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Parasitological Examination of Slender Amaranth Vegetable (*Amaranthus viridis*) and Bush-Okra (*Corchorus olitorius)* from Farms and Markets in Communities around Edu Local Government Area, Kwara State, Nigeria

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ABSTRACT: This paper examined a total of two hundred and fifty (250) samples of slender amaranth vegetable (*Amaranthus viridis*) and bush-okra (*Corchorus olitorius*) from farms and markets in the communities around Edu Local Government Area of Kwara State of Nigeria between January and July 2023 for evaluation of parasites that infect humans using the sedimentation method. Parasites isolated from vegetable samples from the farm showed that *Ascaris lumbricoides* (17.6%) was the most encountered followed by *Entamoeba* histolytica (11.2%) and the least was *Enterobius vermicularis* (3.2%). In the market samples, *Ascaris (11.2%)* was the most prevalent parasites encountered while *Trichuris* trichiura, *Strongyloides* stercoralis and *E.* vermicularis *(1.6%)* were the least prevalent. One hundred and fourteen (45.6%) samples were contaminated with various parasites. Of the total contaminated vegetable, 74/125 (59.2%) were found in the farm vegetables while 40/125 (32.0%) were encountered in the market vegetables. *Corchorus* olitorius were found to be more contaminated in both the farms 39/110 (35.5%) and market 23/110 (20.9%). From the study, it was seen that the rate of contamination was highest in the month of July, while the month of January had the least rate of contamination for both farm and market vegetable samples. The difference in the contamination rate in both farm and market samples were seen to be significant ($P < 0.05$). This study recommends proper washing of vegetables prior to consumption and proper sewage treatment before usage as fertilizer.

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Intestinal parasitic infections are a leading cause of disease in humans, with an estimated two billion individuals worldwide affected by pathogenic and non-pathogenic intestinal parasites (Gelaw *et al.* 2013). Protozoan parasites can cause food-borne diseases, leading to serious health and economic issues in many developing and developed countries (Benti and Gemechu, 2014). Consumption of raw and unwashed vegetables is directly linked to the transmission of parasites in humans, making fruits and vegetables potential vehicles for parasite transmission, especially when consumed raw or unpeeled (Hassan *et al.* 2012). Common parasitic contaminants of fruits and vegetables include Cryptosporidium, Cyclospora, Giardia, *Entamoeba histolytica*, *Entamoeba coli*, and *Ascaris lumbricoides* (Eraky *et al.*, 2014; Amaechi *et al.*, 2016). Vegetables become contaminated through various pathways, such as contamination on the farm during harvesting, through contaminated water used for irrigation or washing, and through infected food handlers (Alli *et al*., 2011; Gelaw *et al.*, 2013). Inadequate systems for routine diagnosis of food-borne pathogens in developing countries often lead to underestimation of the incidence of food-borne pathogens in food, with most disease outbreaks caused by contaminated vegetables going undetected (Uga *et al.*, 2009; Uttah *et al.*, 2013). Consumption of raw vegetables has been associated with high rates of intestinal parasite diseases, indicating that it is an important route of transmission (Eneanya and Njom, 2003). Furthermore, the use of night soils and wastewater in vegetable cultivation poses significant risks of contamination by human intestinal nematodes, putting both consumers and agricultural workers at risk of infection. Despite the potential health risks, vegetables like *Amaranthus viridis* and *Corchorus olitorius* are widely consumed and used for medicinal purposes, but little is known about the potential parasite transmission risk factors associated with their consumption in communities around Edu Local Government Area (L.G.A) Kwara State. Hence, the objective of this paper was the examination of slender amaranth vegetable (*Amaranthus viridis*) and bush okra (*Corchorus olitorius*) from farms and markets in the communities around Edu L.G.A of Kwara State, north central Nigeria.

