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Research Article

Assessment of Water Used In Basic Schools And Its Impact on School Feeding Programme, A Case Study in Mampong Municipality

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Abstract: Millions of children get debilitated and pass on consistently from water, sanitation, and hygiene diseases. Children's ability to learn may be affected by inadequate water, sanitation, and hygiene conditions in several ways. Twenty basic schools under the School Feeding Programme were randomly selected from 10 towns within the Mampong Municipality. A total of 140 pupils were randomly selected from the 20 schools for the study. Water samples were taken from each of the schools for their physicochemical and microbial quality analyses. The findings of the study revealed that most of the water used by pupils in the selected schools had microbial contamination. More than 70% of the towns had total coliforms in water samples whilst 50% of the samples had faecal coliforms. Half of the towns had both faecal and total coliform in their water samples. Total coliform values ranged from 0.67±0.58 to 37.67±19.66 cfu/100ml and faecal coliforms 4.33±4.51 – 11.67±7.64 cfu/100ml.All physicochemical parameters were within allowable limits except pH, which were below the minimum pH level in water recommended by WHO. pH levels were between 5.02±1.59 to 6.23±0.25. It appears that microbial contamination was detected were very high in the form of Total and Faecal Coliform Bacteria. And water samples were slightly acidic, compared to the WHO recommended guidelines.

Keywords: Water quality, Basic Schools, School Feeding, WASH facilities, Mampong Municipality.

INTRODUCTION

The provision of an adequate supply of safe water was one of the eight components of primary health care identified by the International Conference on Primary Health Care in Alma-Ata in 1978 (World Health Organization, WHO, 2009). The inability to achieve MDGs related to safe water supply and sanitation has been a burden on children in most developing countries (UNICEF, 2008). Although progress had been made by most countries concerning child morbidity and mortality rate, there are still much to be done to improve child health (WHO, 2013). Preventing the spread of infectious agents in schools is a good way regarding abating infectious diseases among children and improving their health. Providing water, sanitation, and hygiene (WASH) facilities in schools are very crucial in ensuring the adoption and maintenance of safe sanitation and hygiene practices among school children (Appiah-Brempong et al. 2018). It has been established that WASH provisions in most schools in many low-income countries, are however, persistently insufficient and most often associated with ill effects on health and school attendance (Jasper et al. 2012).

Globally, drinking water has been established as a primary transmission pathway for diarrhea pathogens (Dufour, 2003; WHO, 2010). In industrialized countries, centrally treated drinking water distribution systems have largely eliminated outbreaks of waterborne diseases, such as typhoid fever and cholera (Cutler & Miller, 2005). In developing countries, there is a large body of evidence that improving the microbial quality of drinking water by treatment and safe storage reduces diarrhea (Arnold & Colford, 2007; Fewtrell et al. 2005).

Schools are places where children actively stay for most of the day and therefore for a healthy and conducive learning environment, children need safe water for drinking and hand washing. The high rate of diarrhea and other communicable diseases among school children is partly due to poor knowledge and practice of personal and environmental hygiene (Monney et al, 2014); poor knowledge and practice of the attitude to personal hygiene such as hand washing, have a negative consequence for child's long term 'washing development' (Crosby et al. 2020). All school

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children need good hygiene due to profound effects on school attendance and performance outcome.

The provision of quality water, sanitation, and hygiene in schools been established to improve health, boost educational achievement and promote gender equity, which has a positive impact on the health and hygiene of the pupils and the community as a whole (WHO, 2011). This study, therefore, accessed the availability, accessibility, and quality of water in schools under the School Feeding Program in Ashanti Mampong Municipality.

MATERIALS AND METHODS

The research was conducted in Basic schools within the Mampong Municipality in the Ashanti Region of Ghana. It was also one of the thirty administrative districts in the Ashanti Region of Ghana and 55Km northeast of the Kumasi-Ejura road. It is bounded to the south by Sekyere South district, to the east by Sekyere Central and the North by Ejura-Sekyerdumasi districts. The Municipality's capital is Asante Mampong, located within longitudes $0^{0}05$□W and $1^{0}30$□W and latitudes $6^{0}55$□Nand $7^{0}30$□N (GSS, 2010).

