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Parasitological Study of Water at Various Stages of Purification at Ahmadu Bello University Water Works, Zaria

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Abstract
The parasitological study of water at various stages of purification at the Ahmadu Bello University Water Works, Samaru, Zaria, was carried out to determine some water-residing parasites. The study was conducted using standard parasitological techniques. Parasites observed included, *Entamoeba histolytica, Entamoeba coli, Balantidium coli, Giardia lamblia, Cryptosporidium parvum, Ascaris lumbricoides, Taenia saginata* and *Schistosoma* spp. The sedimentation stage of the water treatment had the highest parasite count of 119 with *Cryptosporidium parvum* in the Coccidian group with the highest occurrence of 17.6% while *Balantidium coli* in the Flagellate group had the lowest occurrence of 5.9%. The filtered water had an overall total parasite count of 43 of which *C. parvum* had 32.6%, while *Giardia lamblia* and *Ascaris lumbricoides* each had 7% occurrences. Water at the chlorination stage had a parasite count of 37 of which *Entamoeba coli* in the Amoebae group had highest occurrence (24.3%), while *A. lumbricoides* in the Nematode group had the lowest occurrence (8.1%). The significance of the result is that water treatment is effective in reducing parasite load, but not efficient in completely removing parasites from treated water. Thus, the traditional way of boiling tap water before drinking is still necessary.

Key words: Water, parasites, Purification, Water works, chlorination, boiling.

INTRODUCTION
The physiological significance of water to the human body cannot be over emphasized and it is no doubt that water is one of the most basic components of human life. Clean and healthy water is a fundamental requirement of the human body that cannot be substituted (Shaibu-Imodagbe, 2013). Hence the popular saying "Water sustains life". Good quality drinking water is primarily sourced from rainfall or from surface water such as streams, rivers, springs and lakes. Where these do not exist or where they exist in quantities that cannot adequately support the dependent populations, ground water resources are exploited in the form of wells and

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boreholes to provide this vital body requirement. This is why water continued to be the centre of ancient and present day civilizations (Shaibu-Imodagbe, 2013).

Waterborne diseases such as Cholera, Typhoid fever and Hepatitis A, which are caused by bacteria, are among the most common diarrheal diseases. Other illnesses, such as dysentery, are caused by parasites that live in water contaminated by the feces of sick individuals. The most common human parasitic protozoa transmitted by water belong to the genera *Giardia* and *Cryptosporidium* (Slifko *et al.*, 2000). Today with the disaster prone environment in which we live, real effort is required toward the system to make human beings step back and ponder the state of things, which they go on ignoring, especially the potential disasters and difficulties that exist (Hulme, 2011). Similarly, the overview of water microbiology as it relates to public health is one of the most important aspects of Microbiology from a human perspective. It is a fact that numerous diseases from microorganisms in water are acquired (Hurst, 2007). According to WHO (2004) almost 137million people in urban communities have no access to safe drinking water and more than 600million urban dwellers do not ensure adequate sanitation in their dwelling places (Alirol *et al*., 2010).

When taken into careful consideration the water, water related and sanitation related disease outbreak is a 'hidden epidemic' hiding in plain sight. In order to address problems such as this, dual water networks (water treatment plant) in which the use of water with a low level of chemical or microbiological contaminants that would not represent a threat to human health was proposed (Kahana and Tal, 2000) by the Ahmadu Bello University (ABU), Zaria and subsequently commissioned in 1981, when the Zaria municipal water supply was found to be incapable of meeting the drinking water needs of the Ahmadu Bello University community. The treatment plant was designed to produce 13.640m^3 per day on full development over 3-phases. The importance of microbiological and parasitological criteria for controlling the contamination of recycled water has been repeatedly emphasized. The study was conducted to determine the presence of some water borne parasites in order to establish the efficiency of water treatment in Ahmadu Bello University Water Works, Samaru, Zaria.

MATERIALS AND METHODS

Study area and Sample Collection Sites:

The study area used was the A.B.U. water treatment plant, which is located within the University premises at an elevation of 655 meter on latitude 11° 08′ 25.60″N and longitude 7° 39′ 19.65″E. (Shaibu-Imodagbe *et al.,*2013). The location for the sample collection was the Sedimentation unit, Filtration unit and the Chlorination unit of the Water Works at the Ahmadu Bello University, Zaria.

Sample Collection and Analysis

Samples were collected at the Ahmadu Bello University water works before disinfection and from various stages of purification. Samples were collected using yarn filters consisting an inlet hose, plastic filter holder with 25 cm long yarn wound filter with a porosity of 5µm, outlet hose, water meter and a limiting orifice flow control device with a slow flow rate (Greenberg, 1985).
Components were thoroughly drained and rinsed between sample collection, using aseptic techniques to protect the sample collector and prevent sample cross contamination (Sanders, 2012). The total volume of water sampled was 1500 liters at the sedimentation stage, the

filtration stage and the chlorination stage. This was obtained by taking 500 liters of water at each stage of treatment (Greenberg, 1985).

