



ORIGINAL ARTICLE

PREVALENCE OF GASTROINTESTINAL PARASITES ON VEGETABLES IN SOME SELECTED MARKETS AND FARMS IN ZARIA METROPOLIS, KADUNA STATE, NIGERIA

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Ethical considerations: When reporting experiments on animals Observation of the ARRIVE guidelines 2.0: Updated guidelines for reporting animal research, published on July 14, 2020 (DOI: 10.1371/journal.pbio.3000410), is applied. The authors ensure that all procedures were performed in compliance with the guidelines for animal care of their institutions or with national/international guidelines.

ABSTRACT

Parasitic infections pose significant threats to human and animal health, particularly in developing countries, where they contribute to socio-economic challenges. This study investigated the prevalence of parasites on vegetables cultivated and sold in farms and markets in Zaria metropolis, Kaduna State, Nigeria. A total of 105 vegetable samples were analyzed using simple sedimentation and saturated salt flotation techniques with a zinc sulfate sucrose medium (specific gravity: 1.21). Overall, 22.9% of the samples were contaminated with parasites. The detected parasites included nematode larvae (8.6%), *Strongyloides* spp. (1.0%), Strongyle eggs (5.7%), *Spirocerca lupi* (1.9%), *Heterakis* spp. (1.0%), *Aspicularis tetraptera* (1.9%), *Entamoeba* spp. (1.0%), *Coccidia* spp. (2.9%), *Balantidium* spp. (1.0%), and *Fasciola* spp. (1.0%). Contamination rates were highest in cucumber (*Cucumis sativus*, 28.6%) and carrot (*Daucus carota*, 28.6%) samples, followed by cabbage (*Brassica oleracea*, 21.2%), onion (*Allium cepa*, 20.0%), and lettuce (*Lactuca sativa*, 17.6%). A significant association was observed between parasite contamination and the two local government areas in Zaria ($\chi^2 = 5.379$, $p = 0.020$). Public health concerns were underscored by the presence of nematode larvae suggestive of *Strongyloides stercoralis*, a helminth capable of reproducing in the environment and secreting larvae in feces. These findings emphasize the need for improved agricultural practices, such as composting human and animal waste before use as manure. Thorough washing of vegetables is strongly recommended to reduce the risk of parasitic infections.

Keywords: farm; gastrointestinal parasite; market; vegetable; Zaria metropolis

INTRODUCTION

Parasitic infections remain a significant global health challenge, particularly in developing countries where poor sanitation exacerbates their socioeconomic impact [1]. Parasites, broadly classified into ectoparasites and endoparasites, include helminths such as roundworms (*Nematodes*), tapeworms (*Cestodes*), flukes (*Trematodes*), and thorny-headed worms (*Acanthocephalans*), as well as protozoans. These organisms often require both definitive and intermediate hosts for their life cycle [2]. Vegetables, an essential component of human diets, are frequently implicated in the transmission of enteric parasites due to contamination during cultivation, harvest, transport, and storage. Common contaminants include *Ascaris lumbricoides*, *Cryptosporidium* spp., *Entamoeba histolytica*, *Giardia intestinalis*, and hookworm species [3, 4]. Studies from various countries, including Ethiopia [4], Ghana [3], and Nigeria [5, 6], highlight a high prevalence of parasitic contamination on vegetables. Recent evidence further confirms that this problem remains widespread. A 2024 systematic review and meta-analysis reported pooled contamination rates of approximately 44–47% for fruits and vegetables globally, with helminths such as *Ascaris* spp. and protozoans like *Giardia* spp. being the most frequently detected parasites, highlighting the persistent public health concern associated with fresh produce consumption [7].