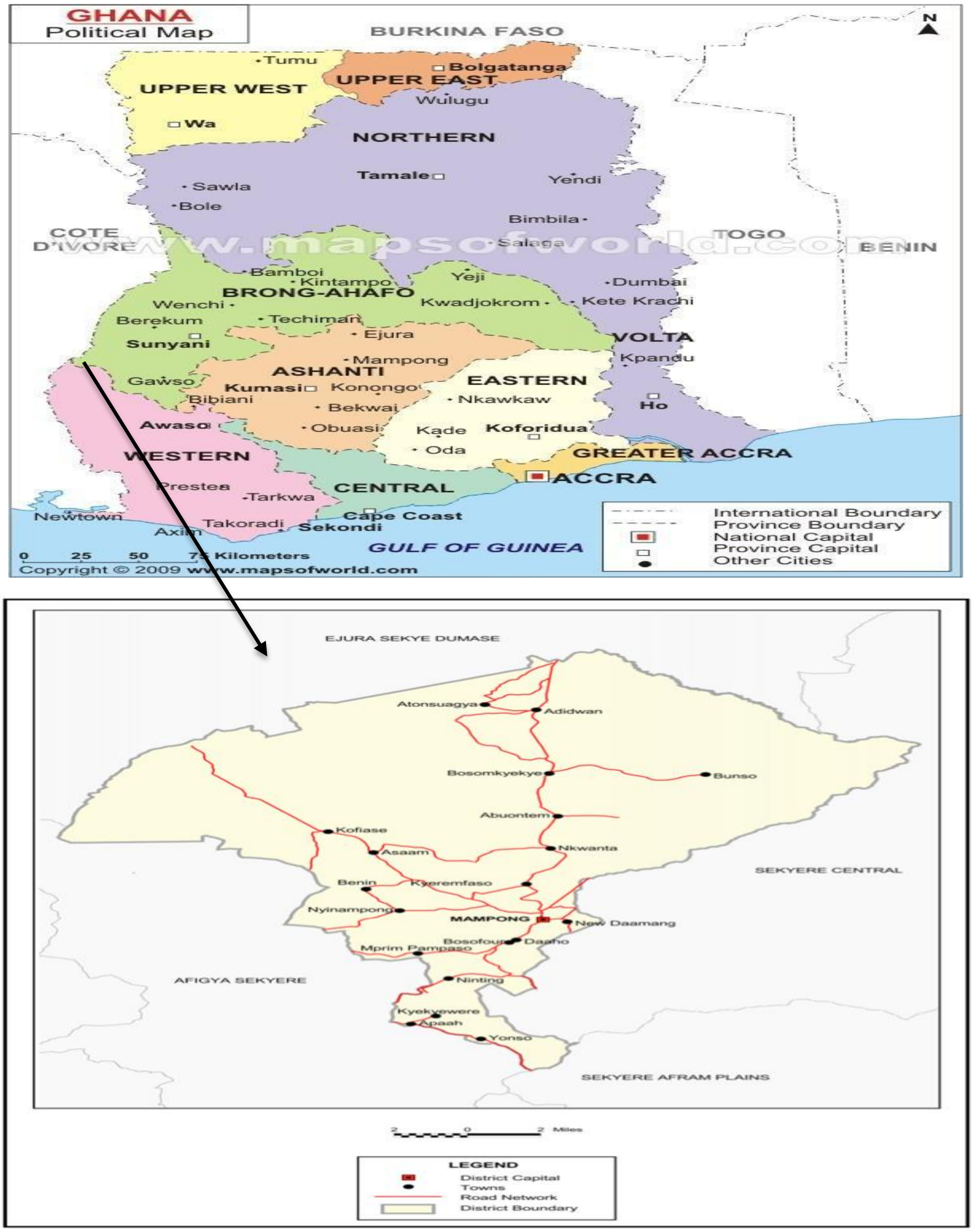

Figure 1: Map of the study area

Sample Size and Data Collection

For the purpose of the study, purposive sampling was used to select respondents from basic schools and headteachers of basic schools under the Government of Ghana (GoG) School Feeding Programme. A total of 140 students from 20 basic schools in 10towns within Mampong Municipality, namely: Mampong, Krobo, Nyinampong, Bosofour, Ninting, Assam, Kofiase, Benim, PSK and Kyiremfaso were selected for the study. At the beginning of the study, the heads of the selected basic schools were duly informed. Before data collection started, the reason for the study and procedures for collecting data was explained to the teachers and pupils.

Data was collected from these basic schools by administering questionnaires to solicit responses on the availability and accessibility of water and WASH facilities. The head teachers of the selected basic schools were interviewed and observations were also made with regards to accessibility and availability of water and WASH facilities in the schools to support the responses received. Water samples were collected from the schools for physicochemical and microbial analyses. The physicochemical parameters analyzed were pH, turbidity, conductivity, total dissolved solids (TDS), total hardness, and temperature, while the Total coliforms and faecal coliform were the microbial analyses conducted on the water samples. The total and faecal coliforms analyses were conducted using Membrane Filtration Technique. The data were analyzed using Statistical Package for Social Science (SPSS V20) and Microsoft Excel 2011 (Mac version).

RESULTS AND DISCUSSIONS

Results from the study indicated that 63(45%) of the total number of respondents used GWCL piped water as their primary source of water for drinking, 49(35%) used borehole, 21(15%) used sachet water and 7(5%) used different sources of water (students bring water from their various homes) as their primary source of drinking water. About 78(55%) of the respondents used GWCL water for other activities, 49(35%) used borehole water for other activities, and 14(10%) used different sources of water for other activities (Table 1).

