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Comparing the Parasitological Quality of Water Used in Low and High Level Restaurants in an Urban Setting in Nigeria

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Abstract:

This study aimed at comparing the parasitological status of water used by some restaurants in Owerri metropolis, Imo State from May, 2019 to February, 2020. Seventy one water samples collected across the vending types (high level and low level restaurants) were evaluated for parasite contamination using standard methods. Data obtained was statistically analyzed with p-value set at 0.05 significance level. The result showed that 14.70% (5) of the samples from high-level restaurants were contaminated. Eleven (29.73%) of the 37 samples from low-level restaurants were contaminated with parasites. Statistical analysis showed the prevalence of contaminated water samples from the 2 vending types was significantly different ($p < 0.05$). The result revealed that 11 (36.36%) of the 30 sampling sites used contaminated water with high-level restaurants recording the lower prevalence. The selected sites showed no significant difference in the occurrence of contaminated water ($p > 0.05$). Three parasites were isolated from 18 (25.35%) of 71 water samples from the two vending types. The parasites identified were *Cryptosporidium* oocyst with an occurrence rate of 8.85% (6), *Giardia* spp.,8 (11.25%), and *Entamoeba* spp., 5(5.64%). Statistical analysis showed that the species-specific prevalence was not statistically significant ($p>0.05$). The overall concentration of parasites in the study was 2.00 oocyst/cyst in 100ml of water. Furthermore, low-level restaurants recorded non-significant higher parasite prevalence of 32.86% with a concentration of 1.8 oocyst/cyst per 100ml of water, as against 31.00% with a concentration of 2.4 oocyst/cyst per 100ml of water observed in high-level restaurants ($p > 0.05$). The findings therefore suggest that parasitic organisms are maintained by a viable ecosystem which thrive in the restaurants and exposes customers to a cycle of endless parasitism. There is need for government and restaurant management to provide safe water supply while maintaining and enforcing sound hygiene and safety measures.

Keywords: *water, parasitological quality, restaurants, Owerri.*

Introduction

The importance of water and food to human existence cannot be over-emphasized. Restaurants have become an important aspect of the food distribution chain in several poor economies, including Nigeria. Restaurants prepare ready-to-eat foods sold in public locations and maintain different safety and hygienic standard. Vendors frequently use surface water, dug wells, boreholes, or standpipes connected to piped water supply as sources (Hutin *et al.,*2003). A survey by Oyeneho and Hedberg, (2013) revealed that fifty-nine percent of the restaurants in a survey population got their water from private bore holes while 41% depended on the city water supply for their water needs. Several of the eateries also prepared their dishes with water drawn from wells. However, it was unknown whether this water had been treated before being used. It is important that water supplied to consumers is suitable for drinking and complies with local and international standards of taste, odour and appearance.

Water-borne parasitic infections are considered a threat and of public health importance, especially in developing countries (Oyedeji, Olutiola, & Mononuola, 2010). Water is responsible for around eighty percent of diseases in humans, as estimated by the United Nations Organization (UN, 2003). The food and water quality sold by food vendors has a direct effect on an individual's and the population's health.

Water quality problems and massive contamination remain unsolved leading to transmission of various water-borne diseases. Protozoan pathogens associated with water contamination include *Acanthamoeba* spp, *Entamoeba histolytica*, *Cryptosporidium*, *Balantidium coli*, *Blastocystis* spp, *Cyclospora cayetanensis*, *Giardia* spp, *Isospora belli*, *Microsporidia*, *Naegleria fowleri* and *Toxoplasma gondi* (WHO, 2011). The control of the water-borne transmission presents real challenges, because a substantial number of pathogens produce cysts, oocysts or eggs that are extremely resistant to processes generally engaged in the disinfection of water sources and in certain instances can be difficult to remove by filtration processes.