In Nigeria, parasitic contamination is under-researched, with limited studies reporting contamination rates in markets and farms. Nevertheless, recent findings from Ado-Ekiti Metropolis revealed that about 65% of vegetables sampled from local markets were contaminated with medically important parasites, including *Strongyloides stercoralis*, *Giardia lamblia*, and *Ascaris lumbricoides*, indicating a substantial risk to consumers [8]. Earlier studies have similarly identified *Ascaris* spp., hookworms, *Trichuris* spp., and *Strongyloides* spp. on vegetables sold in Maiduguri [6], Jos [5], and Ilorin [9]. Contributing factors include the use of untreated manure, wastewater irrigation, and poor post-harvest practices [10]. Environmental factors such as climate, rainfall, and soil type further influence parasite prevalence. The increasing trend of consuming raw or lightly cooked vegetables to preserve nutrients may heighten the risk of parasitic infections [11]. Practices such as using untreated sewage as fertilizer are prevalent in some regions, facilitating the transfer of parasites from

soil to crops and humans [12]. Supporting this concern, a 2024 community-based study in Ethiopia reported a contamination rate of approximately 46.1% among vegetables and fruits sold in peri-urban markets, reinforcing the role of fresh produce as a major route for intestinal parasite transmission in low-resource settings [13]. Addressing this issue requires raising awareness among farmers and consumers, improving agricultural practices, and implementing strict hygiene measures. Research on the prevalence of gastrointestinal parasites in vegetables is vital for informing public health interventions, particularly in regions like Zaria metropolis, Nigeria, where parasitic diseases are endemic. This study aims to determine the prevalence of gastrointestinal parasites on vegetables from selected farms and markets in Zaria.

MATERIALS AND METHODS

Study Area

This study was carried out within the Zaria metropolitan authority, which comprises two local government areas, namely, Zaria and Sabon Gari. Zaria is located in the Northern Guinea Savannah zone within latitudes 10° 59' 18" N and longitudes 7° 41' 46" E at an altitude of 550–700 meters above sea level and a total land area of 300 km². Sabon Gari LGA is located at 11° 9' 50" N, 7° 41' 49" E, with a land mass of 263 km².

Study Design

A cross-sectional study was conducted using a purposive sampling technique to collect samples of five different types of vegetables from four farms and four markets. At the market, vegetables were displayed on tables, while at the farms, they were placed on the ground.

Sample Collection

The vegetables include lettuce (*Lactuca sativa*), cabbage (*Brassica oleracea*), cucumber (*Cucumis sativus*), onion (*Allium cepa*), and carrots (*Daucus carota*). A total of 105 samples were randomly collected and labeled from the above-mentioned farms and markets. The vegetables were placed in clean polythene bags and transported to the laboratory. The samples were stored at 4°C until processed.

Laboratory Procedures

A modification of the method by Abougrain et al. [14] was used as follows: Two hundred and fifty grams of each fresh, unwashed vegetable sample from both markets and farms were weighed into a sterile plastic bowl and washed with 250 ml of physiological saline solution (0.95% NaCl). The washing water was left for 10 hours to allow sedimentation, after which the top layer was discarded. The remaining washing water was centrifuged at 1500 g for 5 minutes. The supernatant was discarded, and the sediment was collected into 30 ml centrifuge tubes. Each of the 105 samples was processed independently.

1. Simple Sedimentation

The sediment was allowed to stand for 30 minutes, and the supernatant was discarded. A thin smear of each sediment was made using a Pasteur pipette on a clean glass slide. The slides were observed under a light microscope using 10x and 40x objective lenses.

2. Saturated Salt Flotation

The supernatant was discarded, and the residue was gently agitated in a sucrose flotation medium with a specific gravity of 1.21, then sieved through gauze placed on a funnel into a test tube. Each test tube was filled to the brim with the flotation medium to form a convex meniscus. A cover slip was placed on top of the test tube for 30 minutes, then carefully removed and placed on a clean glass slide. The slide was examined under a microscope using 40x and 10x objective lenses for the presence of parasite eggs and oocysts. The morphological characteristics of the eggs, as described by Soulsby [15], were used for identification.