In collecting a sample, the inlet hose was connected to the appropriate sample water with the direction of water flow from the outside to the inside of the yarn wound filter cartridge (IPC Eagle Hydro Tube® System Operation Manual). Time was recorded and the volume of sample was measured using containers of known volume. It took 12 seconds to fill containers of 20 liters, it took 5 minutes to filter 500 liters of the sample water. Then the pump was stopped and sampling apparatus was carefully handled to prevent backwashing and loss of particulate matter (IPC Eagle Hydro Tube® System Operation Manual). Residual water was completely drained together with the yarn filter into sterile nylon plastic bags that were properly labelled and sealed. The labeled plastic bag was then placed in a second plastic bag and sealed. The samples were then kept on wet ice bath and transported to the laboratory for further investigations as soon as possible (Greenberg, 1985).

Extraction

During the process of extraction, the filter samples were handled aseptically and the end of the yarn was located on the outside of the cartridge. Fiber was unwound and washed with distilled water by kneading the fluid from the yarn, which was eventually forced out, thereafter the particulate matter from the fiber, was then collected in a sterile container. Through repetition of the extraction process, more materials were extracted until the fiber appears clean, after which the extract was then concentrated (Greenberg, 1985).

Extract Concentration

The filter extract was concentrated by letting the extract settle in the refrigerator overnight and then the particulate matter that settled was separated by a table top centrifuge at 2000rpm for 2 minutes (Standard operation procedure). Using a Pasteur pipette, sediments were picked and placed on a grease free slide and covered with a cover slip (Greenberg, 1985).

Microscopy

The water sample was allowed to settle for some time before being decanted. The supernatant was then centrifuged at 2500 rpm for 10 minutes. About 50 μL of resulting sediment was put on a clean glass slide and stained with a drop of Lugol's iodine. The slide was then covered with coverslip and observed under a light microscope at 100× and 400× magnification (Reena *et al.*, 2016). The respective parasite cysts, trophozoites and helminth eggs were recorded as observed under the microscope. Part of the identification also involves the use of unheated acid-fast and trichrome staining methods to identify *C. parvum, E. histolytica, E. dispar*, and *G. lamblia* (Bakir *et al*., 2003).

RESULTS

The occurrence of parasite at different stages of the water purification, were recorded to be 199 (Table 1). For the Amoeba groups, *Entamoeba histolytica* and *Entamoeba coli* had 8.54% and 20.60% occurrence respectively. The flagellate group respectively were 94.50% and 11.56% occurrence for *Balantidium coli* and *Giardia* spp. The Coccidian had a record of 24.60% occurrence for *Cryptosporidium parvum*.Among the worms, Nematode had 11.56% occurrence for *Ascaris lumbricoides,* while Cestode had 12.56% occurrence of *Taenia saginata* and eventually Trematode which had the least count had just 6.0% occurrence of *Schistosoma* spp.

Parasite count in Sedimentation Stage revealed that this stage had the highest parasite count among the three stages of water treatment, and recorded *Entamoeba coli* and *Cryptosporidium parvum* as the most occurring parasites. This indicates the start of physical removal of parasites by settling. A total of 119 parasites were counted at this stage (Table 2).

Parasite count at the filtration was 43 with *Cryptosporidium parvum* having the highest occurrence, while *Ascaris lumbricoides* had the lowest frequency of occurrence (Table 3).
Parasites were observed to be resistant to chlorination and a total of thirty seven (37) parasites were observed at the chlorination stage (Table 4) *Cryptosporidium parvum* were observed to possess the highest occurrence, while *Ascaris lumbricoides* had the least occurrence.

Table 5 shows total parasite count in each treatment stage and a gradual parasite load reduction is shown.

Table 1: Occurrence of parasites at the different stage of the water purification

Parasite Group	No. of Parasites	Percentage Occurrence %
Protozoa		
Amoeba:		
Entamoeba histolytica	17	8.54
Entamoeba coli	41	20.6
Flagellates:		
Balantidium coli	02	94.5
Giardia lamblia	23	11.56
Coccidia:		
Cryptosporidium parvum	49	24.6
Worms		
Nematode:		
Ascaris lumbricoides	23	11.56
Cestodes;		
Taenia sarginata	25	12.56
Trematodes:		
Schistosoma spp	12	6.0
Total	**199**	**100**

Table 2: Parasite Distribution at the Sedimentation Stage of Water Treatment.

