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HYDROPARASITOLOGICAL ASSESSMENT OF IKWU RIVER, UMUAHIA, SOUTHEAST NIGERIA

***ANYANWU, E. D.,[1] IROLE-EZE, O. P.,[2] ADETUNJI, O. G.[1] AND NNADI, O. F.[1]**
[1]Hydrobiology Unit, Department of Zoology and Environmental Biology, Michael Okpara University of Agriculture, Umudike, Nigeria
[2]Parasitology Unit, Department of Zoology and Environmental Biology, Michael Okpara University of Agriculture, Umudike, Nigeria
*Corresponding author: ekadon@yahoo.com

ABSTRACT

Water is important to human life and public health but most freshwater sources are being polluted through human activities globally. An important rural water source in southeast Nigeria was studied between January and June 2022 in 3 stations for parasitic contamination. Water samples were collected and analyzed using standard methods while parasitological samples were collected using grab and composite filtration methods and analyzed with sedimentation method. The results showed that out of the eleven (11) parameters evaluated, some values of pH, dissolved oxygen, biochemical oxygen demand and chemical oxygen demand did not conform to limits. Five (5) helminthes and protozoa parasites of human health importance were recorded. The overall prevalence was 33.33%. Grab method prevalence was 22.22% while composite filtration method was 44.44%. Strongyloides stercoralis was most prevalent (22.22%), Balantidium coli (16.67%) and Ascaris lumbricoides (2.78%), Fasciola gigantica (2.78%) and Entaemoeba histolytica (2.78%). Station 2 had the highest parasitic load (9) and station 3, the least (3). May 2022 had the highest number of parasites and none in April 2022. The prevalence was influenced by physicochemical parameters, sampling methods, human activities and season. In view of the high prevalence rate, the water needs to be treated before use and open defecation discouraged around the river.

KEYWORDS: *Water, Contamination, Waterborne parasite, Environment, Grab, Composite*

INTRODUCTION

The importance of water to human life and public health cannot be overemphasized, unfortunately a very large proportion of human population do not have access to good quality and quantity of water (Manetu and Karanja, 2021). Tran *et al*. (2016) reported that about 3 billion people will be in water-stressed environment: lacking access to freshwater by 2025. Consequently, water-borne diseases will continue to be on the increase globally. For fecal-oral parasites, water resources can bring together different hosts, infectious materials in small enclosures and create hotspots for diseases (Titcomb *et al*., 2021). Waterborne parasites are contracted directly or indirectly during human-water contact through consumption or skin exposure as they go about their normal water-related activities (Oryan and Alidadi, 2015; Barnes *et al*., 2021).

Human activities are closely associated with the water environment (Rutkowska *et al*., 2022) and water quality is dependent on the activities in the watershed (Manfrin *et al*., 2016; Camara *et al*., 2019). Such activities can result in degradation of water quality and lead to health problems (Gqomfa *et al*., 2022). Extreme water pollution can even contribute to the disappearance of aquatic biota (Yang *et al*., 2020) and parasites response to environmental perturbation can provide valuable information about ecosystem health (Sures *et al*., 2017). Grabner *et al*. (2023) reported that parasites can act as added biological stressor in an environment already under the influence of multiple-stressors, especially when pollutants and parasites are presented together.

Previous studies have shown that Ikwu River is an important water source; providing for a wide range of human needs (Anyanwu and Emeka, 2019; Anyanwu *et al*., 2022a). Anyanwu and Jerry (2017) also reported the prevalence of freshwater snails that are intermediate hosts to some water-borne parasites in the river. Hence, this study is aimed at assessing water-borne parasites in relation to physicochemical parameters of Ikwu River, Umuahia, Southeast Nigeria.

MATERIALS AND METHODS

Study Area

The study was carried out in Ikwu River, which is located in Umuire Community along Umuahia – Uzoakoli Road, Umuahia, South-east Nigeria within 5°34′11.988″ – 5°34′48.000″N and 7°28′44.400″ - 7°28′52.764″E (Figure 1). Ikwu River went through Umuire and Umuegwu Okpula communities and discharge into the Imo River Basin.

