Prevalence and Distribution of Intestinal Parasites in Edible Vegetables Sold In Selected Markets in Anambra State, Southeast Nigeria

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ABSTRACT

Vegetables are essential to human nutrition, but in many developing countries, they represent a source of parasitic infection. This risk is heightened by the common use of untreated wastewater for irrigation and the frequent consumption of raw or undercooked vegetables. Despite growing public health concerns, there is paucity of evidence on parasitic contamination of raw vegetables sold in Awkuzu and Nteje markets in Anambra State, Nigeria. A total of 240 vegetables were collected from 24 vendors in the 2 markets and each vegetable was first washed with normal saline, and the normal saline solution used centrifuged. The sediment was examined microscopically for infective stages of parasites. Chi-square test was used to determine association between variables at $p<0.05$. The results showed that 35.4% of all vegetable samples were contaminated. Parasites found include Ascaris lumbricoides, Taenia spp Balantidium coli, Coccidia spp. and Toxocara spp. Ascaris lumbricoides had the highest infection prevalence (30%), Taenia spp. had the second highest infection rate 2.5%. among vegetables, of the 7 types of vegetable examined, Amaranthus cruentus was the most contaminated (60%) and Piper guanines was the least contaminated (13.3%). There was significant association between vegetable type and parasitic contamination ($p>0.05$). There was no significant difference in contamination between vegetables sold in Nteje market (35.7%) and then those sold in Awkuzu (30.0%). The study showed moderate prevalence and variation in parasite distribution across vegetables types. The findings echo the need for improved agricultural water, sanitation and hygiene practices and behaviour change communication to reduce contamination risks.

KEYWORDS
Parasitic contamination, raw vegetables, Public health, Ascaris lumbricoides, Prevalence, Awkuzu and Nteje markets, Anambra State, Nigeria, Wastewater irrigation, Food safety

I. INTRODUCTION

Vegetables are an important part of human nutrition, offering a wide range of edible plant parts such as roots, stems, flowers, fruits, and leaves. They are packed with essential nutrients, including vitamins, proteins, and dietary fibre, which contribute significantly to maintaining good health and reducing the risk of various diseases. Growing awareness of these health benefits has led to increased vegetable consumption, with studies highlighting

their role in lowering the risk of heart disease, stroke, and certain cancers. However, vegetables are highly vulnerable to contamination by enteric pathogens at any stage of production, from cultivation to consumption. This contamination can result from several factors, including the use of polluted irrigation water, untreated manure, fecal contamination from humans and animals, and poor hygiene practices during harvesting, storage, and food preparation. In developing countries like Nigeria, these risks are heightened by the common use of untreated wastewater for irrigation and the frequent consumption of raw or undercooked vegetables, contributing to a higher prevalence of intestinal parasitic infections. Globally, soil-transmitted helminthic infections affect over 1.5 billion people, predominantly in tropical and subtropical regions, including sub-Saharan Africa, the Americas, China, and East Asia (WHO, 2018).

Research in Nigeria has shown significant contamination of edible vegetables with intestinal parasites. Ezeagwuna et al. (2024) found a prevalence of 25.6% for *Ascaris lumbricoides* and 7.6% for Hookworm spp. in leafy vegetables from Ogidi market, Anambra State. Similar studies reported a 28.0% prevalence of *Ascaris lumbricoides* in Ilorin, Kwara State (Amaechiet al., 2016) and a 20.4% prevalence in salad vegetables from Abakaliki, Ebonyi State, with Fasciola spp. showing a lower prevalence of 5.3% (Ani et al., 2015). The persistence of these parasites is often exacerbated by poor social and environmental conditions, particularly in the unplanned slums of developing nations. With parasitic infections widespread in both urban and rural settings, these infections tend to be more prevalent in impoverished rural areas. Despite these findings, there is currently no baseline data on the extent of parasitic contamination in raw vegetables in Awkuzu and Nteje, highlighting a critical gap in knowledge that this study aims to address. This study therefore aimed to investigate the prevalence and distribution of intestinal parasites in raw vegetables sold in Awkuzu and Nteje commonly consumed vegetables

