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RESEARCH ARTICLE

ANALYSIS OF PHYSICOHEMICAL PARAMETERS AND PREVALENCE OF ENTAMOEBA HISTOLYTICA IN WATER DRAWN FROM CAST AND NON-CAST WELLS IN ZARIA, NIGERIA

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Abstract

The availability and accessibility of drinking water is important for the development of any community. Lack of access to safe drinking water eludes millions of people every day. As a result, waterborne diseases have become a serious threat throughout the world, especially in developing countries with poor conditions of public health. This study was designed to assess the physicochemical and parasitological quality of well water samples obtained from Zaria communities and to compare the level of contamination between wells with internal wall casting (cast wells) and wells without internal wall casting (non-cast wells). A total of 142 wells (53, 44 and 45 wells from Samaru, Sabon-gari and Tudun wada respectively from both cast and non-cast wells) were collected for a period of six months encompassing both rainy and dry seasons (July to September for rainy season and November to January for dry season). Water samples from these wells were collected and analyzed for temperature, pH, electrical conductivity (EC) and total dissolved solids (TDS), and for the presence of cysts of Entamoeba histolytica. Temperature and pH had values that were within the normal ranges of 20^0C-32^0C and 6.5-8.5 respectively. EC and TDS had values beyond the acceptable limits of 180-500μS/cm and 300-500mg/L respectively. An overall prevalence of 27.5% was recorded for Entamoeba histolytica cysts in the study area and the parasite cysts were higher in cast wells (30.5%) than in non-cast wells (23.3%). The presence of Entamoeba histolytica in these wells is of public health significance considering its implications in gastrointestinal diseases, and suggests that water obtained from these wells are not suitable for domestic purposes without adequate treatment.

Introduction:-

Water is extremely essential for the growth and survival of all living things including man. The provision of adequate supply of clean and safe drinking water is vital for human health and can reduce the burden of common illnesses, such as diarrheal disease, especially in young children (Edokpayi et al., 2018 ; Desalegn et al., 2014). The

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demand for water has always been driven by population pressure (Okolo et al., 2018). It is estimated that a minimum of 7.5 liters of water is required for individual consumption, personal hygiene and food preparation. Hence; a safe, affordable, reliable and easily accessible, quality water supply is crucial for household activities, good health and agriculture. Compounding the water challenge is climate change which affects not only the water availability but also quality, demand and use (Mouratiadou et al. 2016; Okolo et al., 2018) with diverse implications beyond the water sector alone.

Nigeria is one of the countries in the world that have unsafe water supplies especially in rural communities. About 90 million people in Nigeria do not have access to safe drinking water and about 130,000 children under the age of five die every year from preventable waterborne diseases. Therefore lack of access to safe water supply is a serious threat to the country (Adeyinka et al., 2014). In rural communities, water for human consumption and domestic uses is primarily obtained from shallow (hand dug) wells and this constitutes the major source of ground water; other available sources are from rivers, streams, lakes, ponds and rainfall. Faecal contamination is the main source of contamination of these water sources due to unhygienic human practices such as open field defaecation, animal waste and seepage from septic systems (Hammuel et al., 2014).

Groundwater provides potable water to an estimated 1.5 billion people worldwide on a daily basis (Palamuleni and Akoth, 2015). Groundwater quality varies from place to place, sometimes depending on seasonal changes (Vaishali, and Punita, 2013), the types of soils, rocks and surfaces through which it moves (Seth and Tagbor, 2014). Generally, groundwater is considered to be cleaner and safer than surface water because it is less susceptible to microbial contamination due to the lengthy time of their travel in subsurface environment, and the soils and rocks through which groundwater flows screens out microorganisms, especially bacteria and protozoa (Aboh et al., 2015). However, in recent years, an increasing threat to groundwater quality has become of great concern as microbial and chemical contaminants have been detected in groundwater. (Shittu et al., 2008; Adefemi and Awokunmi, 2010; Apampa et al., 2017). These contaminants are mostly derived from watershed erosion as well as drainage from sewage, swamps, or soil with high humus content due to lack of compliance to standard guidelines guiding groundwater exploration or well construction (Eduvie et al.,2003; Aboh et al., 2015)