MATERIALS AND METHODS

Study Area: Description of the Study Area The research was carried out in the Edu Local Government Area (LGA) in Kwara State, located in the north-central part of Nigeria. The geographical coordinates of the area are approximately latitude 905’0’’N and longitude 4057’0’’E. The L.G.A. covers an area of 2542 square kilometers and has a population of 201,469 (NPC, 2007). Kwara state is one of the 36 states in Nigeria, situated on the west coast of Africa, with Ilorin as its capital. The state spans an area of about 36,825 square kilometers and is characterized by the predominant religions of Islam and Christianity. The entire study area exhibits ecological uniformity, with high relative humidity and an annual rainfall ranging between 900-1000 mm. The region experiences high temperatures (27ºC - 28ºC) for most of the year, with a distinct rainy season lasting 7 months from April to October and a shorter dry season lasting 5 months from November to March. These favorable climatic conditions support intensive agricultural activities, with farming and fishing being prominent. The area is suitable for the cultivation of crops such as potatoes, yams, rice, maize, cassava, groundnuts, and pepper. However, basic infrastructure including electricity, roads, potable water, hospitals, and waste disposal facilities are inadequate. The majority of the inhabitants reside in rural agricultural areas and are engaged in subsistence farming. For the study, five out of ten communities were selected randomly, namely Kpiledgi, Shonga, Kpututa, Tada, and Bindofu, which share homogenous characteristics.

Study Design: A total of 250 samples of two different types of vegetables, *Amaranthus viridis* and *Corchorus olitorius* leaf, were collected from five farms and five markets. The collections were conducted in both seasons of the year, specifically in January and July 2023, representing the dry and rainy seasons, respectively. The samples were collected fortnightly over a period of seven months. Sampling Locations/Sites Fresh vegetables were harvested from five farms situated in the villages of Kpiledgi, Shonga, Kpututa, Tada, and Bindofu. It was observed that all the farms used animal manure as fertilizer and practiced crop irrigation during the dry season. The markets where the farm produce was sold were selected as the sites for vegetable collection.

Vegetable collection: On each sampling day, random samples of each vegetable type were purchased from five different vendors in the markets. Similarly, 100g samples of each vegetable type were randomly harvested from each of the five farms.

Parasitological Examination: The vegetables were screened using a method described by Alli *et al.*, 2011, and Tomass and Kidane, 2012. A 100g sample of each vegetable was washed in physiological saline (0.85% NaCl) to remove any parasite eggs, larvae, or cysts. The wash water was strained through a layer of iron gauze to remove impurities and then left for sedimentation overnight. The sediment was further processed, stained, and examined under a light microscope for parasite detection.

Identification of Parasites: The morphological characteristics of the parasites, such as the shapes and sizes of the eggs and larvae, were used for their identification, following the guidelines provided by the World Health Organization (WHO, 1994).

Statistical data analysis: The data analysis was performed using Statistical Package for Social Sciences (SPSS) version 20.0. The prevalence of parasites in the vegetable samples from farms and markets was compared using the Chi-square test. A significance level of $P < 0.05$ was considered.

RESULTS AND DISCUSSION

Parasitic contamination in the different farms and markets studied within Edu L.G.A shows that farms located in Bindofu village recorded the highest contamination rate of 18(72.0%) whereas, farms located in Tada recorded the least 13(52.0%). At $P < 0.05$ the rate of contamination amongst the five markets was significant (Table 1). *C. olitorius* leaf were more infected than *A. viridis* (Table 2). Rate of parasitic contamination both in the farm 18(90%) and market 13 (65%) was recorded in the month of July while the least occurred in the month of January for farm 5(23.8%) and market 2(6.8%). At $P<0.05$ it was significant (Table 3). It was observed that samples collected from the farm during the rainy season were more contaminated 50 (82.0%) than the dry season sampled vegetables 24(37.5%). Similarly, vegetable samples collected from the market were more contaminated in the rainy season 30(49.2%) than those collected during the dry season period 10(15.6%) (Table 4). In terms of parasites isolated, for the farm vegetables, *Ascaris lumbricoides* were isolated the most 22(17.6%) while *Enterobius vermicularis* had the least occurrence 4(3.2%). Similarly, samples collected in the market revealed that *A. lumbricoides* had the highest occurrence 14(11.2%) while the least prevalence was seen in *Trichuris trichiura*, *Strongyloides stercoralis* and *Enterobius vermicularis* 2(1.6%) (Table 5).