A. Study Area

The present study was conducted in Awkuzu (6.2424°N, 6.9397°E) and Nteje (6.2813°N, 6.5230°E) in Oyi Local Government Area (LGA), Anambra State, Nigeria. The area is predominantly inhabited by the Igbo ethnic group, with an estimated population of 168,201 (NPC, 2006). Oyi LGA is located in the tropical rainforest belt of West Africa. The area has an annual rainfall of 2000 mm, and temperatures range from 22°C to 32°C in the dry season. Awkuzu comprises three main sections—Ezi, Ifite, and Ikenga—further divided into sub-villages. Ezi includes Iru-Anyika, Aka-Ezi, Igbu, and Ozu; Ifite has Amabo, Isioji, and Ifite-Umueri; and Ikenga consists of Ezinkwo, Nkwelle-Awkuzu, Umuobi, Ukpomachi, Dusogu, Otoko, and Umudioka. Nteje, the Oyi LGA headquarters, is located about 25 km northeast of Onitsha (Ojukwu, 2016). The main markets include Nkwo in Awkuzu and Eke igwe in Nteje, which operates only on Eke market days. The area is characterized by human settlements, waterways, and a predominantly agrarian economy, with additional engagement in trading and civil service (Agulonye, 2020).

B. Sample Collection

Vegetable samples, including commonly consumed varieties, were systematically collected from 24 sellers across two markets. A standardized quantity of each vegetable type was

sampled, ensuring uniformity and equal representation from both study locations (Trainer et al. 2010). Samples were collected between 8:00 AM and 10:00 AM, transported to the laboratory under sterile conditions in labelled polythene bags for parasitological examination.

C. Sample Analysis and Examination

In the laboratory, the vegetable samples were labelled according to their collection sites. A 100-gram sample of each vegetable was washed in 100 ml of normal saline in a sterile beaker to dislodge potential parasitic eggs, cysts, and larvae. The resulting suspension was filtered through a sterile sieve to remove debris. The filtrate underwent sedimentation by centrifuging at 2500 rpm for 5 minutes. After centrifugation, the supernatant was carefully decanted without disturbing the sediment. The sediment was then examined microscopically using x10 and x40 objective lenses for the presence of parasites.

II. **STATISTICAL ANALYSIS**

Data were analysed using descriptive statistics and chi-square tests with the Statistical Package for Social Sciences (SPSS). Statistical significance was set at $P < 0.05$, and prevalence was calculated as percentages. Data were presented in tables according to the study objectives.

A. Results

Tables 1 shows that A. *lumbricoides* had the highest prevalence at 72 (30%), and *Toxocara* spp. the lowest at 1 (0.4%). Among vegetables, A. cruentus (Spinach/Green) shows the highest parasite burden at 18 (60%), while P. guineense (Uziza) had the lowest at 4 (13.3%). A significant association exists between vegetable species and parasite contamination ($P < 0.05$). Figure 1 shows Prevalence of parasites in vegetables sold in Awkuzu and Nteje. The findings indicate that *Amaranthus cruentus* (Spinach/Green) had the highest contamination at 18 (60.0%), while *Piper guineense* (Uziza) had the lowest at 4 (13.3%). The overall prevalence is 35.4%.

There were significant differences in contamination rates between parasites prevalence across the different vegetables examined ($P<0.05$). Figure 2 specifically highlights the distribution of parasites across the different vegetable types, with *Ascaris lumbricoides* being most widely distributed occurring in each and every vegetable type, and *Taenia* spp being the second most widely distributed occurring in 5 vegetable types.

Meanwhile, *Toxocara* spp was the least common parasite, occurring only in water leaf (Tellinum triangulare). Figure 3 illustrates parasite distribution in the Awkuzu and Nteje markets. Chi-square analysis reveals that Nteje had a higher prevalence of contamination at 43 (35.7%) compared to Awkuzu at 42 (35%). There was however no significant difference in contamination rates between the two markets ($P > 0.05$).

Table 1: Prevalence and intensity of parasites in vegetables sold in Awkuzu and Nteje

Parasite Species	Examined Vegetables	Contaminated Vegetables	Prevalence (%)
A. *lumbricoides*	240	72	30%
Taenia spp.	240	6	2.5%
B. Coli	240	4	1.7%
Coccidia spp.	240	2	0.8%
Toxocara spp.	240	1	0.4%
Total (All)	240	85	35.4%