Waterborne gastrointestinal parasites such as Cryptosporidium parvum, Giardia lamblia and Entamoeba histolytica are frequently associated with morbidity, particularly in children. Worldwide, these parasites are the common cause of waterborne infections. Outbreaks of these infections have been associated with faecal contamination (Bilal et al., 2003; Desalegn et al., 2014).

In the absence of regular fresh water supplies, people residing in Zaria communities rely on groundwater from hand dug wells for their domestic and drinking purposes. Some of these wells are usually lined with hand-laid stones, or concrete blocks or pre-cast concrete sections. Modern wells are lined with pre-cast concrete rings. It is therefore necessary that these wells should be routinely checked to ensure the safety of water obtained from them.

Materials And Methods:-

Study Area:

The study was conducted in Zaria. Zaria is a major city in Kaduna state in Northern Nigeria and is home to the popular Ahmadu Bello University. It was one of the original seven Hausa city-states, formally known as Zazzau. It occupies an area of about 300Km^2 at latitude 11^0 07’ 51’’N and longitude 7^0 43’ 43’’E with a population of 408198 according to the 2006 census. Water samples were collected from three locations namely; Samaru, Sabon-gari and Tudun wada

Sample Collections:

A total of 142 wells (53, 44 and 45 wells from Samaru, Sabon-gari and Tudun wada respectively from both cast and non-cast wells) were collected for a period of six months encompassing both rainy and dry seasons (July to September for rainy season and November to January for dry season).

Table 1:- Distribution of samples across the sampling locations.

Sampling location	Number of cast wells	Number of non-cast wells
Samaru	30	23
Sabon-gari	20	24

Tudun wada	12	27
total	**68**	**74**

Well water samples were collected in clean 100 ml capacity bottles and transported to the Department of chemistry, A.B.U, Zaria for physicochemical analyses. But temperature and pH were taken at the point of sampling. Similarly, water samples were collected using 10 liters graduated Gerry cans and transported to the Department of Microbiology, A.B.U, Zaria for examination of parasites. The Gerry cans were disinfected with sodium hypochloride as the cysts of Entamoeba histolytica are resistant to chlorination. All samples were collected during the early hours of the day (between 8am and 10am) and analysed not later than 6hrs from the time of collection (APHA, 1992).

Physicochemical Analyses:
The major water quality parameters assayed in this study were temperature, pH electrical conductivity (EC) and total dissolved solids (TDS).

Temperature Measurement:
The temperature was measured using a digital thermometer (HANA Model). The meter was switched on and allowed to warm for 15mins. The electrode attached to the meter was introduced into the water sample and measurement was taken after a stable reading was obtained.

pH Measurement:
The pH was measured using a digital pH meter (HANA Model). The meter was switched on and allowed to warm for 15mins. The electrode attached to the meter was introduced into the water sample and measurement was taken after a stable reading was obtained.

Conductivity Measurement:
Conductivity of the water sample was measured using a digital conductivity meter thermometer (HANA Model). The meter was switched on and allowed to warm for 15mins. This was then standardized with 0.01M KCl. The electrode attached to the meter was immersed into the water sample and measurement was taken after a stable reading was obtained.

Total Dissolved Solids:
The programme menu of conductivity meter used above was switched to total dissolved solids and the result for total dissolved solids was displayed and reading was taken.