Every pupil should use a minimum of 5 liters of water during school hours but quite a number of schools selected did not have adequate water for students to drink and wash their hands (UNICEF, 2012; WHO, 2011). Inadequate water for drinking might lead to a detrimental effect on the health of school children (Chard et al. 2019; McMichael, 2019). Insufficient water for drinking also means inadequate water for proper hygiene delivery (Ray, 2020; Carter *et al.*, 1999; Islam et al. 2020). According to WHO, the source of water must be within 100m from the collection point and the collection time should not exceed 30 minutes (Howard *et al.*, 2003; UN, 2010). Though the time used by the respondents who fetched water from accessible points around the schools were all less than the WHO recommended time, there were respondents who did not have access to the accessible water points in the school premises. If a school does not have a functional water facility within the schools premises, children will have to walk a long distance to fetch water, this might contaminate the water upon reaching the school, such actions might create health risks (Jasper et al. 2012; WHO, 2008). Such situation is likely to affect water consumption pattern among school children (Franse et al. 2019) and also reduce their active learning periods in class and their absorption rate due to tiredness.

Table 1: Respondents' response on the sources of water

Parameter	Responses	N (%)
Primary source of water for drinking	GWCL piped water	63 (45)
	Borehole water	49 (35)
	Sachet water	21 (15)
	Other sources	7 (5)
Source of water for other activities	Borehole water	48 (34.3)
	GWCL piped water	78 (55.7)
	Other sources	14 (10)
Adequacy of water	Yes	140 (100)
Accessibility of water	No	14 (10)
	Yes	126 (90)
Responsibility of fetching water	Each class	54 (38.7)
	All students	80 (57.1)
	Class 5	6 (4.2)
Equipment for fetching water	Bowl	7 (5)
	Bucket and gallon	133 (95)
Duration for fetching water	1-5 minutes	113 (80.7)
	5-10 minutes	20 (14.2)
	10-15 minutes	4 (2.9)
	15-20 minutes	3 (2.1)