Accessibility and observed anthropogenic activities were the criteria used in the selection of the sampling stations. Station 1, located upstream on the right along Umuahia – Uzoakoli Road was the reference site. No activities were observed during the study except periodic signs of cattle watering. Station 2 was located by the left side of Umuahia – Uzoakoli Road, 350m downstream of Station 1. Human activities were intense upstream of Station 2 - bathing, washing of cars, motorcycles and tricycles, children swimming, abstraction of drinking water, washing of fruits and vegetables by market women. Minimal sand mining and open defecation were also observed. Station 3, located within Umuire community is a major source of water for most domestic activities. It is about 430m downstream of Station 2. Human activities include abstraction of drinking water, washing of clothes, bathing, swimming and minimal sand mining. Solid wastes are disposed on the bank of the river and stormwater from the community discharge into the river during rainfall events. Open defection was very common around the river even though it is their major source of water for most activities.

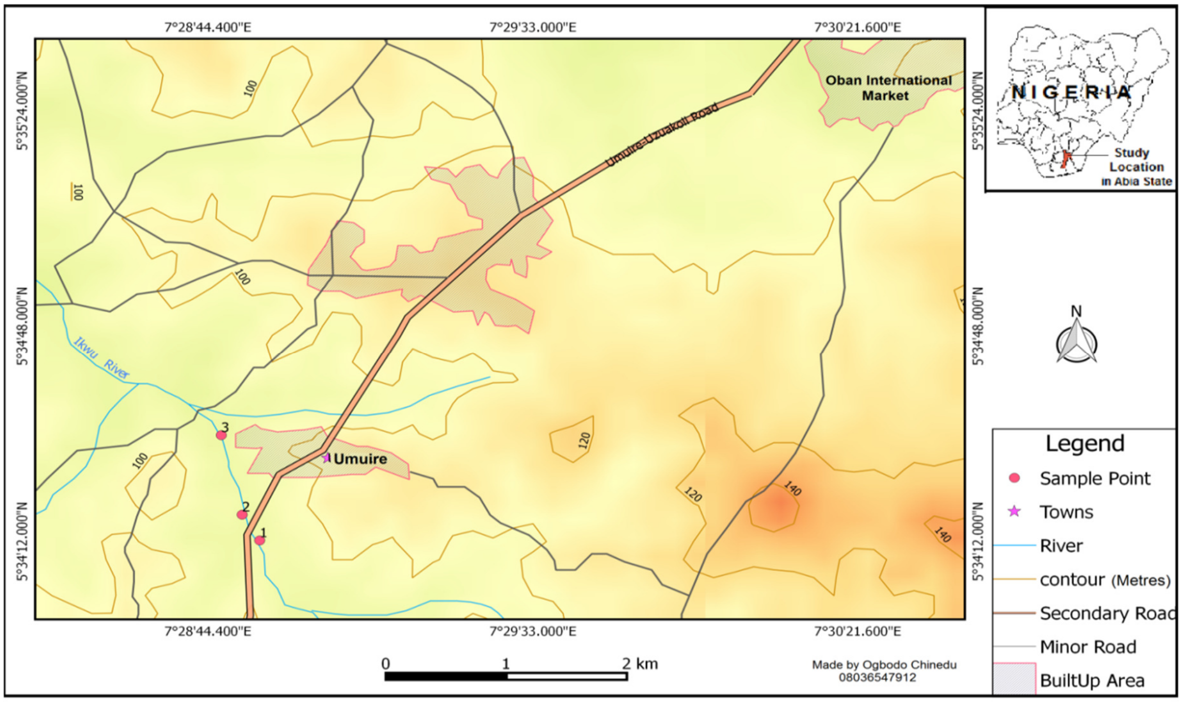

Fig. 1: Sampling stations of Ikwu River, Umuahia, Southeast Nigeria

Water Samples

Water samples were collected from Ikwu River monthly from January and June 2022. The samples were collected in 1litre plastic bottles and transported in ice chests to the laboratory for analysis. The physicochemical parameters were analyzed using standards methods described by American Public Health Association (APHA) (2012). Eleven physicochemical parameters were evaluated - water temperature, flow velocity, pH, electrical conductivity, total dissolved solids, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, phosphate, nitrate and sulphate.