Parasitological Analysis:
Membrane filtration technique was used to filter the sampled volume (10 L) of water through 0.4µm membrane filter paper at a flow rate of 3litres per minute following the method described by Medema, 1992 and Bishop and Inabo, 2015. Particulate retained from the membrane filter paper was washed in 50mls sterile distilled water. The parasites cysts were then concentrated by centrifugation at 300rev/min for 2mins. The supernatant was discarded and a wet mount preparation of the residue was made and examined under the microscope using x10 and x40 objectives. A drop of lugol's iodine was used to create a good background to view the cysts. The parasite cyst was identified using colour atlas of parasitology (Parija and Prabhakar, 1995; Sullivan, 2000)

Results:-

Physicochemical Parameters:
The mean values of the physicochemical parameters in cast and non-cast wells are presented in tables 2 and 3. Temperature ranges between 24.9^{0}C and 26.4^{0}C with a narrow range of 1.5^{0}C. The pH of the water samples ranges between 6.9 and 8.5. The highest conductivity (1201 µS/cm) was observed during the rainy season in Tudun wada while the lowest (786 µC/cm) was observed also during the rainy season in Sabon-gari. TDS also had a range of 146 mg/l.

Table 4 shows the comparison of the mean values of the physicochemical parameters of the well water samples drawn from the three sampling locations. Conductivity was higher in Tudun wada (1119 µS/cm) compared to Samaru (847µS/cm) and Sabon-gari (797 µS/cm), and the difference was statistically significant ($P = 0.03$). There were no significant differences with the other parameters between the locations ($P > 0.05$).

Table 5 presents the analysis of variance of the mean values of the physicochemical parameters of the well water samples drawn during the rainy and dry season. The parameters were not affected by seasonal influence (P > 0.05). There were also no significant differences in the physicochemical parameters of the water samples between wells with internal wall casting and wells without internal wall casting as shown in table 6. This could mean that internal wall casting does not have a direct impact of the physicochemical quality of water (P > 0.05).

Table 2:- Mean values of physicochemical parameters in cast and non-cast wells during the rainy season (mean ± standard error of mean).

Parameters/location		Samaru	Sabon-gari	Tudun wada
Temperature(^{0}C)	**Cast**	26.1 ± 0.271	25.4 ± 0.275	25.7 ± 0.317
	Non-cast	26.3 ± 0.403	25.5 ± 0.388	26.0 ± 0.392
PH	**Cast**	6.9 ± 0.119	7.1 ± 0.157	7.1 ± 0.130
	Non-cast	6.8 ± 0.153	7.0 ± 0.181	6.9 ± 0.174
Electrical Conductivity (µS/cm)	**Cast**	835 ± 52. 39	799 ± 46.50	1186 ± 72.59
	Non-cast	796 ± 77.95	786 ± 63.42	1201 ± 87.50
Total Dissolved Solids(mg/l)	**Cast**	551 ± 50.86	616 ± 87.45	646 ± 59.07
	Non-cast	540 ± 78.14	600 ± 87.45	604 ± 74.45

Table 3:- Mean values of physicochemical parameters in cast and non-cast wells during the dry season (mean ± standard error of mean).

Parameter/location		Samaru	Sabon-gari	Tudun wada
Temperature (^{0}C)	**Cast**	25.8 ± 0.194	24.9 ± 0.557	25.7 ± 0.189
	Non-cast	26.0 ± 0.243	26.4 ± 0.236	25.8 ± 0.209
PH	**Cast**	7.2 ± 0.085	8.2 ± 1. 142	6.9 ± 0.851
	Non-cast	7.0 ± 0.103	8.5 ± 1.476	6.8 ± 0.946
Electrical Conductivity (µS/cm)	**Cast**	892 ± 42.06	801 ± 51.90	1023 ± 51.78
	Non-cast	863 ± 46.50	803 ± 51.90	1066 ± 58.88
Total Dissolved Solids(mg/l)	**Cast**	554 ± 38. 01	577 ± 48.74	557 ± 34.08
	Non-cast	576 ± 43.90	576 ± 43.29	580 ± 41. 10

Table 4:- Comparisons of the mean values of the physicochemical parameters of the well water samples drawn from the three sampling locations (mean ± standard error of mean).