Interview with heads of the basic schools indicated that 19(95%) of the twenty schools had functional water facilities within the school, while 1(5%) had no water facility within the school. Out of the 19 schools with functional water facility, 13(65%) had no measures (bowls for fetching water, presence or absence of cover lid, environmental hygiene, etc.) to keep their functional water facility clean, 7(35%) had measures in keeping their functional water facility clean. Observation made in the schools that had no measures to keep their water clean also indicated that the workers as well as the pupils used different water drawing bowls that were dirty for fetching water from the water receptacles. Water has high potential to be polluted during collection, storage and fetching from containers (Amenu, Spengler, André, & Zárate, 2014). According to UNICEF, an estimated 1.9 billion school days could be gained if the Millennium Development Goals (MDGs) related to safe water supply and sanitation are achieved and the incidence of diarrhoeal illness is reduced (Hutton *et al.*, 2004). Water was not accessible to physically challenged students for 12(63.2%) of the schools whilst 7(36.8%) had water accessible to physically challenged students (Table 2). About 55% of the heads indicated that they experienced a shortage of water in a month with reasons being broken pipelines and taps not flowing, while 45% said they never experienced any shortage in a month (Table 2). Shortage of water could lead to improper cleaning of eating bowls of students and cooking bowls while at the same time preventing adequate hand washing by students (Nuwagaba *et al.*, 2020). According to McMichael C. (2019), a literature review of water, sanitation and hygiene (WASH) in schools in low-income countries indicated that ensuring access to safe and sufficient water and sanitation and hygiene promotion in schools has great potential to improve health and education.

Table 2: Interviews with Heads of the Selected Basic Schools

Parameter	Responses	N (%)
Functional water facility near the school	No	1(5)
	Yes	19 (95)
Measures to maintainclean water facility	No	13 (65)
	Yes	7 (35)
Accessibility of water to students	No	1 (5)
	Yes	19 (95)
Accessible to physically challenge	No	12 (63.2)
	Yes	7 (36.8)
Shortage of water in the last one month and reason	Yes	11 (55)
If Yes, reason	Broken pipeline	7 (35)
	Tap not flowing	4 (20)
	No	9 (45)
Reliability of water source	Excellent	3 (15)
	Good	16 (80)

Availability of WASH Facilities

Preventing the spread of infectious agents in schools is a good way regarding abating the infectious diseases among children. Providing water, sanitation, and hygiene (WASH) facilities in schools are very crucial in ensuring the adoption and maintenance of safe sanitation and hygiene practices among school children (Appiah-Brempong et al. 2018; UN, 2010). Results from the study indicated that 105(75%) of the respondents had toilet facilities in their school whilst 35 (25%) indicated that they had no toilet facility in their schools. The absence of toilet facilities in school could be a cause for open defecation by the school children which could likely lead to the spread of infectious diseases which can lead to morbidity and absenteeism in schools (Jasper *et al.*, 2012). Moreover, about 25 (23.8%) of the students who had toilets in their schools did not use the toilets, based on aesthetically displeasing reasons of bad odour, toilets soiled with faeces and the presence of too many students (Table 3). These are clear underscoring factors of poor management of the school toilets which could contribute to open defecation in the school environment and poor personal hygiene for the students. These could be a recipe for polluting the water used for the school feeding because the students after using the poorly managed toilets or open defecation might come back to contaminate the water through handling. Though the toilet might be present in the schools, they might not be adequate for the number of students in the school. This was established in respect of the student population in the affected schools and the available number of toilets. The standard practice for the use of toilet facilities in schools is one toilet per 20 students but according to the National implementation model for WASH in schools for Ghana Education Service, a maximum of 50 pupils should use one toilet hole per toilet cubicle (Thorn 2017; Ghana Education Service, 2012). With the availability of a hand washing facility, 126 (90%) of the respondents had hand washing facilities in their schools while 14(10%) had none in their schools. Though most of the basic schools had hand washing facility they were inadequate, 2(1.4%) had only one hand washing device, 8(5.7%) had two, 40(28.6%) had three and