Parasitological Samples

Parasitic samples were collected along with the water samples using Grab and Composite filtration sampling methods. The grab sample was collected once (Nas and Ali 2019; Vantsawa *et al*., 2020; Ejike *et al*., 2021). The composite filtration method used in plankton studies (Imoobe and Adeyinka, 2010; Anyanwu and Mbekee, 2020) was introduced for comparison; hence a collection of 100 litres of water filtered through a plankton net (55µ). The samples were transported in ice chests to the Zoology and Environmental Biology Laboratory, Michael Okpara University of Agriculture, Umudike. The samples were refrigerated at 4°C until processed within 24 hours.

Parasitological Assessment

Sedimentation method described by Cheesbrough (2010) was used. The samples were filtered with a gauze filter and debris removed. The filtrate was poured into 10ml centrifuge tube and centrifuged immediately at 3000 rpm for 10 minutes. The resultant sediment was stirred with a clean applicator stick after the supernatant was discarded. A drop was placed on a clean slide, covered with a glass slip and examined microscopically using 10x objective with the condenser iris closed sufficiently. The 40x objective was used to examine small cysts and eggs. The trophozoites, cysts and eggs isolated were counted and recorded.

Prevalence was calculated using the formula:

$$\text{Prevalence} = \frac{\text{Number Infected}}{\text{Total number examined}} x \frac{100}{1}$$

Data Analysis

Descriptive Statistic Package of Microsoft Excel was used to summarize the water results. One-way ANOVA was used for test of significant difference among the stations and source of significant difference at $P < 0.05$ was determined with Tukey pairwise posthoc test. The differences in the parasite prevalence were tested by Chi-square and P value of < 0.05 was taken as significant.

RESULTS

Physicochemical Parameters

The summary of physicochemical parameters evaluated in Ikwu River is shown in Table 1. There was no significant difference in the parameters among the stations except flow velocity. The water temperature values ranged between 19.5 and 25.9°C. The lowest water temperature value was recorded in station 1 (May 2022) while the highest value was recorded in station 3 (March 2022). The flow velocity values ranged from 0.12 - 0.48 m/s. (Table 3.1). Station 2 recorded the lowest flow velocity value in February 2022 while the highest was recorded in station 3 (January 2022). Station 3 was significantly ($p < 0.05$) higher than the other stations.

Table 1: Summary of Physicochemical Parameters recorded Ikwu River, Umuahia (with range in Parenthesis)

Parameters	**STN 1** Mean±SEM	**STN 2** Mean±SEM	**STN 3** Mean±SEM	**P- value**	**FMEnv 2011**
Water Temperature (°C)	22.22±0.10 (19.5 - 25.0)	22.50±1.03 (19.7 - 25.7)	23.33±0.97 (20.0 - 25.9)	F = 0.33 P > 0.05	-
Flow Velocity (m/s)	$0.25±0.03^{a}$ (0.18 - 0.37)	$0.20±0.03^{a}$ (0.12 - 0.35)	$0.38±0.04^{b}$ (0.26 - 0.48)	F = 8.06 P < 0.05	-
pH	7.07±0.52 (6.1 - 8.7)	7.13±0.48 (6.1 - 8.7)	7.10±0.48 (6.2 - 8.6)	F = 0.004 P >0.05	6.5 – 8.5
Electrical Conductivity (µS/cm)	102.0±9.37 (66.0 - 130.0)	98.33±6.30 (76.0 - 118.0)	96.33±7.96 (66.0 - 119.0)	F =0.13 P > 0.05	-
Total Dissolved Solids (mg/L)	50.4±5.69 (33.0 - 65.0)	48.2±3.71 (38.0 - 59.0)	47.2±4.69 (33.0 - 59.0)	F = 0.01 P >0.05	-
Dissolved Oxygen (mg/L)	5.45±0.72 (3.0 - 7.4)	4.43±0.77 (2.7 - 7.4)	4.30±0.69 (2.0 - 7.0)	F = 0.75 P > 0.05	6
Biochemical Oxygen Demand (mg/L)	2.08±0.27 (1.2 - 3.0)	2.12±0.16 (1.5 - 2.7)	2.5±0.26 (1.7 - 3.3)	F = 0.98 P > 0.05	3
Chemical Oxygen Demand (mg/L)	19.88±1.17 (16.3 - 23.2)	20.63±4.39 (10.4 - 40.8)	17.58±1.92 (10.4 - 23.2)	F = 0.31 P > 0.05	30
Phosphate (mg/L)	0.40±0.12 (0.10 - 0.83)	0.26±0.07 (0.11 - 0.53)	0.26±0.05 (0.11 - 0.47)	F = 0.88 P > 0.05	3.5
Nitrate (mg/L)	1.12±0.45 (0.48 - 3.36)	1.10±0.41 (0.16 - 2.96)	0.99±0.31 (0.27 - 2.37)	F = 0.06 P > 0.05	9.1
Sulphate (mg/L)	0.33±0.13 (0.03 - 0.77)	0.34±0.14 (0.05 - 0.77)	0.29±0.10 (0.06 - 0.62)	F = 0.06 P > 0.05	100