Parameter/location	Samaru	Sabon-gari	Tudun wada	P-Value
Temperature(^{0}C)	26.1 ± 0.265	25.6 ± 0.390	25.8 ± 0.184	0.10ns

PH	7.0 ± 0.132	7.7 ± 0.651	6.9 ± 0.855	0.40ns
Electrical Conductivity (µS/cm)	847 ± 31.00[b]	797 ± 44.75[b]	1119 ± 74.50[a]	**0.03s**
Total dissolved solids (mg/l)	555 ± 39.75	592 ± 59.75	596 ± 61.28	0.38ns

Table 5:- Comparisons of the mean values of the physicochemical parameters of the well water samples drawn during the rainy and dry season (mean ± standard error of mean).

Parameter/season	Dry season	Rainy season	P-Value
Temperature(^{0}C)	25.83 ±0.22	25.77 ± 0.07	0.81ns
PH	6.70 ± 0.06	7.43 ± 0.46	0.38ns
Electrical Conductivity (µS/cm)	933 ± 31.60	908 ± 49.36	0.87ns
Total Dissolved Solids(mg/l)	593 ± 24.17	570 ± 33.34	0.40ns

Table 6:- Comparisons of the mean values of the physicochemical parameters of the well water samples drawn from cast and non-cast wells (mean ± standard error of mean).

Parameter/season	Cast	Non-cast	P-Value
Temperature(^{0}C)	25.24 ±0.39	25.76 ± 0.16	0.20ns
PH	6.90 ± 0.09	7.63 ± 0.68	0.31ns
Electrical Conductivity (µS/cm)	905 ± 37.68	905 ± 39.36	0.99ns
Total Dissolved Solids(mg/l)	565 ± 33.32	558 ± 29.75	0.88ns

The results on the prevalence of Entamoeba histolytica in the well water samples collected during the rainy and dry seasons are presented in Table 7. An overall prevalence rate of 27.5% was recorded in the sampling area (Zaria). The highest prevalence of 34.1% was recorded in Sabon-gari while the lowest prevalence of 24.4% was recorded in Tudun wada. Prevalence rate of 33.3% and 21.4% was recorded during the rainy and dry season respectively.

The percentage occurrence of the parasite in well water samples drawn from cast and non-cast wells in Zaria are presented in Table 8. Prevalence rates of 33.8% and 21.6% were recorded in cast and non-cast wells respectively. Table 9 shows the effect of internal wall casting on the occurrence of Entamoeba histolytica in the well water. There was a statistical between cast and non-cast wells.

Table 7:- Prevalence of Entamoeba histolytica in the well water samples during the rainy and dry seasons.

Location	Number of samples		Number of positive samples (%)		Total
	R	D	R (%)	D (%)	
Samaru	28	25	7 (25.0)	6 (24.0)	13 (24.5)
Sabon-gari	24	20	12 (50.0)	3 (15.0)	15 (34.1)
Tudun wada	20	25	5 (25.0)	6 (24.0)	11 (24.4)

Total	72	70	24 (33.3)	15 (21.4)	39 (27.5)

Key; R – Rainy season
D – Dry season

Table 8:- Occurrence of Entamoeba histolytica in the well water samples drawn from cast and non-cast wells.

Location	Number of samples		Number of positive samples (%)		Total
	Cast	Non-cast	Cast (%)	Non-cast (%)	
Samaru	30	23	9 (30.0)	4 (17.4)	13 (24.5)
Sabon-gari	20	24	7 (35.0)	7 (29.2)	14 (31.8)
Tudun wada	18	27	7 (38.9)	5 (18.5)	12 (26.7)
Total	68	74	23 (33.8)	16 (21.6)	39 (27.

Table 9:- Effect of internal wall casting on the occurrence of Entamoeba histolytica in the well water samples from Zaria.