Data Analysis

The Statistical Package for the Social Sciences (SPSS), version 21, was used to analyze the data. Chi-square tests were performed to assess the association between parasite eggs and the factors studied. P-values ≤ 0.05 were considered significant. The number of positive samples was divided by the total number of samples to calculate the estimated prevalence.

RESULTS

The overall prevalence of parasitic contamination was 22.9% (24/105). Specifically, the prevalence in Sabon Gari and Zaria Local Government Areas (LGAs) was 31.6% (18/57) and 12.5% (6/48), respectively. Statistical analysis revealed a significant association between the prevalence of parasite eggs and the LGAs sampled ($p = 0.02$) (Table 1). When comparing sources, the prevalence of parasite eggs was slightly higher in vegetables sampled from markets (28.0%) compared to farms (18.2%), although this difference was not statistically significant ($p = 0.231$) (Table 1). The prevalence of parasite eggs was highest in cucumbers and onions (28.6%) compared to cabbage (21.2%), carrots (20.0%), and lettuce (17.6%). However, the differences were not statistically significant ($p = 0.903$) (Table 1).

Among market samples, the prevalence of parasite eggs varied across the four markets studied: Sabon Gari Market (33.0%), Samaru Market (41.7%), Tudun Wada Market (21.4%), and Galma Market (11.1%) (Table 2). For farm samples, prevalence rates were 12.5% in Shika Farm,

Table 1. Prevalence of gastrointestinal parasite eggs/oocysts on vegetables in Zaria metropolis, Kaduna State, Nigeria

Variable	Category	Number examined	Number positive	Prevalence (%)	Chi-square	P-value
LGA	Sabon Gari	57	18	31.6	5.379	0.020
	Zaria	48	6	12.5		
Source	Market	50	14	28.0	1.432	0.231
	Farm	55	10	18.2		
Type of vegetable	Cabbage	33	7	21.2	1.053	0.903
	Carrot	20	4	20.0		
	Lettuce	17	3	17.6		
	Cucumber	14	4	28.6		
	Onion	21	6	28.6		
	Total	105	24	22.9		

Table 2. Distribution of gastrointestinal parasite eggs/oocysts on vegetables across selected markets and farms in Zaria metropolis, Kaduna State, Nigeria

Source	Category	Total No. Examined	Number Positive	Prevalence (%)	Chi-Square	P-value
Market	Sabon Gari	15	5	33.0	4.744	0.315
	Samaru	12	5	41.7		
	Tudun Wada	14	3	21.4		
	Galma	9	1	11.1		
	Total	50	14	28.0		
Farm	Shika	16	2	12.5	8.085	0.89
	Bomo	13	5	38.5		
	Tudun Wada	11	3	27.3		
	Gyallesu	15	0	0.0		
	Total	55	10	18.2		

Table 3. Prevalence of nematode, trematode and protozoan eggs/oocysts on vegetables in Zaria metropolis, Kaduna State, Nigeria

LGA	No. examined	Prevalence Nematode (%)	Prevalence Trematode (%)	Prevalence Protozoan (%)	Fisher Exact	P-value
Sabon Gari	57	16 (28.1)	2 (3.5)	1(1.8)	11.407	0.010
Zaria	48	3 (6.2)	0 (0.0)	3(6.2)		
Total	105	19 (21.1)	2 (1.9)	4 (3.8)		

38.5% in Bomo Farm, 27.3% in Tudun Wada Farm, and no parasite was observed in Gyallesu Farm (Table 2).

The types of parasites observed included nematodes, trematodes, and protozoans (Fig. 1). In Sabon Gari LGA, the prevalence of these categories was 28.1%, 3.5%, and 1.8%, respectively. In Zaria LGA, the prevalence rates were both 6.2% for nematodes and protozoans. A significant association was also observed between the prevalence of parasite categories and the LGAs sampled ($p = 0.01$) (Table 3).

