boiled at a temperature of 100^0C for 15minutes. It was allowed to cool to approximately 45^0c. After cooling, 18ml of the media poured into each plate (earlier sterilized in an oven at regulated temperature) and was allowed to solidify. Samples inoculation followed and was allowed to stand for 20 -30minutes. The samples were put into an incubator and incubation was allowed to take place for 18-24 hours at 37^0c. Colonies were allowed to develop. Counting was carried out through direct examination using a microscope (Suleiman and Michael, 2013). The same method was used to determine total coliform in the samples but this time nutrient agar was weighed according to the manufacturer's instructions.

For Salmonella species *SS* agar was used. 60 g of the medium in one liter distilled water was mix well, heat with frequent agitation and boil for one minute. Sterilization in autoclave at 121^0C was done for 15 minutes. The resulting media was poured into already sterilized plates i. e. after allowing the plates to warm to room temperature and the agar surface to dry, inoculation followed and samples incubation was carried out at 35-37°C 18-24 hours. Colony morphology were then examined and counted using microscope.

RESULTS AND DISCUSSION

Concentration of Salmonella Species in Drinking Water in the Study Area During Rainy and Dry Season

The mean concentration of *salmonella* spp. in the well and borehole water during rainy and dry seasons are presented in Figure 2 below in respect to the local government area. The results showed that in well water during rainy season the mean concentration of salmonella spp. ranged from (153– 272 CFU/ml), the highest salmonella spp. value was recorded in Mayo-Belwa, while the least value was recorded in Girei. Also, the salmonella spp. value during dry season for well water across the sampled local government area ranged from (25 – 37 CFU/ml), the highest salmonella spp. value was recorded in Mubi-North local government area, while the least salmonella spp. value was recorded Girei local government area.

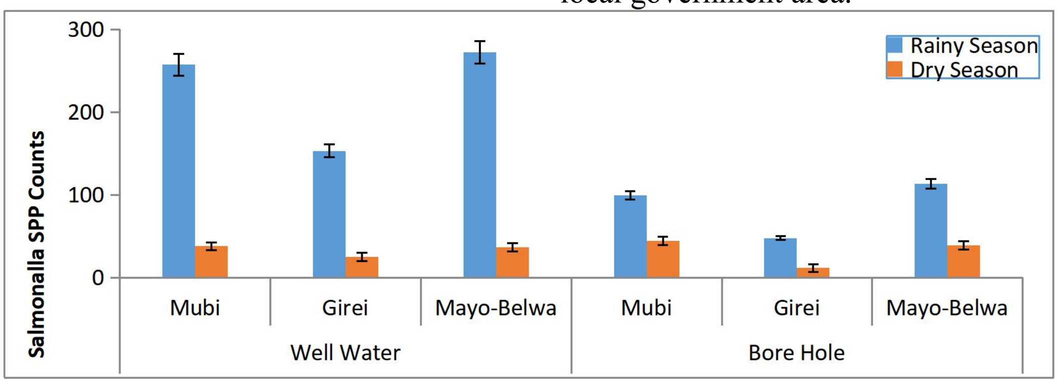

Figure 2: Mean concentration of Salmonella Species in Drinking Water in the Study Area During Rainy and Dry Season

The analysis of variance of Salmonella spp. values in well water during rainy and dry season for three local government areas showed significant difference at $p<0.05$.

The mean concentration of salmonella spp. for borehole water in the study area during raining season ranged from (47 – 113 CFU/ml). The highest mean concentration of salmonella spp. was recorded in Mayo-Belwa while least value was recorded in Girei local government area. During dry season, the mean concentration of salmonella spp. recorded in borehole water ranged from (11 – 44 CFU/m). The least mean concentration of salmonella spp. was recorded in Girei local government area while the highest value was recorded in Mubi-North. The analysis of variance of salmonella spp. values in borehole water during rainy and dry season for three local government areas showed significant difference at $p<0.05$.

Concentration of Total Coliforms Counts in Drinking Water in the Study Area During Rainy and Dry Season

The mean concentration of total coliforms counts for the respective well and borehole water during rainy and dry seasons are presented in Figure 3 below in respect to the local government area. The results showed that in well water during rainy season the mean concentration of total coliforms counts ranged from (418 – 624 CFU/ml), the highest mean concentration of total coliforms counts was recorded in Girei , while the least value was recorded in Mayo-Belwa local government area because their water sources are located along the river bank where pollution load is very high due to refuse dump. Also, the mean concentration of total coliforms counts recorded during dry season for well water across the sampled local government areas ranged from (81 – 126

CFU/ml), the highest mean concentration of total coliforms counts was recorded in Mubi-North, while the least value was recorded in Girei local government area. The analysis of variance of total coliforms values in well water during rainy and dry season for three local government areas showed significant difference at p<0.05.