Occurrence of parasite	Cast	Non-cast	P-value
Absence	45 (66.2)	58 (78.4)	
Present	23 (33.8)	16 (21.6)	0.031s

Discussions:-

The observed temperature in the study falls within the normal range of 20-32^{0}C (WHO, 2011) that allows the survival and proliferation of most microorganisms in water. There is no health impact regarding temperature values in water (Nigeria Industrial Standard (NIS), 2007).

The pH is an important parameter in evaluating the acid-base balance of water. It is also an indicator of acidic or alkaline condition of water status. The pH of the water samples were within the normal range of 6.5 – 8.5 (WHO, 2011). The pH of water is generally affected by the geology of the area and the buffering capacity of water. Exposure to extreme pH can affect the health of consumers of the water and its disinfection (Akaahan et al., 2010). With effective disinfection with chlorine, the pH should be preferably less than 8 (WHO, 2003).

Electrical conductivity had values beyond the acceptable limit of 180-500μS/cm (WHO, 2009). This may be due to the dissolution of some earth metal materials by infiltration. Total Dissolved Solids (TDS) also showed higher values above the desirable limit. TDS in water supplies can originate from natural sources, sewage, urban and industrial wastes. Although there is no recent data on health effects associated with the ingestion of TDS in water, however, high TDS in water can affect the taste of the water (WHO, 2011).

Analyses of variances on the data obtained shows there were no significant differences in the physicochemical parameters of the well water samples drawn during the rainy and dry season. The parameters were not affected by seasonal influence. There were also no significant differences in the physicochemical parameters of the water samples between wells with internal wall casting and wells without internal wall casting as shown in table 6. This could mean that internal wall casting does not have a direct impact of the physicochemical quality of water.

Parasitic contamination of groundwater has always been of great importance to public health especially in rural communities. The presence of Entamoeba histolytica in drinking water presents serious risk of disease (Muhammad et al., 2010). Entamoeba histolytica has been detected in ponds, dams, wells, taps and boreholes in Dutsin-ma Local Government Area, Katsina State, Nigeria (Abdullahi et at, 2018). In the present study the prevalence of cysts of

Entamoeba histolytica varied between location and well casting. The prevalence rate was higher in Sabon-gari (31.8%). This could be because most of the wells sampled were public wells, not properly covered (some without cover) which allowed contaminated surface water to drain into the wells. Also, because it is a high commercial area, during daily operations, reasonable quantities of different wastes are dumped on fresh waterways consistently. This could lead to occasional minor flooding and/or contamination of the water sources. There was also higher prevalence during the rainy season (33.3%). This may be due to high level of surface runoff and infiltration. The implication of this finding is that this pathogen may pose serious hazard to the health of consumers of the water directly without any treatment.

The overall contamination rate of 27.5% was recorded in the study area. This was lower than that of 72.9% reported by Bishop and Inabo in 2015 and higher than that of 19.9% reported by Yousefi et al., 2009. Higher parasite prevalence (30.5%) was observed in wells with internal wall casting than in well without internal wall casting (23.3%). Bishop and Inabo, (2015) also reported a higher parasite prevalence in wells with internal wall casting (48.7%) than in well without internal wall casting (25.8%). The casting of the internal walls of wells may provide a structural attachement sites for parasites, their eggs and cysts. Also, some components of the materials used in casting may support the growth of the parasites. However, there is no evidenced data to support this claim; therefore, there is a need for further research.

Conclusion:-

All the samples had temperature and pH values within the range that allows the survival and growth of microorganisms in water. But most of the samples had EC and TDS exceeding the acceptable limit.

The presence of cysts of Entamoeba histolytica in hand dug wells in some parts of Zaria communities is of great concern. This is indicative of improper well construction, maintenance and poor sanitation and hygiene practices. The wells fail to meet the standard for safe water and are therefore not safe for domestic purposes especially for drinking purpose.

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