$\chi^2=54.62$, df = 4, P≈ 0.0001

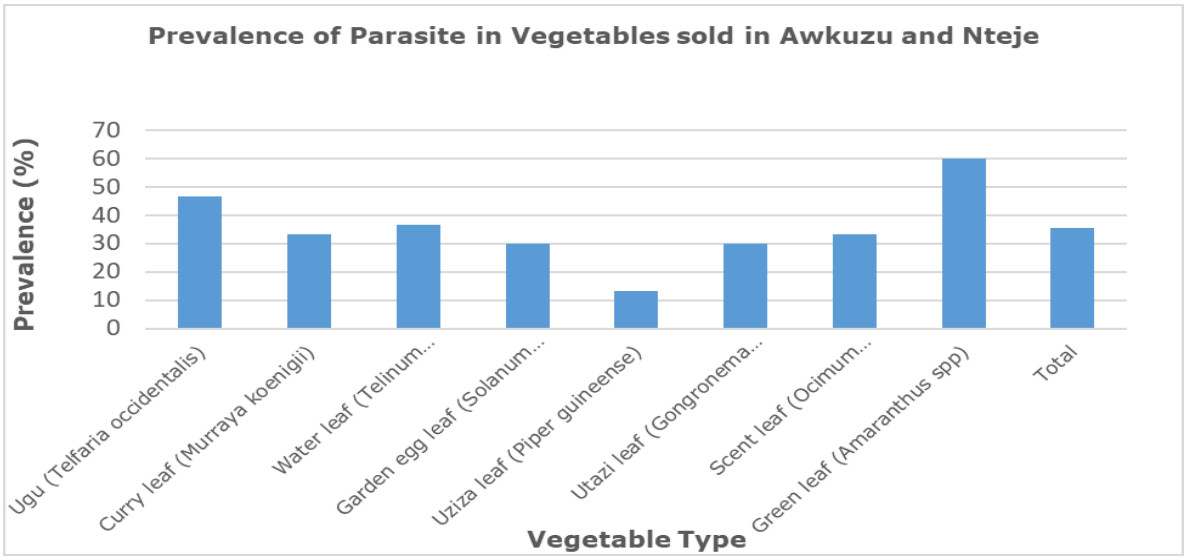
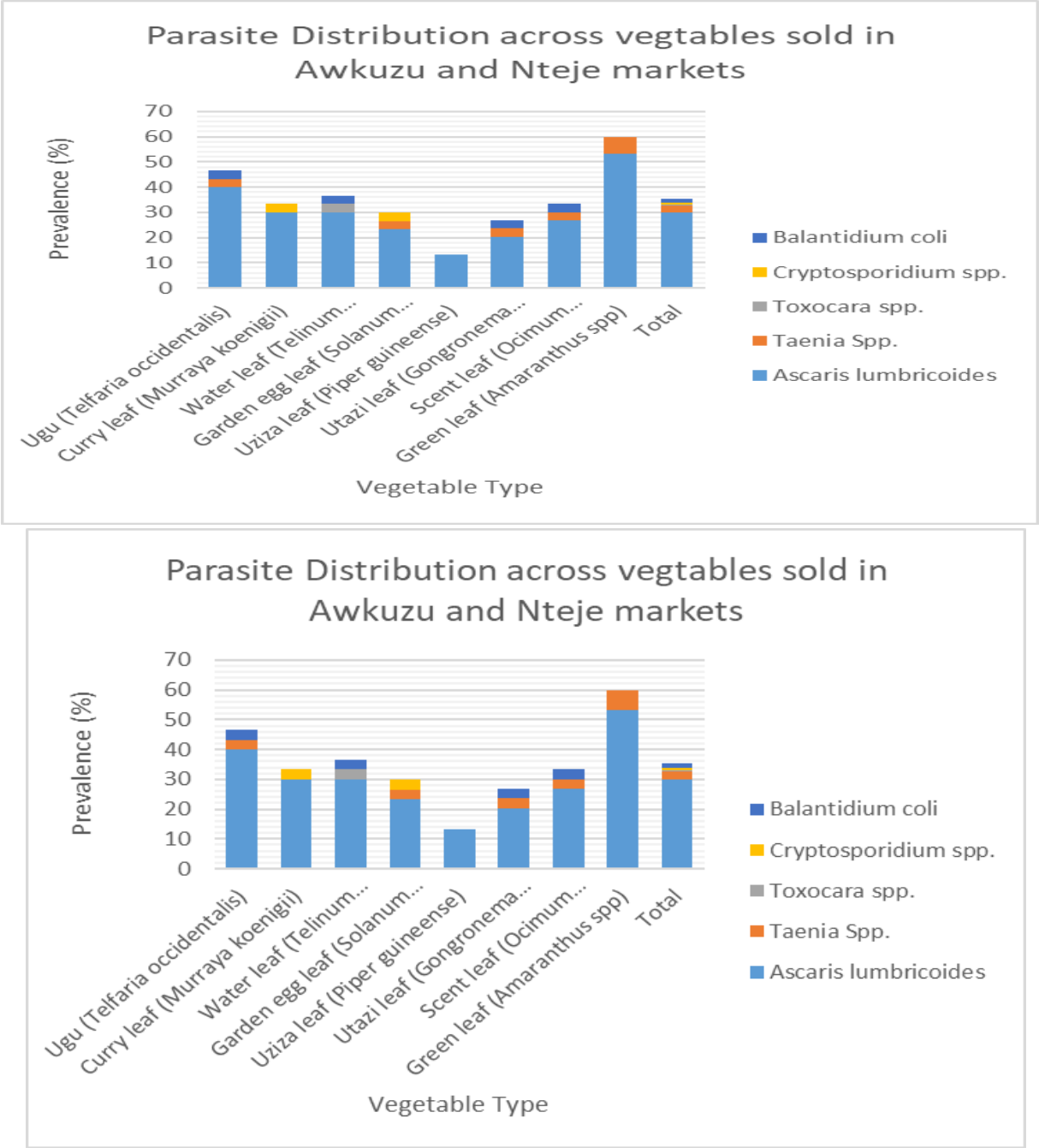