DISCUSSION

The prevalence of helminth and protozoan eggs on freshly cultivated and marketed vegetables from the Zaria and Sabon Gari local government areas of Kaduna State is of public health significance, but it is lower than reports from Jos Plateau (36.0%) [5], Ilorin (40%) [16], Abeokuta (73.5%) [17], and Port Harcourt (29.5%) [18]. Conversely, it is higher than findings from Ibadan (11.6%) [19] and Maiduguri (3.5%) [6]. Variations in prevalence across these studies may be attributed to differences in sample types, collection methods, seasonal factors, farming practices, and water or soil quality. The vegetables examined

in this study included cabbage, lettuce, carrots, cucumber, and onions. Detected parasites included *Strongyloides stercoralis*, nematode larvae, strongyle eggs, *Spirocerca*, *Heterakis*, *Aspicularis*, *Entamoeba histolytica*, coccidia, *Balantidium*, and *Fasciola*. Cucumbers and onions exhibited the highest contamination levels, differing from previous studies [20, 21] which did not sample cucumbers. Amaechi et al. [16] found lettuce to be the most contaminated, while Tchounga et al. [1] reported cabbage as the least contaminated.

Nematode larvae, likely *Strongyloides stercoralis*, were the most prevalent parasite, indicating fecal contamination. This poses significant public health risks due to the parasite's ability to proliferate independently of a host. Strongyle eggs were also common, possibly linked to manure types and treatments used in vegetable cultivation. Vegetables from Bomo farms had the highest contamination, likely due to irrigation with water from River Bomo, which is contaminated by open defecation, refuse dumping, and runoff from pit latrines and sludge, consistent with observations by Dauda et al. [22]. High contamination in Samaru and Sabon Gari markets may stem from their sourcing of vegetables from Bomo farms, poor handling practices, lack of adequate water for washing, and poor storage conditions. The detection of *Aspicularis tetraptera*