a, b = Means with different superscripts across the rows are significantly different at p<0.05; SEM= Standard Error of Mean; FMEnv. (2011) - National Environmental (Surface and Groundwater Quality Control) Regulations

The pH values ranged between 6.1 and 8.7. Most of the pH values were within the acceptable limit (6.5 - 8.5) set by FMEnv. (2011). The lowest pH values were recorded in stations 1 (January and March 2022) and 2 (March 2022) while the highest were recorded in stations 1 (May and June 2022) and 2 (June 2022). The electrical conductivity values ranged between 66.0 and 130.0µS/cm. The lowest electrical conductivity values were recorded in stations 1 and 2 (May 2022) while the highest was recorded in station 1 (February 2022). The total dissolved solid (TDS) values ranged between 33.0 and 65.0 mg/L. The TDS values followed the same trend with electrical conductivity (EC). The lowest TDS values were recorded in stations 1 and 2 (May 2022) while the highest was recorded in station 1 (February 2022). The dissolved oxygen (DO) values recorded were between 2.0 and 7.4mg/L. The lowest DO was recorded in station 3 (May 2022) while the highest value was recorded in station 1 (April 2022). Station 1 recorded relatively higher values throughout the study. A few of the values were within the acceptable limit (>6 mg/L) set by FMEnv. (2011).

The biochemical oxygen demand values recorded ranged between 1.2 and 3.3 mg/L. The lowest BOD value was recorded in station 1 (March 2022) while the highest value was recorded in station 3 (January 2022). All the values recorded were within the acceptable limit of 3mg/L set by FMEnv. (2011) except in station 3 (January 2022). The chemical oxygen demand (COD) values recorded ranged between 10.4 and 40.8 mg/L. The values were within acceptable limit (30mg/L) set by FMEnv. (2011) except in station 2 (May 2022). Stations 2 and 3 recorded the lowest values in March 2022 while station 2 recorded the highest value in May 2022. The phosphate values recorded ranged between 0.10 and 0.83 mg/ l. The lowest and highest values were recorded in station 1 in April 2022 and January 2022 respectively. The values were within acceptable limit (3.5 mg/L) set by FMEnv. (2011). The nitrate values recorded ranged between 0.16 and 3.36 mg/L. The lowest value was recorded in station 2 (February 2022) while the highest value was recorded in station 1 (January 2022). All the values were within the acceptable limit (9.1 mg/L) set by FMEnv. (2011). The sulphate values recorded ranged between 0.03 and 077mg/L. The lowest value was recorded in station 1 (April 2022) while the highest value was recorded in station 1 (June 2022). All the values were within the acceptable limit (100 mg/L) set by FMEnv. (2011).

Parasitic Assessment

A total of thirty-six (36) water samples were collected, out of which five (5) parasites of varying developmental stages (egg, cyst, and trophozoites) were recorded. The parasite species were mainly helminthes represented by *Strongyloides stercoralis* (Bavay, 1876), *Ascaris lumbricoides* (Linnaeus, 1758) and *Fasciola gigantica* (Cobbold, 1855) and protozoa - *Balantidium coli* (Malmsten, 1857) *and Entaemoeba histolytica* (Schaudinn 1903). The overall prevalence was 12 (33.33%) while the composite filtration method had higher prevalence 8 (44.44%) than the grab method 4 (22.22%); though not significant ($X^2_{df(1)} = 1.02, p > 0.05$). *S. stercoralis* was the most prevalent 8(22.2%), followed by *B. coli* 6 (16.7%) and others 1(2.78%) (Table 2).