The mean concentration of total coliforms counts for borehole water in the study area during raining season ranged from (288 – 435 CFU/ml), the highest mean concentration of total coliforms counts was recorded in Girei local government area while least value was recorded in Mubi- North local government area (Figure 2). During dry season the mean concentration of total coliforms counts in borehole water ranged from (84 – 107 CFU/ml) and the least mean concentration of total coliforms counts was recorded in Mayo-Belwa local government area while the highest mean concentration of total coliforms counts was recorded in Mubi- North local government area. The analysis of variance of total coliforms values in borehole water during rainy and dry season for three local government areas showed significant difference at p<0.05.

This finding agrees with that made by Adednego et al. (2013) who recorded high total coliforms counts in well water during rainy season than dry season. Also, study by Nemade et al. (2012) reported significant high total coliforms count in borehole water in rainy season than dry season (p<0.05). Their study attributed high total coliform counts to the effect of erosion during rainy season which might have eroded contaminated human and animal waste into drinking water. This agrees with the view held by Olalekan et al. (2015) that the high total coliform counts are due to water pollution caused by fecal contamination. Carreira et al. (2014) expressed that one of the way a well water or borehole could be contaminated with coliform counts is when there is seepage of contaminant through well casing- cracks or holes in the well casing allow water that has not been filtered through the soil to enter the well. This seepage is common in the wells made of concrete, clay tile, or brick. Kerr and Butterfield (2013) expressed the presence of total coliform counts in drinking water is a serious problem due to the potential for contracting diseases from pathogens. Ali et al., (2012) suggested that whenever coliforms have been detected, boiling, repairs or modifications of the water system may be required until disinfection through re-testing confirm that contamination has been eliminated.

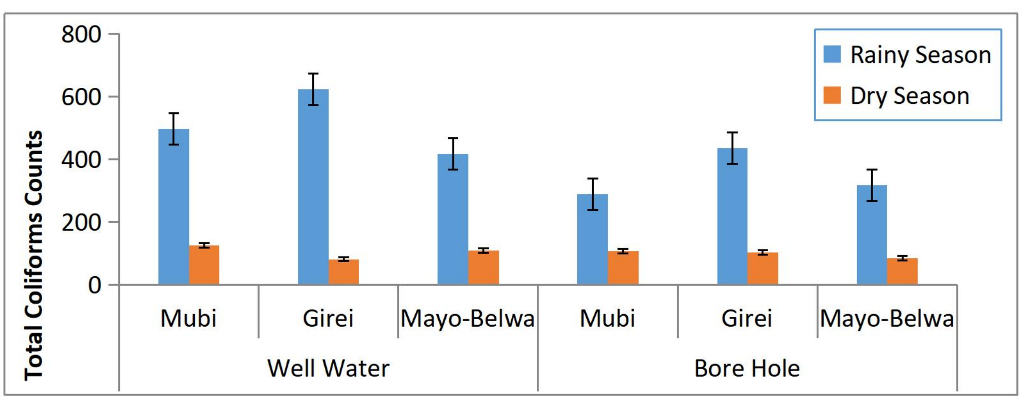

Figure 3: Mean concentration of total coliforms Counts in Drinking Water in the Study Area during rainy and Dry Season

Concentration of *E. coli* Counts in Drinking Water in the Study Area during rainy and Dry Season

Figure 4 below presents the results on the mean concentration of total E. coli Counts in the respective well and borehole water during rainy and dry seasons across the Mubi-North, Girei and Mayo-Belwa local government area of Adamawa state respectively. The results showed that in well water during rainy season, the mean E. coli values ranged from (33 – 71 CFU/ml), the highest mean concentration of total E. coli Counts was recorded in Girei local government area, while the least value was recorded in Mubi- North local government area. Also, the mean concentration of total E. coli Counts recorded during dry season for well water across the sampled local government areas ranged from (97. – 131 CFU/ml), the highest mean concentration of E. coli Counts was recorded in Mubi-North, while the least value was recorded in Mayo-Belwa local government area. The analysis of variance of total E. coli Counts in well water during rainy and dry season for three local government areas showed significant difference at $p<0.05$.

The mean concentration of E. coli counts for borehole water in the study area during raining season ranged from (9 – 94 CFU/ml), the highest mean concentration of total E. coli Counts value was recorded in Girei local government area while least value was recorded in Mubi- North local government area. During dry season the mean concentration of total E. coli Counts in borehole water ranged from (107 – 136 CFU/ml), the least mean E. coli value recorded in Mubi- North local government area while the highest value was recorded in Girei local government area. The analysis of variance of E. coli counts in borehole water during rainy and dry season for three local government areas showed significant difference at $p<0.05$.