Figure 1: Prevalence of parasites in vegetables sold in Awkuzu and Nteje

χ2=15.19, df = 7, P=0.034



Parasite Distribution across vegtables sold in Awkuzu and Nteje markets
Prevalence (%)
70
60
50
40
30
20
10
0
Ugu (Telfaria occidentalis)
Curry leaf (Murraya koenigii)
Water leaf (Telinum...
Garden egg leaf (Solanum...
Uziza leaf (Piper guineense)
Utazi leaf (Gongronema...
Scent leaf (Ocimum...
Green leaf (Amaranthus spp)
Total
Vegetable Type
Balantidium coli
Cryptosporidium spp.
Toxocara spp.
Taenia Spp.
Ascaris lumbricoides

Figure 2: Parasite distribution across vegetable types sold in Awkuzu and Nteje markets

$\chi 2=23.41$, df = 28, P=0.498

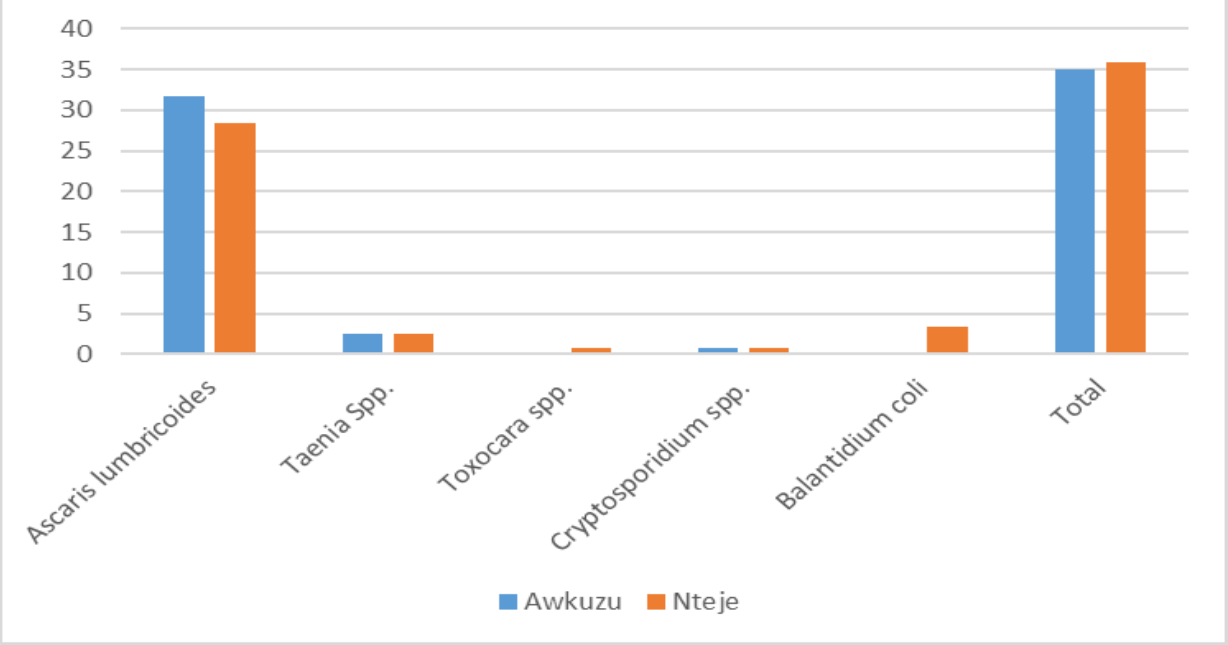


Figure 3: Distribution of parasites across Awkuzu and Nteje markets

χ^2=0.351, df = 1, P=0.553

III. DISCUSSION

The study identified five parasitic species on edible vegetables with their respective developmental stages. A. *lumbricoides* and *Taenia* spp have been consistently identified across Jos, Ibadan, Kaduna and Anambra state in previous studies indicating their wide spread prevalence in edible vegetables in Nigeria. The presence of protozoans observed in this study including B. coli and E. histolytica detected in this study echo the risks of protozoan infections from the consumption of vegetables this finding is in agreement with previous findings from a similar study conducted by Eslahi et al. (2024). The presence of *Toxocara*spp in this study is notable as it is not commonly reported in other regions of the country thus suggesting localized environmental factors like the presence of infected animals in the farming vicinity.