Table 2: Prevalence in relation to parasites and stations

Stations	Number examined	Number species infected					Total	P - value
		Ss	Al	Bc	Eh	Fg		
Stn 1	12	4(33.33)	0	1(8.33)	0	0	5(41.67)	0.02
Stn 2	12	3(25.00)	1(8.33)	3(25.00)	1(8.33)	1(8.33)	9(75.00)	
Stn 3	12	1(8.33)	0	2(16.67)	0	0	3(25.00)	
Total	36	8(22.22)	1(2.78)	6(16.67)	1(2.78)	1(2.78)	17(47.22)	0.34

Key: Ss = *S. stercoralis*, Al = *A. lumbricoides,* Bc = *B. coli,* Fg = *F. gigantica,* Eh = *E. histolytica*

The prevalence of *S. stercoralis* and *B. coli* was significantly different ($X^2_{df\ (4)}$ = 11.74, p < 0.05) from the other parasites. The highest parasitic load (9, 75.00%) made up of 3 eggs (*S. stercoralis*), 1 cyst (*A. lumbricoides*), 3 cyst (*B. coli*), 1 cyst (*E. histolytica*) and 1 egg (*F. gigantica*) was recorded in station 2. Followed by station 1 (5, 41.67%) made up of 4 eggs of (*S. stercoralis*) and cyst (*B. coli*) while station 3 had the least (3, 25.00%) - 1 egg (*S. stercoralis*) and 2 cysts (*B. coli*). There was no significant difference in the spatial prevalence ($X^2_{df\ (2)}$ = 2.18, *p* > 0.05).

All the parasites were recorded in the composite filtration method and 2 in the grab method (Table 3). *S. stercoralis* had the highest prevalence in both methods – grab method (2, 11.11%) and composite method (6, 33.33%), followed by *B. coli*-grab method (1, 5.56%) and composite method (5, 27.78%). Others had 1(5.56%) in the composite filtration method and none in the grab method. The prevalence of *S. stercoralis* and *B. coli* was significantly different from the others ($X^2_{df\ (1)}$ = 5.05, p < 0.05) especially in the composite filtration method.

Table 3: Prevalence in relation to parasites and sampling methods

Sampling Method	Number examined	Number infected					Total	P - value
		Ss	Al	Bc	Eh	Fg		
Grab	18	2(11.11)	0	1(5.56)	0	0	3(16.67)	0.02
Composite	18	6(33.33)	1(5.56)	5(27.78)	1(5.56)	1(5.56)	14(77.75)	
Total	36	8(22.22)	1(2.78)	6(16.67)	1(2.78)	1(2.78)	17(47.22)	

Key: Ss = *S. stercoralis*, Al = *A. lumbricoides,* Bc = *B. coli,* Fg = *F. gigantica,* Eh = *E. histolytica*

Strongyloides stercoralis was recorded in 5 months, *B. coli* in 4 months and others in 1 month each (Table 4). The highest number of parasites (6) was recorded in May 2022, followed by 4 in January 2022. However, none was recorded in April 2022. The monthly prevalence was not significantly different ($X^2_{df\ (5)}$ = 5.27, p > 0.05).

Table 4: Prevalence in relation to parasites and sampling period

Month	Number examined	Number infected					Total	P - value
		Ss	Al	Bc	Eh	Fg		
January	6	1(16.67)	1(16.67)	1(16.67)	0	1(16.67)	4	0.38
February	6	1(16.67)	0	1(16.67)	0	0	2(33.33)	
March	6	1(16.67)	0	2(33.33)	0	0	3(50.00)	
April	6	0		0	0	0	0	
May	6	3(50.00)	0	2(33.33)	1(16.67)	0	6(100)	
June	6	2(33.33)	0	0	0	0	2(33.33)	
Total	36	8(22.22)	1(2.78)	6(16.67)	1(2.78)	1(2.78)	17(47.22)	

Key: Ss = *S. stercoralis*, Al = *A. lumbricoides,* Bc = *B. coli,* Fg = *F. gigantica,* Eh = *E. histolytica*

DISCUSSION

Impacts of environmental factors on the prevalence of parasites have been reported by researchers (Modu *et al*., 2016; Wali *et al*., 2016; Qayoom and Shah, 2017; Shlash *et al*., 2023).