76(54.3%) had four. Inadequate hand washing facilities is likely to lead to poor hand hygiene practices (Behailu et al. 2016). However, studies have established that poor hand hygiene practices potentially contribute to community-based infections which include gastrointestinal, skin and respiratory infections (Crosby et al. 2020). A study which looked at the impact of poor hand hygiene in college students specifically found a link between poor hand hygiene practices to increased occurrences of infectious diseases, medical visits and absence from class and work (Prater, 2016). On students understanding of when (moments) hand should be washed, 29(20.7%) indicated before and after eating only, 38 (27.1%) said after playing only while 59 (42.1%) mentioned different critical times. These responses from the students clearly indicated that most of them lacked the understanding of handwashing education which could contribute to the failure of the school feeding programme to achieve its ultimate goal.

Table 3: Availability of hand washing facilities in schools

Parameter	Responses	N (%)
Availability of toilet facility	No	35 (25)
	Yes	105 (75)
Type of toilet facility	VIP	26 (18.7)
	KVIP	78 (55.7)
	Pit latrine	1 (0.7)
Use of school toilet	Yes	80(76.2)
	No	25 (23.8)
Reasons for not using school toilet	Smelling (bad odour)	10 (40)
	Highly soiled with faeces	9 (36)
	Too many students present	6 (24)
Hand washing facility in a school	No	14 (10)
	Yes	126 (90)
Number of hand washing facilities	One	2 (1.4)
	Two	8 (5.7)
	Three	40 (28.6)
	Four	76 (54.3)
No. of times you wash your hands	2 times	29 (20.7)
	3 times	38 (27.1)
	4 times	59 (42.1)
Moments hand washing is needed	Before & after eating only	29 (20.7)
	After playing only	38 (27.1)
	Critical moments***	59 (42.1)

****Before, during, and after preparing food, before eating food, before and after caring for someone who is sick, before and after treating a cut or wound, after using the toilet, after changing diapers or cleaning up a child who has used the toilet, after blowing your nose, coughing, or sneezing, after touching an animal, after touching garbage*

Physicochemical Quality of the Water Used in Schools

The physicochemical and microbial quality of the water used in the schools under the school feeding programme in Mampong Municipal were carefully sampled and analyzed to determine how these could impact on the health of the pupils and the success of the school feeding. The results of these laboratory studies are presented in Table 4.

pH

The pH of pure water is referred to as the measure of hydrogen ions concentration in water which ranged from 0 to 14. In general, water with a pH of 7 is considered neutral while pH lower than 7 is referred to as acidic and a pH greater than 7 known as basic. The lowest and highest pH were recorded in Nyinampong and Assam (5.02±1.59 and 6.23±0.25 respectively (Table 4). According to WHO standards, the pH of the water should be 6.5 to 8.5. This implied that all the water samples taken from the selected schools were acidic showing pH value below the permissible limit (6.5 - 8.5). Mohsin et al (2013) noticed that low pH in water from Bahawalpur City tends to be toxic and with a high degree of pH it turned into the bitter taste. Basically, the low pH might be due to the amount of dissolved carbon dioxide (CO2), which forms carbonic acid in water (Edimeh et al. 2011). Water with low pH has the potential to dissolve ions from its metal containers especially cooking bowls made from aluminum which are the common types used for cooking in Ghana (Jabeen et al. 2016).

Turbidity

Turbidity is important in determining the quality of drinking water as it can create a Conducive environment for microbes to escape the disinfection process (Soros et al. 2019). The turbidity of the water samples ranged from 0.11±0.95 - 1.84±0.16 NTU, although the ideal limit of turbidity is 1 NTU, the maximum desirable limit set by WHO is 5 NTU.

Therefore the turbidity of water from the sampled schools was within acceptable limits.