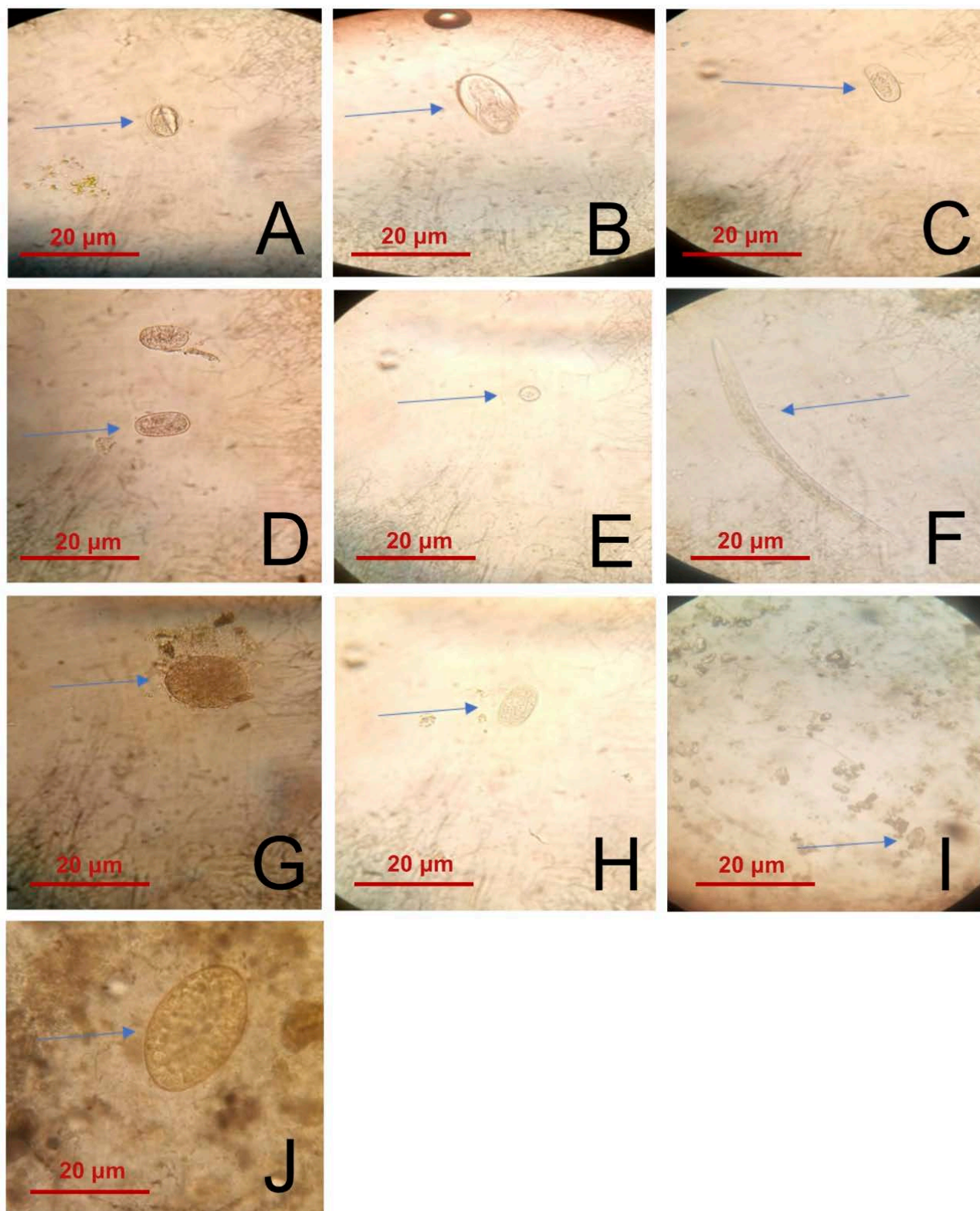


Fig. 1. Gastrointestinal parasite eggs and oocysts on vegetables sampled; A: *Strongyloides* egg, B: *Aspicularis tetraptera* egg, C: *Spirocera lupi* egg, D: *Strongyle* egg, E: *Coccidia* oocysts, F: *Nematode* larvae, G: *Balantidium* cysts, H: *Heterakis* egg, I: *Entamoeba* cysts, J: *Fasciola* egg (using a light microscope at x40 magnification as captured with a digital camera)

eggs in market samples suggests rodent contamination during storage.

A higher prevalence of contamination was observed in market-sourced vegetables compared to farm-sourced ones. This likely reflects additional contamination during handling, washing with contaminated water, or inadequate storage facilities. These findings underscore the need for improved farming, handling, and hygiene practices to mitigate health risks associated with vegetable consumption in the region.

CONCLUSIONS

This study confirms a 22.9% prevalence of helminth and protozoan contamination in vegetable samples from farms and markets in the Zaria metropolis. Nematode larvae, likely *Strongyloides*, and strongyle eggs were the most common parasites, underscoring the risk of consuming contaminated vegetables. These findings highlight the importance of monitoring and improving hygiene practices in vegetable cultivation and marketing to reduce the risk of parasitic contamination and protect public health.

Health education on personal hygiene and safe eating practices should be prioritized in the study area. Markets must be equipped with modern sanitary amenities such as toilets, running water, and proper drainage systems to enhance hygiene. Preventing contamination requires integrated strategies, including proper wastewater treatment, crop restrictions, and improved wastewater application techniques.

Data Availability Statement

The raw data of this article will be made available by the authors without undue reservation.

Ethical Statement

Ethical approval was not necessary for this work.

Conflict of Interest

No conflict of interest.

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Authors' contributions

AAI, EDO, and CVO designed the research; AAI and CVO collected the samples; EDO and AAI analyzed and interpreted the data. AAI, EDO, and CVO contributed to writing the manuscript. All authors read and approved the final manuscript.

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