Parasites	No. of Parasites	Percentage Occurrence %
Parasite Group		
Protozoa		
Amoeba:		
Entamoeba histolytica	13	10.9
Entamoeba coli	21	17.6
Flagellates:		
Balantidium coli	7	5.9
Giardia lamblia	11	9.2
Coccidia:		
Cryptosporidium parvum	21	17.6
Worms		
Nematodes:		
Ascaris lumbricoides	17	14.3
Cestodes:		
Taenia saginata	17	14.3
Trematodes:		
Schistosoma spp	12	10.1
Total	**119**	**100**

Table 3: Parasite Distribution at the Filtration Stage of Water Treatment

Parasites	No. of Parasites	Percentage Occurrence %
<u>Protozoa</u>		
Amoeba:		
Entamoeba histolytica	6	13.9
Entamoeba coli	9	20.9
Flagellates:		
Balantidium coli	4	9.3
Giardia lamblia	3	7
Coccidia:		
Cryptosporidium parvum	14	32.6
<u>Worms</u>		
Nematodes:		
Ascarislumbricoides	3	7
Cestodes:		
Taenia saginata	4	9.3
Total	**43**	**100**

Table 4: Parasite Distribution at the Chlorination stage of Water Treatment

Parasite Group	No. of Parasites	Percentage Occurrence %
<u>Protozoa</u>		
Amoeba:		
Entamoeba coli	9	24.3
Flagellates:		
Giardia lamblia	7	18.9
Coccidia:		
Cryptosporidium parvum	14	37.8
<u>Worms</u>		
Nematodes:		
Ascaris lumbricoides	3	8.10
Cestodes:		
Taenia saginata	4	10
Total	**37**	**100**

Table 5: Total Parasite Distribution in Water Treatment Stages at ABUWater Works, Samaru, Zaria.

Treatment Stage	No. of Parasites (%)
Sedimentation	119 (59.80)
Filtration	43 (21.61)
Chlorination	37 (18.59)
Total	**199 (100)**

DISCUSSION

The results obtained showed that Sedimentation stage had the highest parasite count of 119, and chlorination stage had the least parasite count of 37 and at the filtration stage the parasite count was 43 showing the significant drop in parasite load in water after filtration. This could be due to the fact that the sedimentation stage is the starting point where no deliberate purifying action had been taken and therefore parasites are concentrated. The purification stage removes many of the parasites while the chlorination stage inactivates yet many parasites, significantly in comparison. With the results obtained from the different purification stages, it can be deduced that the process is significantly effective in decreasing parasite load downstream, but not sufficiently efficient.

Furthermore, the result suggests that although, there was a significant decrease in parasite load at the filtration stage compared to the sedimentation stage. However, the porosity of the filter bed allowed some level of parasites to pass through and so may not be absolutely efficient in terms of total parasite removal.

Water treatment and purification is the life line of promoting public health and safety, but what the result suggested was that water treatment in ABU water works is effective in reducing parasite load and contamination, but it is not efficient in making water completely free of parasites.

The parasites identified pose a serious threat to the public health and safety of the ABU community. Parasites observed after filtration in the chlorinated water show that the rapid sand filters are not absolutely efficient in trapping all the microorganisms.

Parasite count obtained indicated that high levels of contamination could lead to water borne infection, which could cause devastating effects to public health as stated by Katherine (1998) as one of the causes of diarrhea in children under five years of age. From the results obtained, there is reduction in parasite load but the water is still not safe for consumption by ABU community.

The presence of parasites such as *Cryptosporidium parvum* in chlorinated water was notable and consistent is with what is obtained in literature, this is due to resistance to chlorine, presence of other parasites suggest inadequate filtration and resistance to chlorine.

New data also contradict previous assumptions that ground water is inherently free of parasites such as *Cryptosporidium*. For example, Hancock *et al.* (1998) recently reported a study of 199 ground water samples tested for *Cryptosporidium*. They found that 5% of vertical wells, 20% of springs, 50% of infiltration galleries, and 45% of horizontal wells tested contained *Cryptosporidium* oocysts.

Cryptosporidium was initially thought to be an opportunistic pathogen of immunocompromised persons, but a number of waterborne outbreaks, plus frequent cases in immunocompetent individuals, have disproved this. Indeed, *C. parvum* is now one of the most commonly identified intestinal pathogens throughout the world. Its occurrence is dependent on factors that include season, and the age and other demographic characteristics of a population: among children aged 1–5 years with diarrhoea, *C. parvum* may be the most frequently found pathogen (Palmer, 1990).

CONCLUSION

In this complex urban civilization of the ABU community water treatment remains a lifeline in promoting public health and safety. Inadequately treated water raises the risk of spread of harmful microorganisms as seen in the result of this study, which presented the existence of *Entamoeba histolytica, Entamoeba coli, Balantidium coli, Giardia lamblia, Cryptosporidium parvum, Ascaris lumbricoides, Taenia saginata* and *Schistosoma* spp. Filtration and chlorination of community water supply prove to be invaluable tools in mitigating to a reasonable extent, the risk of parasitic infestation, even if they may sometimes fall short of achieving absolute elimination.

RECOMMENDATION

Since treated water is distributed to human population, it is important that adequate water treatment is ensured to completely eliminate the survivability of microorganisms. Because of the possibility of failure in achieving and maintaining quality standards for drinking water, tap water meant for drinking could be boiled. The research and implementation of a more effective model for the purification of water should be invested in and awareness programs should be organized to educate people on the need to boil their tap water before consumption so as to promote a healthier and safer community.

Maintaining reliable treatment performance is critical for minimizing microbial risk, because health effects associated with some parasitic contaminants tend to be due to short-term, single dose exposure rather than long-term exposure.

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