Electrical conductivity (µS/cm)

The amount of dissolved solids in water determines the electrical conductivity. An increase in ion concentration increases the electrical conductivity of water. High conductivity also means an increase in salinity. Electrical conductivity (EC) actually measures the ionic process of a solution that enables it to transmit current. According to WHO standards, the EC value of drinking water should not exceed 400 µS/cm (Rakib *et al.*, 2020). However, the conductivity of all the drinking water samples collected from the schools ranged from 54.97±3.06 – 376.87±91.2, which indicated the presence of some ionic solutions in water but were good for drinking.

Total dissolved solids (TDS) (mg/l)

Water is able to dissolve a wide range of inorganic and some organic minerals or salts such as potassium, calcium, sodium, bicarbonates, chlorides, magnesium, sulfates, etc from its environment. These dissolved minerals can produce un-wanted taste, odour and color in water. This is an important parameter for the use of water. The average value of TDS in the water samples of the selected schools ranged from 19.67±2.59 - 204.47±36.10 mg/L (Table 4). WHO desirable limit is 500mg/l whilst the maximum permissible level is 2000 mg/l (Jothiavenkatachalam *et al.,* 2010). TDS values observed in water samples from the schools were within the desirable limit. These findings were similar to the results of studies conducted by Salifu et al. (2015) and Sebiawu et al. (2014) which found average TDS of groundwater for drinking from Upper West and Northern regions to be 200 mg/l.TDS in water may be associated with concentrated wastewater from both residential and rainfall-runoff. Drinking water with a high TDS level above the EPA standard causes undesirable taste and gastrointestinal irritation (Patil *et al.*, 2012).

Total hardness (mg/l)

It is not caused by a single substance but by a variety of dissolved polyvalent metallic ions, predominantly calcium and magnesium cations. Hard water is characterized by high mineral contents that are usually not harmful to humans. It is often measured as calcium carbonate ($CaCO_3$) because it consists mainly of calcium and carbonates the most dissolved ions in hard water. In the study areas, the hardness of the water sampled ranged from 9.45±3.44 to 180±118.23 mg/l (Table4). Any water which contains calcium carbonate at concentrations below 60 mg/l is described as soft; 60–120 mg/l, is moderately hard; 120–180 mg/l, is hard; and more than 180 mg/l, is very hard (McGowan, 2000). According to World Health Organization (WHO), the total hardness of drinking water should be 500 mg/l and the results clearly indicate that total hardness of water samples from the schools was within the WHO standards and therefore suggesting that it is not harmful for consumption by the students.

Temperature (^{o}C)

The temperature of the water samples ranged from 29.33±0.58 °C to 31.67±0.58 °C (Table 4). A rise in temperature of water leads to an increase in chemical reactions in water, reducing the solubility of gases, especially, oxygen which affects its taste and odour (Kale, 2016). There is no specific guideline on drinking water temperature but it is noted that increasing temperatures above room temperature makes it increasingly unpleasant to consumers and encourages microbial growth (Rhoads, *et al.,* 2015; WHO, 2009). According to the American College of Sports Medicine, water, and other drinks should be between 10 and 22.2^{o}C for optimal hydration (Meyer *et al.,* 2019). Though the drinking water used by the schools had comparatively higher temperatures, by the standards of American College of Sports Medicine, it could not be said to be bad since ambient temperature in the tropical environment dictates that, provided there is no microbial growth.