There is increased interest worldwide on the significance of restaurant food as part of a general concern for food security and health. Hence, assurance of public health through the accessibility of safe water and food is an absolute requirement. Water that is safe and readily available is essential for public health, whether it is used for drinking, cooking or recreational activities. Water quality and its impact on products and processes are commonly disregarded in food preparation and handling. The quality of water used in producing and processing food determines the quality and safety of the food. Therefore, there is a need for continuous research on water quality and sanitation which brought about the isolation and determination of rate of parasitic contamination of different water sources used by low- and high-level restaurants in the study area. Research of such will provide information on the status of water sources in an environment which will help to reduce the risk of water-borne infections and diseases.

Study Area

Owerri town of Imo State, located in the South-East geopolitical zone of Nigeria, lies within longitude 5°29'06"N and latitude 7°02'06"E occupying an area between the lower River Niger and the upper and middle Imo River (Government of Imo State, 2006). The Nigeria census in 2006 recorded 3.93 million (2.03 million males and 1.9 million females) as the population of Imo State and the populace is made up of mainly the Igbo ethnic group. The State has a population density of about 707.9 per square kilometer and occupies an area of 5289.49 square kilometers (Government of Imo State, 2006). The major sources of water in Owerri are sub-surface water (Nworie and Otamiri Rivers), and numerous private / commercial bore holes that litter the town.

Methodology

The study was conducted among restaurants food vendors in Owerri town for ten months (May 2019- February 2021). In this study, restaurants are classified according to food pricing, menu styling, and service and randomly selected for the study; High-level restaurant's food price is high, the menu comprises a variety of food items; different meal packages are offered including a buffet system where a minimum of 30 food items is captured in the menu. Each table or customer is assigned a well-dressed uniformed steward to offer service.

In low-level restaurants, fixed and limited items are cooked. Buffet facilities are not available; people come to eat regular meals and stewards are limited in number. Usually, the hygiene level is not strictly maintained as in high-level restaurants.

Major hotels, fast food restaurants, five-star restaurants were grouped as High-level restaurants; Mid-end restaurants, Food canteens, School and hospital cafeterias were grouped as Low-level restaurants.

Sample Collection

A total of 71 water samples (34 food preparation and 37 drinking water samples) were collected from 30 consenting food vending sites. Cumulatively, thirty four of the samples were from High-level restaurants, while 37 were from Low-level restaurants. Samples were collected from boreholes, public water supply, storage tanks, drinking water jugs and containers, satchet water and bottled water using standard procedures (Simon-Oke et al., 2020). The study noted water used for food preparation and drinking.

The samples were labelled with dates of collection, nature or source of water, the site of collection. Samples were conveyed to the laboratory of Department of Animal and Environmental Biology, Imo State University, Owerri, within three hours of collection in a light-proof insulated cold box containing ice packs for further analysis.

Parasitological Analysis

Parasitological analysis of water samples were carried out using techniques described by earlier studies (Pam *et al.*, 2018; Simon-Oke *et al.*, 2020). The parasites were properly identified by the morphological structures of their cysts, ova or larvae on microscopy as well as taxonomic keys according to Cheesbrough (2006).

Result

Table 1 reveals the prevalence of parasite contaminated water samples from water used for food preparation and drinking by the vending types. The result showed that 14.70% (5) of the samples from high-level restaurants were contaminated. Eleven (29.73%) of the 37 samples from low-level restaurants were contaminated with parasites. Statistical analysis showed the prevalence of contaminated water samples from the 2 vending types was significantly different ($p < 0.05$).