Table 1: Location Specific parasitic contamination in Edu L.G.A, Kwara State, Nigeria

Farms	Number sampled	Contamination rate n (%)	Markets	Number sampled	Contamination rate n (%)
Kpiledgi	25	14 (56.0)	Kpiledgi	25	7 (28.0)
Shonga	25	14 (56.0)	Shonga	25	8 (32.0)
Kputata	25	15 (60.0)	Kputata	25	8 (32.0)
Tada	25	13 (52.0)	Tada	25	6 (24.0)
Bindofu	25	18 (72.0)	Bindofu	25	11 (44.0)
Total	125	74 (59.2)	Total	125	40 (32.0)
X^2	1.142		X^2	0.104	
P-value	0.001		P-value	0.001	

Table 2: Vegetable-Specific parasite contamination in farms and market vegetables in Edu L.G.A, Kwara State, Nigeria

Farm vegetables	Number sampled	Number sampled	Contamination rate n (%)	
Viridis	115	115	14.8)	
Olitorius	110	110	23 (20.9)	
Total	125	125	40 (32.0)	
X^2			23.034	
P-value		0.001*ns		0.000*ns

n= number contaminated; X^2= Chi-square; ns= not significant

Food-borne parasitic contamination in vegetables poses a significant public health concern, particularly in developing nations. This study focused on assessing parasitic contamination in 250 samples of two commonly consumed vegetables among the Nupe people in north central Nigeria, both at the farm and market levels. Results revealed that 114 samples were infected with one or more parasites, indicating a contamination rate of 45.6%. Such a high contamination level presents a considerable health risk to the local population, potentially leading to a food-borne crisis if left unchecked.

Table 3: Monthly specific prevalence rate in Edu LGA, Kwara State, Nigeria

Farm months	No. sampled	Rate of contamination n (%)	Market months	Number sampled	Rate of contamination n (%)
Jan	21	5 (23.8)	Jan	21	2 (6.8)
Feb	21	8 (38.1)	Feb	21	3 (14.3)
March	22	11 (50.0)	March	22	5 (23.8)
May	21	15 (71.4)	May	21	7 (33.3)
June	20	17 (85.0)	June	20	10 (50.0)
July	20	18 (90.0)	July	20	13 (65.0)

Table 4: Seasonal specific prevalence of parasitic contamination in Edu LGA, Kwara State, Nigeria

Farm Season	Number sampled	Rate of contamination n (%)	Market season	Number sampled	Rate of contamination n (%)
Dry season	64	24 (37.5)	Dry season	64	10 (15.6)
Rainy season	61	50 (82.0)	Rainy season	61	30 (49.2)
Total	125	74 (59.2)	Total	125	40 (32.0)
X^2		0.008			
P-value		0.001			

Table 5: Distribution and location specific pattern of parasites in farms and markets in Edu L.G.A, Kwara State, Nigeria

Farms	Number sampled	*Ascaris lumbricoides*	*Entamoeba histolytica*	*Taenia species*	Hookworm	*Trichuris trichiura*	*Strongyloides stercoralis*	*Enterobius vermicularis*
Kpiledgi	25	5 (20.0)	2 (8.0)	1 (4.0)	3 (12.0)	2 (8.0)	1 (4.0)	0 (0.0)
Shonga	25	7 (28.0)	4 (16.0)	1 (4.0)	1 (4.0)	1 (4.0)	0 (0.0)	0 (0.0)
Kputata	25	3 (12.0)	4 (16.0)	2 (8.0)	3 (12.0)	0 (0.0)	2 (8.0)	1 (4.0)
Tada	25	3 (12.0)	2 (8.0)	1 (4.0)	1 (4.0)	1 (4.0)	3 (12.0)	2 (8.0)
Bindofu	25	4 (16.0)	4 (16.0)	2 (8.0)	3 (12.0)	2 (8.0)	2 (8.0)	1 (4.0)
Total	125	22 (17.6)	14 (11.2)	7 (5.6)	11 (8.8)	6 (4.8)	8 (6.4)	4 (3.2)
X^2		0.0061						
P-value								
Markets								
Kpiledgi	25	3 (12.0)	2 (8.0)	0 (0.0)	1 (4.0)	1 (4.0)	0 (0.0)	0 (0.0)
Shonga	25	2 (8.0)	1 (4.0)	1 (4.0)	1 (4.0)	1 (4.0)	1 (4.0)	1 (4.0)
Kputata	25	4 (3.2)	3 (12.0)	1 (4.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Tada	25	2 (8.0)	2 (8.0)	0 (0.0)	2 (8.0)	0 (0.0)	0 (0.0)	0 (0.0)
Bindofu	25	3 (12.0)	2 (8.0)	2 (8.0)	2 (8.0)	0 (0.0)	1 (4.0)	1 (4.0)
Total	125	14 (11.2)	10 (8.0)	4 (3.2)	6 (4.8)	2 (1.6)	2 (1.6)	2 (1.6)
X^2								
P-value								

Significant difference (P<0.05) was observed in the prevalence of Ascaris species and Entamoeba histolytica across the farms (Table 6).