Table 4: Physico-chemical parameters of drinking water samples of schools in Mampong

Town	Parameter					
	pH	**Turbidity (NTU)**	**Conductivity (µS/cm)**	**Total Dissolved Solids (mg/l)**	**Total Hardness (mg/l)**	**Temperature (^{0}C)**
Kyirimfaso	5.31±1.60	1.84±0.16	101.19±4.46	35.84±3.26	9.45±3.44	30.33±1.15
Nyinampong	5.02±1.59	0.93±0.56	253.25±8.98	19.67±2.59	180.87±118.23	31.67±0.58
PSK	5.44±1.48	1.69±0.97	376.87±91.2	204.47±36.10	12.67±1.15	29.33±1.15
Krobo	5.68±0.45	1.71±0.18	172.47±2.51	30.45±0.97	10.73±0.70	30.50±0.87
Ninting	5.47±0.30	0.48±0.11	54.97±3.06	36.02±1.42	23.27±0.61	29.33±1.15
Bosofour	5.39±0.42	0.11±0.95	55.12±18.74	34.65±4.60	20.87±5.67	29.67±0.58
Assam	6.23±0.25	1.33±0.83	76.63±1.52	42.69±2.73	28.20±3.65	31.00±1.72
Mampong	5.89±0.3	1.17±0.28	197.50±6.10	88.28±1.21	47.60±3.03	31.00±1.00
Kofiase	5.47±0.59	0.26±0.08	55.92±24.96	27.38±12.10	26.00±11.91	29.33±0.58
Benim	6.18±0.32	1.49±0.17	73.38±2.62	37.11±1.24	21.93±3.06	31.00±1.72
WHO Guideline	**6.5 – 8.5**	**1 – 5**		**500 – 2000**	**500**	**-**

Microbial Quality of Water Used in Schools.

The microbial parameters of water were based on Total coliform and faecal coliform. Results from the study on the presence of Total coliform in the drinking water ranged from nil to 37.67±19.66 cfu/100ml. Water samples taken from 7(70%) of the towns in the study area had Total coliforms ranging from 0.67±0.58 cfu/100ml to 37.67±19.66 cfu/100ml which exceeded the maximum permissible load (0/100 cfu/ml) for drinking water (Table 5).The presence of total coliforms in water indicates inadequate treatment or contamination from the ambient environment and is associated with gastrointestinal diseases (Shafqat *et al.*, 2018).The study confirmed the presence of faecal coliforms in most of the water samples tested. Faecal coliform counts in water from all sources ranged from 4.33±4.51cfu/100 ml– 11.67±7.64 cfu/100 ml. The results suggested that the quality of the water as indicated were not good because for water to be considered to have no risk to human health, the faecal coliforms counts/100 ml and total coliform counts/100 ml should be zero (Tesfaye, 2015). This standard has also been prescribed by the Ghana Standard Authority (GSA) and WHO standards. Although total coliform might not always be directly related to the presence of faecal contamination or pathogens in the drinking water, this study found that most of the water samples contained both total coliform and faecal coliform. Most of the water samples were not wholesome for drinking by the school children. Continuous drinking of water from such sources could affect the health of the students and derail the gains of the school feeding program.

Table 5: Microbial analysis of drinking water samples of schools

Towns	Parameter	
	Total Coliform (Cfu/100ml)	**Fecal coliform cfu/100ml**
Kyirimfaso	13.67±11.02	11.67±7.64
Mampong	NIL	NIL
Krobo	15.00±3.0 0	NIL
Ninting	4.00±4.58	4.57±2.52
Kofiase	8.33±7.64	2.67±2.52
Assam	20.00±7.00	4.33±4.51
Nyinampong	0.67±0.58	NIL
Bosofour	NIL	NIL
PSK	NIL	NIL
Benim	37.67±19.66	4.00±2.00
WHO Guideline	NIL	NIL

CONCLUSION

A number of schools in the study area did not have hand washing facilities to make them wash their hands and even where present, the facilities were not adequate for those who had it. Therefore their hand washing practices were affected by the inadequate availability of facilities, and their knowledge of hand washing. Some schools in the study areas had the challenge of shortage of water which could affect the feeding and the health of the school children. The pH of the drinking water types in the schools studied was too low as compared to the standards recommended by WHO and EPA, which could affect the quality of the water used for preparing the food and health of the children. The microbial quality of the water used in most of the schools did not meet the international microbial water quality standards and could be a recipe for health implications for the pupils.

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Conflict of Interest

The author declares no conflict of interest.

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