Table 1. Prevalence of Parasite Contaminated Water from Two Different Sources in the Vending Types

Type of vending	Water usage	Number of samples	Number of specific samples contaminated with parasites (%)	Total Number of samples for **A** contaminated with parasites N=64(%)	Total Number of samples for **B** contaminated with parasites N=66 (%)		p-value
Restaurant 1(R1)	**A.** Food preparation	17	5 (29.41)	10(15.62)	6 (9.09)	T-value is (0.0764 usage)	.942
	B. Drinking	17	0 (0.00)			□□□=17.02 (vending)	.0002
	Sub-total	34	5 (14.70)				
Restaurant 11 (R11)	**A.** Food preparation	17	5 (29.41)				
	B. Drinking	20	6 (30.00)				
	Sub-total	37	11 (29.73)				
	Total	71	16(22.53)				

Note: R1 = High level restaurants; R11 = Low level restaurants. **A**= Water for food preparation; **B**= Drinking water served to customers

Table 2. Prevalence of Parasite Contaminated Water Samples Based on Vending Sites

Type of Vending	Number of sites sampled	Number of sites with parasite contaminated water for food preparation(%)	Number of sites with parasite contaminated water for drinking (%)	Actual Number of sites with parasite contaminated water(%)		P-value
Restaurant 1 (R1)	16	5 (31.00)	0 (0.00)	5 (31.00)	Overall prevalence=0.15	0.92
Restaurant 11 (R11)	14	5 (35.71)	6 (32.65)	6 (32.86)	Different Usage= 4.33	0.11
Total	30	10 (33.33)	6 (20.00)	11 (36.36)		

Note: S= Street food vendors; R1 = High level restaurants; R11 = Low level restaurants

Overall, more water samples for food preparation, 10(15.62%) were contaminated than samples for drinking 6(9.09%). The result could not incriminate water usage as a significant determinant of the level of contamination of the water samples ($p > 0.05$).

Table 2 shows the proportion of 30 different vending sites from which contaminated water samples were collected. The result revealed that 11 (36.36%) of the 30 sampling sites used contaminated water, high-level restaurants recording the lower prevalence. The selected sites showed no significant difference in the occurrence of contaminated water ($p > 0.05$). Some of the sites had the two water usage types contaminated, while a fewer number had only one water usage type contaminated, however, contamination of water for different usages was not dependent on the type of vending practised.

The prevalence and concentration of parasite species across the three vending types are illustrated in Table 3. Three parasites were isolated from 18 (25.35%) of 71 water samples from the two vending types. The parasites identified were *Cryptosporidium* oocyst with an occurrence rate of 8.85% (6), *Giardia* spp.,8 (11.25%), and *Entamoeba* spp., 5(5.64%). Statistical analysis showed that the species-specific prevalence was not statistically significant ($p>0.05$), however, the proportion of *Giardia* spp *and Entamoeba* spp was significantly different ($p< 0.05$). The overall concentration of parasites in the study was 2.00 oocyst/cyst in 100ml of water. *Giardia* spp. recorded the highest concentration/mean oocyst per 100ml of water (2.40), while the least (2.23 cyst per 100ml) was observed with *Cryptosporidium. Entamoeba* spp., recorded a mean value of 2.23 oocyst per 100ml of water. However, the difference in the concentration of parasites was not significant, ($p> 0.05$).

Furthermore, low-level restaurants recorded higher parasite prevalence of 32.86% with a concentration of 1.8 oocyst/cyst per 100ml of water, while prevalence of 31.00% with a concentration of 2.4 oocyst/cyst per 100ml of water was observed in high-level restaurants. The result showed that the type of vending does not determine either the parasite species that contaminated the water or the concentration of parasite in the water, ($p> 0.05$).

Table 3 shows the concentration of parasite species isolated from water used for different purposes in the vending types. The concentration of the parasite species isolated from the water samples did not differ significantly based on water usage ($p>0.05$). The species recorded varying oocyst and cyst count, however, they were not determined by the type of water usage and were not statistically different ($p>0.05$).

Discussion

The parasitological investigation provided a clear indication of parasitic contamination of the water used for food preparation and drinking in the respective vending types. The prevalence of contamination varied between vending types and water usage.