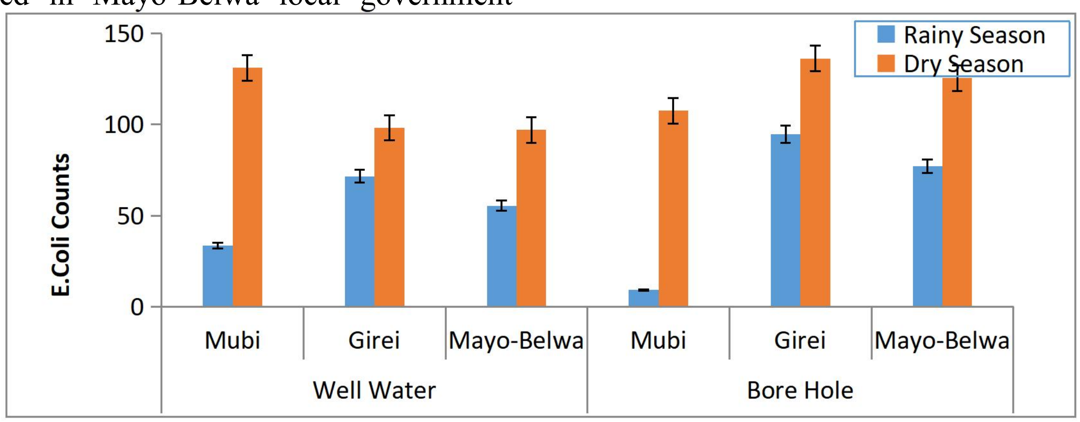

Figure 4: Mean Concentration of *E. Coli* Counts In Drinking Water In The Study Area During Rainy And Dry Season

Generally, results obtained from the present study agree with some existing literatures and shows that in well water during rainy season the mean concentration of salmonella spp. ranged from (153– 272 CFU/ml), Total coliforms, well water during rainy season mean concentration ranged from (418 – 624 CFU/ml), During dry season, values ranged from (81 – 126 CFU/ml), while for E.coli, in well water during rainy season, the mean values ranged from (33 – 71 CFU/ml),. During dry season ranged from (97. – 131 CFU/ml), Studies by Levantesi *et al.* (2012) and Eriksson-de-Rezende *et al.* (2014) recorded higher salmonella spp. in water during the rainy season than the dry season.

Also, McEgan *et al.* (2014) reported higher salmonella spp. in borehole water during the rainy season than the dry season and higher value was attributed to higher human and animal activities within their study vicinity that heighten the infection of Salmonalla spp in the water. Findings indicates significant higher bacteriological composition in well water during rainy season than dry season ($p<0.05$). This finding agrees with that made by Adednego *et al.* (2013) who recorded high total coliforms counts in well water during the rainy season than dry season. Also, study by Nemade *et al.* (2012) reported significant high total coliforms count in borehole water in rainy season than dry season ($p<0.05$). This agrees with the view held by Olalekan *et al.* (2015) that the high total coliform counts are due to water pollution caused by fecal contamination.

The current finding concur with that made by Klein (2013) which indicated significant higher E. coli in well water during the rainy season than dry season ($p<0.05$). Also, studies by Rhodes and Kator (2012) and Nemade *et al.* (2012) recorded a significant higher E. coli in borehole water in different sites during the rainy season than it being recorded during the dry season ($p<0.05$). Conclusively, the current finding indicated significant higher bacteriological composition in well water during rainy season than dry season ($p<0.05$). Hence, calls for monitoring and continues survey. Salmonella SPP was discovered across the study Areas. This is the causative agent of typhoid fever which is a reoccurring fever that at times can be fatal to health. The high total coliform counts during the rainy season across the study areas may be due to water pollution caused by fecal contamination which percolates through the underground streams to different water bodies like wells and boreholes and this is a great threat to life.

CONCLUSION

E. coli count across the different sources of drinking water (well and borehole) in Mubi-North, Girei and Mayo-Belwa local government areas shows increases with increase in water volume during the rainy season, and decreases during the dry season as water volume decreases. This may be attributed to flow of refuse dumps, related waste and erosion activities that transport residues from farmlands, commercial centers and along the water ways which find their ways into the water bodies. Its worth noting that the presence of E. Coli in drinking water, no matter how small the concentration can cause a substantial number of diseases to the consumers which are risky to their well being.

Based on the finding and conclusion from this study, the followings are the recommendations:

There should be general sensitization on danger of sinking wells or boreholes on water ways or low land where waste, residue or effluents could be easily enter drinking water sources.

. There is need for the immediate treatment of the sources of drinking water in Mubi-North, Girei and Mubi- North Local Government Areas, to prevent the full blown of health risk that are likely to be associated with presence of pathogens in their drinking water.

a. Further studies are recommended to explore all possible pollutants which are not covered by this research work to fast track necessary monitoring, treatment, improvement of water quality etc., with the view towards safe guiding the general well-being of the consumers.
b. No dumping of refuse of any kind should be allowed near water bodies especially those meant for drinking. Defecation close to water sources should strictly bound.

c. Better management practices, remediation strategies, and overall awareness of the global issues associated with fecal pollution are needed in order to improve the chances of sustainable water resources for future generations in all countries

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