The water temperature was influenced by season. The lowest value recorded in station 1 was after a heavy rainfall event in May 2022 while the highest in station 3 was due to the dry season in March 2022. Precipitation is a major determinant of season in the tropics (Park *et al*., 2011) while air temperatures determine water temperatures (Park *et al*., 2016). Parasites thrive in temperatures suitable for their survival (Simon-Oke *et al*., 2020; Villar-Torres *et al*., 2023) and parasites prevalence increases with increasing water temperature (Abba *et al*., 2018).

The pH ranged from moderate acidic to moderate alkaline. The lowest pH value recorded in station 2 (February 2022) and highest station 3 (January 2022) could be due to human activities in the river during the dry season. Simon-Oke *et al*. (2020) reported that pH affects the occurrence of the parasites in the water sources. Abba et al. (2018) reported a positive correlation between pH and prevalence of helminthes parasites.

The flow velocity values were moderate; though station 3 was significantly higher than stations 1 and 2. Flow velocity can influence the removal of pollutants and also affect aquatic organisms (parasites) by washing them away (USEPA, 2022).

The electrical conductivity and total dissolved solids values were moderate and were influenced by season. The lowest values recorded in stations 1 and 2 in May 2022 was due to dilution from rainfall event on the sampling day (Pal *et al*., 2015) while the highest value in station 1 (February 2022) was due to dry season effect. Little or no rainfall, low flow velocity, high temperatures and evaporation could result in higher concentration. Abba *et al*. (2018) and Ajeagah and Fotseu (2019) reported a positive correlation between electrical conductivity and the prevalence of helminthes parasites.

The DO values were moderate. The lowest DO value in station 3 (May 2022) was due rainfall event on the sampling day. Dissolved oxygen levels can be rapidly depleted when large quantity of oxygen-consuming compounds and organic matters are discharged into the river as a result of rainfall (Pearce and Schumann, 2010). On the other hand, the highest value recorded in station 1 (April 2022) could be attributed to increased photosynthesis as result of high temperature and water clarity before the onset of rains. Station 1 recorded relatively higher values throughout the study probably due to minimal human activities. A few of the values were within the acceptable limit (>6 mg/L) set by FMEnv. (2011); indicating moderate water quality. Waruiru *et al*. (2020) reported that parasites thrive in water with low dissolved oxygen concentration.

The biochemical oxygen demand values were low. The lowest value recorded in station 1 (March 2022) could be due to minimal human activities while the highest in station 3 (January 2022) could be due to human activities. Station 3 was within Umuire community and witnessed high human activities (including open defecation) especially during the dry season. All the values recorded were within the acceptable limit of 3mg/L set by FMEnv. (2011) except in station 3 (January 2022). Al-Marjan and Abdullah (2015) observed a relationship between the BOD_5 concentration and the prevalence of fish infestation by the *Trichodina* sp. The prevalence of the parasite increased with increased concentration of BOD_5; an indication of increased organic pollution.

The chemical oxygen demand values were low; indicating low organic pollution. The values were within acceptable limit (30mg/L) set by FMEnv, (2011) except in station 2 (May 2022). The lowest values recorded in stations 2 and 3 (March 2022) could be due to low input from the environment during the dry season and the highest recorded in station 2 (May 2022) was the effect of rainfall event on sampling day. It can also be from wastewater from car washing activities. Studies have shown that car wash effluents usually contribute to high concentrations of COD (Odeyemi *et al*., 2018; Rai, *et al*., 2020; Anyanwu *et al*., 2022b).

The phosphate values were also low and within acceptable limit. The lowest and highest values recorded in station 1 in April 2022 and January 2022 respectively could be due reduction from environmental input and concentration due to little or no rainfall, low flow velocity, high temperatures and evaporation during the dry season (Houssou *et al*., 2017). High concentration of phosphate encourages the prevalence of parasites in water (Ajeagah and Fotseu, 2019).

The nitrate values recorded were also low and within the acceptable limit. The lowest value recorded in station 2 (February 2022) could be due low environmental input while the highest value was recorded in station 1 (January 2022) could be due to concentration because of little or no rainfall, low flow velocity, high temperatures and evaporation during the dry season (Houssou *et al*., 2017). High concentration of nitrate also encourages the prevalence of parasites in water (Ajeagah and Fotseu, 2019).