Table 3. The concentration of parasite species isolated from water used for different purposes in the vending types

Type of Vending	Water usage	Number of samples	*Cryptosporidium* oocyst (C) Mean±SD	Number of samples	*Giardia* spp. (G) Mean±SD	Number of samples	*Entamoeba* Spp.(E) Mean±SD	Number of samples	*Cryptosporidium oocyst& Giardia* spp.(C&G) Mean±SD	Number of samples	*Entamoeba & Giardia* spp.(E&G) Mean±SD	Water usage *Mean±SD*	F-ratio/ p-value
Restaurant 1 (R1)	A. Food preparation	3	3.00±0.81	2	1.5±0.50	0	0	0	0	0	0	2.40±1.02	0.954/ .34
	B. Drinking	0	0	0	0	0	0±0.00	0	0	0	0	0±0.00	
Restaurant 11 (R11)	A. Food preparation	2	2.50±0.50	0	0	2	2.5±1.5	1	2	0	0	2.2±1.17	
	B. Drinking	0	0	4	2.00±0.70	1	1	0	0	1	3	2.00±0.816	
Species Oocyst/cyst mean ±SD		5	2.75 ±0.25	6	1.75±0.25	3	1.75±0.75	1	2.00±0.00	1	3.00±0.00		
F-ratio p-value	C&G C&E E&G 0.36426 .699719	1.16 .694			0.86 .816		0.30 .975						

Note: S= Street food vendors; R1 = High level restaurants; R11 = Low level restaurants. A= Water for food preparation; B= Drinking water served to customers.

The results showed that 16 (22.53%) of 71 water samples collected from 30 vending sites were contaminated with parasites. The result incriminated 11 (36.66%) of the vending sites, pointing to the problems of water management, lack of hygiene and possible faecal contamination from domestic animals and human excreta. The observed, moderate prevalence agrees with the observations and answers to the surveys, showing inadequate water treatment, sewage and waste disposal systems and poor hygienic practices. The non-significant difference in the prevalence of parasite contaminated water across the vending types and type of water usage could be attributed to the similar sources of water, safety and hygienic practices observed in the operations of the vending types during the survey.

The result of the parasitological survey showed that the water samples contained varying degrees of presence of three (3) intestinal parasites including *Giardia* spp, *Entamoeba* spp, *and Cryptosporidium.* This result is consistent with the report of Ani and Itiba (2015) who isolated *C. parvum, Giardia* spp*, and E. histolytica* during their study in different sources of drinking water in Abakaliki, Ebonyi State, Nigeria. Tanyuksel *et al.* (2001) acknowledged these three parasites to be the most common cause of infection globally. The result differs with the report of Anyanwu *et al.* (2018) which did not isolate *Cryptosporidium*, but found helminthic parasites, *Onchocerca volvulus, Taenia* specie*s and Trichuris trichura* and Ekwunife *et al.* (2010) which did not isolate *Cryptosporidium*, but found in addition *Ascaris lumbricoides* (5.6%), Hookworm and *Trichuris trichura.*

No helminth eggs were found in the water samples studied, which can be explained by a strong percentage of latrine presence that decreased anarchical defecations. This aligns with findings of studies by Ani and Itiba (2015) in Nigeria and Rafiei et al. (2014) in Iran but contrasts results obtained by Anyanwu et al.(2018) which detected both helminths and protozoa in samples. This variation may be due to the differences in water sources coupled with the fact that water is by a large degree not essential in the life cycle of most helminthic parasites. While it is likely that helminths could be present, they may have however remained undetected by the method employed in this study.

The most occurring parasite observed in this study was *Entamoeba* spp (12.31%), followed by *Cryptosporidium* (10.00%). The peak occurrence rate of *Entamoeba histolytica* (45.3%) has been recorded by Ani and Itiba (2015), while Ekwunife et al. (2010) and Anyanwu et al. (2018) observed a lower and non peak prevalence of 4.8% and 3.2% in studies of domestic water sources. *Entamoeba histolytica* is the principal aetiologic agent of human amoebiasis. The parasite poses a substantial threat to community health in under developed nations including Nigeria, and it is recognized as the second major cause of death from parasitic infections worldwide (Raza, 2013). Ihejirika et al. (2019) reported recent cases of the disease in Owerri.