The findings of this study revealed moderate parasite prevalence with highest prevalence's of A. *lumbricoides* and *Taenia* spp than other parasite species. This could be as a result of the common practice of using untreated animal and human compost as fertilizer thus introducing parasitic organisms into the soil which could in turn contaminate the vegetables. Higher prevalence of parasitic helminthic has been recorded in similar studies, and has been attributed to poor hygiene practices during and after harvesting. For instance, a study conducted in Dutsin-Ma, Katsina State reported high prevalence (88.9% parasitic contamination of vegetables grown). In the study, the authors attributed the high prevalence to the common practice of using contaminated waters for irrigation as well as washing of vegetables (Khalid et al. 2018). In Ibadan, Oyo State, lower prevalence were

recorded, although this was attributed to the smooth-surfaces vegetables in the study (tomatoes and cucumbers) which are less likely to harbour parasites.

The findings of the study revealed statistically different parasite contamination among the vegetable types that among the vegetables surveyed, Amaranthus spp (commonly called green) exhibited the highest contamination rate at 60% and the second highest prevalence was recorded in Talinum triangulare (ugu), and *Piper guineense* (uziza) had the lowest parasite contamination rates. Comparatively, a study conducted in Ihiala LGA of Anambra state reported highest contamination rates among Solanumm elongena (garden egg leaf), whereas cent leaf. Meanwhile, a study in Ede Town of Osun State found Spinacia oleracea (African spinach) was the most contaminated vegetable and Celosia argentea was the least contaminated. The variations in contamination rates suggest that localized, environmental factors including differences in water, sanitation and hygiene as well as agricultural practices could significantly influence prevalence of parasites in edible vegetables grown in Nigeria. From the findings, A. *lumbricoides* had the widest distribution, with every vegetable sampled having A. *lumbricoides* parasites infestation. *Taenia* was the next most distributed parasite present in more than half of the vegetable. The wide distribution suggests that A. *lumbricoides* eggs are pervasive in the environment likely due to contaminated soil. A. *lumbricoides* has been reported to be resilient and able to withstand harsh conditions heat and drought and can stay remain viable for year. This aligns with findings from a systematic review and meta-analysis of multiple studies done in Nigeria which revealed that A. *lumbricoides* was the most prevalent nematode of fruits and vegetables.

Awkuzu had slightly higher overall prevalences of parasites than Nteje, more so, *Taenia* spp and Cryptosporidium had equal prevalence in both Nteje and Awkuzu, while, B. coli and *Toxocara* species were completely absent in Nteje but present at low prevalence in Awkuzu. The parasite prevalence at both markets suggest the presence of similar hygiene challenges like poor farming and handling practices across both locations. This echoes findings reported by Adamu et al (2012) in Abuja and Egbom et al. (2025) in Imo State where similar parasite contamination patterns were reported across vegetables sourced from different locations. However, differences have also been reported especially in studies where vegetable handling and market hygiene practices. For instance, in Benue state, vegetables sold in markets close to open drainage systems recorded significantly higher parasite loads.

IV. CONCLUSION

This study highlights the moderate but concerning prevalence of parasitic contamination in edible vegetables, with *Ascaris lumbricoides* and *Taenia* spp being the most widely distributed across all sampled vegetables. The variations in parasite types and contamination levels across vegetable species and different locations (Nteje and Awkuzu) underscore the influence of local environmental and hygiene practices on parasite transmission. Therefore, improved agricultural and handling/hygiene practices, including the use of clean water for irrigation and proper washing of vegetables before sale and consumption, are strongly recommended. Moreover, public health awareness campaigns on safe handling and preparation of vegetables is recommended.

Author contributions: NCC and NEI wrote the first draft, OEO edited the manuscript NOI and OOA developed the protocol OCS did the experimental design, CJI and OEO oversaw monitoring and study implementation while NCC did the statistical analysis of the work.

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C. Competing interest: The authors declare that they do not have any conflicts of interest.

D. Data availability: The data used to support the findings of this study are available upon reasonable request.

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