Table 6: Vegetable specific distribution pattern of parasites in sampled vegetables from farms and markets in Edu L.G.A, Kwara State, Nigeria

Vegetables Farms	Number sampled	*Ascaris lumbricoides*	*Entamoeba histolytica*	*Taenia species*	Hookworm	*Trichuris trichiura*	*Strongyloides stercoralis*	*Enterobius vermicularis*
A. .Viridis	115	14 (12.2)	8 (7.0)	3 (2.6)	5 (4.3)	3 (2.6)	3 (2.6)	2 (1.7)
C .olitorius	110	8 (7.3)	6 (5.5)	4 (3.6)	7 (6.4)	3 (2.7)	5 (4.5)	2 (1.8)
X^2	0.0055							
P-value	0.001							
Market								
A. .viridis	115	6 (5.2)	4 (3.5)	2 (1.7)	2 (1.7)	1 (0.9)	1 (0.9)	0 (0.0)
Corchorus Olitorius	110	8 (7.3)	6 (5.5)	2 (1.8)	4 (3.6)	1 (0.9)	1 (0.9)	2 (1.8)
X^2	0.0067							
P-value	0.001							

This finding aligns with similar studies, such as one conducted in Tripoli, Libya, which reported a contamination rate of 58% (Abougrain *et al*., 2010). Conversely, lower rate of 16.2% were observed in Saudi Arabia (Al-Megrin, 2010) and higher contamination rates of 65% in Tehran, Iran (Fallah *et* *al.*, 2002). Certain factors that might have contributed to the high contamination rate may include the type of agricultural practices used by the farmers in the study area when compared to others in previous studies. The study area was seen to be highly contaminated with faeces, which is a contributory factor to the high contamination rate recorded. Most of the farmers used animal manure as fertilizers in their farms. Vegetable samples collected directly from the farms were found to be more contaminated than those collected from the market. The likely reason might be that the vegetable vendors wash their vegetables after buying from farmers before taking it to the market. Similar observation where vegetable farm samples were more infected than vegetables collected from the market was recorded by Gharavi *et al.,* 2002. Farms in Bindofu recorded the highest contamination rate, likely because of the intense use of untreated sewage water and the use of animal dungs from pig homes. The practice of open defecation was well pronounced in this area which might increase contamination rate through water run offs. This agrees with the observation of Amaechi *et al.*, 2016 that reported that vegetables grown in rural areas are more prone to potential contamination as a result of environmental contamination. The environments around the market place in Bindofu village were messy and are likely to harbour parasites. Previous authors have alluded to the fact that leafy vegetables because of its uneven surfaces tend to facilitate sticking of parasites' eggs, larvae, cysts and oocysts (Eneanya and Njom, 2003; Damen *et al*., 2007; Eraky *et al*., 2014). *C. olitorius* leaf was signficantly more contaminated than *A. viridis* leaf likely because it had greater contact with the contaminated soil where run offs and flooding could facilitate parasitic contamination from the soil unto the vegetable.The highest rate of contamination was observed in July probably because it is the peak of the rainy season that allows parasites to thrive and proliferate. The least contamination rate occurred in the month of January a dry season where parasites are known to proliferate less (Al-Megrin, 2010; Eraky *et al.*, 2014). Ascaris species were the most predominant parasite recovered followed closely by *Entamoeba histolytica* cyst. *Ascaris lumbricoides* are tough in nature, also have a high adhesive nature which makes it difficult to get rid of them by washing. The eggs of Ascaris are laid in large numbers and also have the ability to withstand harsh environmental conditions. Regarding parasite load from vegetable samples in both farms and market indicates that washing of the vegetables by the vendors might have tremendously reduced the level of parasitic contamination in the vegetable gotten from the market as compared to those samples collected from the farms. This corroborated previous reports (Gharavi, 2002; Fallah *et al*., 2012).

Conclusion: The current research found significant levels of parasitic contamination in vegetables obtained directly from the farm as well as those purchased from the local market in the study area. It is recommended that farmers take proper measures to treat wastewater and animal manure before utilizing them for farm irrigation. Additionally, practicing health education and improving individual hygiene practices through constant vegetable washing prior to consumption is emphasized.

Declaration of Conflict of Interest: The authors declare no conflict of interest.

Data Availability Statement: Data are available upon request from the corresponding author.

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