Cryptosporidium is the second prominent parasite isolated, and it has been known to be an important water-borne disease causative agent associated with several gastrointestinal diseases in humans (Razzolini, da Silva Santos & Bastos, 2010). *Cryptosporidium* oocysts have been isolated in many drinking-water supplies. Oocysts can persist for weeks to months in water and are resistant to disinfection. In 2011, Dozie et al. (2011) reported a prevalence of 19.9% in Owerri. However, Iyaji et al. (2018) and Chollom et al. (2013) recorded 0% parasitic contamination in borehole water during their study in Heipang, a rural community in Plateau State, Nigeria. Generally, *Cryptosporidium* infection is self-limiting in the immunocompetent but deadly in immunocompromised people.

The least isolated parasite in this study *Giardia* spp (7.00%) is known to be resistant to disinfectants utilised in water treatment. Ani and Itiba (2015) and Anyanwu et al.(2018) observed higher prevalence of 34.4% and 12.5% respectively in their study on domestic water sources.

In the USA, *G. lamblia* is by far the main agent of water-borne gastroenteritis outbreaks (Barwick et al., 2000), and it is at times regarded as a causative agent of food-borne gastroenteritis (CDC, 1989). Incidence of giardiasis and prevalence is higher in places of deplorable sanitation, particularly in under-developed countries including Nigeria (Mintz et al., 1993).

The lack of variation and prevalence of parasites in relation to the selected study sites, vending types and water usage may possibly be due to the fact that the parasites are subject to similar weather conditions that supports their survival. Also, it can be closely linked to similar poor sanitary attitude of the vendors in the two vending types as stated earlier. The poor sanitary attitudes of the people who live near the water sources in the different sites could also be a contributory factor. This is in accordance with the finding of Gyang *et al.* (2017) who recorded no variation in the prevalence of parasites across selected sites in Lafia LGA of Nasarawa State.

The mean concentration of cysts (*Giardia* ,1-4/10ml and *Entamoeba*, 1-3/10ml) and oocysts (*Cryptosporidium,*1-3/10ml) detected in this study is of great importance concerning public health, considering that the ingestion of low doses of infective (oo)cysts may establish an infection in individuals with disabilities in the immune system or those suffering from malnutrition (DWAF, 1996; Chalmers & Davies, 2010) if they are found to be infectious to humans. The result did not reveal any significant difference in the parasites' concentration across the vending types and water usage. This portends equal transmissibility of the parasites across the variables considered.

The implications of these findings therefore suggest that parasitic organisms are maintained by a viable ecosystem which thrive in the restaurants. This thus exposes customers to a cycle of endless parasitism resulting in low productivity with attendant morbidity and mortality. Therefore, there is need for the government to reactivate the public water supply with complementary water treatment to help reduce the risk of water-borne infections. The carbon filtering systems employed by some households, satchet and bottled water companies in treatment of common water source (boreholes) have no capacity to remove *Cryptosporidium* and other resistant microbes. Public enlightenment programs and health education should be regularly organized to expose staff and management of restaurants and other food vendors to basic hygiene and sanitary practices necessary for food handling and preparation to ensure the safety and quality of their food.

Conclusion

Poor quality domestic water portends grave health consequences for the populace. Crucial safety issues that escalate the chances of outbreaks of water- and food-borne parasitic diseases originating from many of these restaurants were highlighted by this study. Government interventions in terms of the provision of portable water supply, routine inspection of restaurants prior to licensing to practice as well as organizing public enlightenment programs, training and health education workshops for food vendors will go a long way to mollify these health risks.

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