The sulphate values were also low and within the acceptable limit. The lowest value recorded in station 1 (April 2022) could be due low environmental input while the highest recorded in station 1 (June 2022) could be due to environmental input as a result of the onset of the rains (Houssou *et al*., 2017). Sulphate could be toxic to aquatic organisms at elevated levels (Elphick *et al*., 2011; Zak *et al*., 2020).

The five (5) parasites were helminthes and protozoa parasites of human health importance are in line with Gyang *et al*. (2017) and Anyanwu *et al*. (2018). In terms of abundance, the 17 parasites recorded were lower than 36 recorded by Gyang *et al*. (2017) and 18 parasites recorded by Anyanwu *et al*. (2018). The overall prevalence (33.33%) was higher; Iyaji *et al*. (2018) recorded a lower 15.6% in Kogi State, Nigeria and Ani and Itiba (2015) recorded 28.1% in a stream in Abakaliki, Ebonyi State. The high prevalence rate is a pointer that transmission of parasites occurs when water is contaminated (Efstratiou et al., 2017). The high prevalence rate could be attributed to the sampling method. The composite filtration method gave a higher prevalence though not significantly different ($X^2_{(1)} = 1.02$, $p = 0.32$) from conventional grab method. The composite filtration method was introduced for comparison with the conventional grab method used in related studies (Nas and Ali, 2019; Vantsawa *et al*., 2020; Ejike *et al*., 2021).

S. stercoralis and *B. coli* were most prevalent. *S. stercoralis* is the causative agent of strongyloidiasis; an infection commonly associated with low socioeconomic and poor hygienic conditions especially in the rural areas (Pecorella *et al*., 2022). *B. coli* is an emerging zoonotic parasite that causes balantidiasis in animals and humans (Ahmed *et al*., 2020) and rivers could be contaminated with cattle dung when they are watered (Hussin and Al-Samarai, 2016). Watering of cattle observed periodically in stations 1 and 2 between January and April 2022 could be the source of *B. coli* (Bilal *et al*., 2009).

Station 2 had the highest prevalence, which could be attributed to human activities. Notably were market women washing fruits and vegetables upstream of the sampling point and open defecation. Open defaecation does not only negatively affect drinking water quality but also make them unfit for drinking (Okullo *et al*., 2017). In rural African regions, fecal contamination of water arises from runoffs from nearby bushes and forest which serve as defecation sites for rural dwellers (Manetu and Karanja, 2021; Rohmah *et al*., 2022). Pathogens in the environment can be mobilized by heavy rainfall events and with increased run-off from the fields, discharging them into waterbodies (Semenza and Menne, 2009). Station 3 had the lowest prevalence, though open defecation was very common around the station. The high flow velocity observed in the station may have aided the removal of the parasites. Stream flow also affects transport distance, as higher flow velocities can transport pathogens longer distances and potentially affect downstream communities (USEPA, 2022).

The composite filtration method introduced in this study was more effective than the conventional grab method. All parasite groups were recorded with the composite filtration method and 2 with the grab method. *S. stercoralis* and *B. coli* were effectively collected with the composite filtration method with significant difference.

S. stercoralis was recorded in 5 months, *B. coli* in 4 months and others in 1 month each. The highest number of parasites recorded in May 2022 could be attributed to the effect of rainfall event on the sampling day. Rainfall events can introduce or remove parasites from a flowing water body (Semenza and Menne, 2009; Manetu and Karanja 2021; USEPA, 2022). The second highest recorded in January 2022 was due to little or no rainfall and low flow velocity. Extended dry periods between precipitation events reduce stream flow volume and sometimes can increase density of pathogens in the water column (Cann *et al*., 2013; Coffey *et al*., 2014). No parasite was recorded in April 2022, which could be as a result of flushing following the onset of rains (Poulin, 2020).

CONCLUSION

This study assessed some physicochemical parameters and parasitic contamination of an important rural river. The parameters were within the permissible limits except some pH, dissolved oxygen, biochemical oxygen demand and chemical oxygen demand values. The parasite species were mainly helminthes and protozoa of human health importance. The prevalence was high; influenced by physicochemical parameters, sampling methods, human activities and season. The new composite filtration method introduced in this study proved to be effective method with better result. In view of the high prevalence rate, the water needs to be treated before use and open defecation discouraged around the river.

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