Original Research Article

Parasites Associated with Open markets Vegetables: Implication for Public Health Interventions in Ethiope East, Southern Nigeria

Abstract

Objectives: Vegetables have been reported to be a mechanical means of transmission of human intestinal parasites. This study is aimed to ascertain the association between parasites and vegetables sold in Ethiope East, Delta State, Nigeria. **Methods:** Two hundred and seventy (270) vegetables were subjected to sedimentation and zinc sulphate floatation techniques for parasitic investigations. **Results:** Of the 270 vegetables examined, 184(68.15%) were infected. *T. occidentalis* had the highest prevalence (9.26%), closely followed by *B. oleracea* and *D. carota* with a value of 8.89% and 8.15% respectively. The highest parasite prevalence was observed in Abraka (78.89%), followed by Eku (72.22%) and Okpara water-side (53.33%). Abraka had its highest prevalence in *D. carota* and *C. sativum* with a prevalence of 11.11 and 10.00% respectively. Statistically, there was no significant difference in the contaminated vegetable ($p > 0.05$) but a considerable significant difference was noted in the market locations ($p < 0.05$). The highest percentage occurrence of parasites was *A. lumbricoides* with a percentage occurrence of 23.49. The most prevalent parasites in Abraka were *Ascaris lumbricoides* (45.56%) and *Entamoeba histolytica* (30.00%). There was significant effect ($p < 0.05$) in the prevalence of parasites ($p = 0.0003$; $df = 6$; $F = 11.07$) and markets locations ($p = 0.0019$; $df = 2$; $F = 11.01$). The Principal Component Analysis showed that the study locations positively influence the occurrence of parasites with Abraka location accounting for 95.99% of the total variance. The analysis further showed that *A. lumbricoides, Trichuris trichura,* and hookworm prevalence were strongly correlated to Abraka and Okpara water-side locations. **Conclusion:** Given the public health importance of the parasites isolated, there is a need for improved environmental sanitation, personal hygiene and surveillance systems in vegetable transportation, storage and means of displays in Ethiope East and Delta State at large.

Keywords: Vegetable parasites, Prevalence, Abraka, Eku, Okpara water-side, Public health.

1.0 INTRODUCTION

The voracious consumption of vegetables has increased in recent years because of their attendant health and nutritional benefits [1]. Vegetables form a key component of a healthy diet, highly beneficial for the maintenance of health and the prevention of diseases [2]. Vegetables are low in calories, fat and sodium, and supply fiber, vitamins, minerals, and other health-promoting phytochemicals. The importance of vegetables in supplying most of the vitamins and minerals such as carotene, ascorbic acid, riboflavin, iron, iodine and calcium cannot be over-emphasized.

Consumption of a diet rich in vegetables may reduce the risk of stroke, help reduce blood cholesterol levels and lowers the risk of cardiovascular diseases, type 2 diabetes, and certain cancers of the mouth, stomach, colon and rectum [3]. Potassium in some vegetables may also reduce the risk of kidney stones, bone-calcium loss and maintain healthy blood pressure; while antioxidants in vegetables help protect the body from oxidant stress, diseases and cancers by boosting immunity. Fibers absorbed in the colon retain moisture and ease faecal excretion, and defenses against hemorrhoids, colon cancer, and protracted constipation. The foliate in vegetables helps in the formation of red blood cells and reduces the risk of neural tube defects, spin Bifida and anencephaly during foetal development in pregnancy. Consumption of vegetables generally helps to maintain healthy life and body weight [3].

However, eating faecal-contaminated vegetables contributes significantly to the spread of intestinal parasite illnesses [4]. The increased consumption of fresh vegetables has been linked to several documented cases of parasitic diseases. In most cases, the vegetables are eaten raw or lightly cooked to retain their natural taste and to preserve heat-labile nutrients. This practice, however, facilitates the transmission of parasitic infections [5,6]. These vegetables are major risk factors for the prevalence and transmission of intestinal parasites in developing nations principally due to poor personal hygiene and sanitation [7].

Vegetables have been incriminated in the transmission of amoebiasis, giardiasis, toxoplasmosis, cryptosporidiasis, taeniasis, fascioliasis, strongyloidiasis and major helminthiasis, as well as eggs and larvae of *Cyclospora cayatanensis*, *Isospora* species *Hymenolepis nana*, *Toxocara* species, *Trichostrongylus* species, *Enterobius vermicularis* [6,8]. Universally, these human intestinal parasitic infections exhibit various clinical symptoms calling for public health interventions [9]. Infants, the elderly, and immuno-compromised persons are particularly vulnerable and at more risk of parasitic infections [10]. However, environmental epidemiological factors for parasites prevalence have not been properly elucidated but outbreaks of amoebic dysenteries, giardiasis and balantidiasis caused by *Daucus carota* carrot), *Brassica oleracea* (cabbage), *Lactuca sativa* (lettuce), and *Telfairia occidentalis* (fluted pumpkin leaf) have been documented.

Globally, approximately 3.5 billion people are infected with intestinal parasitic infections, of which 450 million exhibit symptoms with an annual mortality of 200 thousand reported [11,12]. Nearly 300 million people in resource-limited countries suffer from severe significant morbidity [13.14]. Parasitic infections are widespread in Nigeria and other Sub-Saharan African countries where they afflict various demographic groups [15]. The second most frequent factor contributing to outpatient morbidity in Nigeria is due to intestinal parasitic infections [16]. These infections have been linked to several physical and mental health issues, including diarrhea, anemia, stunting, physical weakness, poor educational performance, and growth retardation in children [15].

Intestinal parasites are primarily transmitted by fecal-oral route, mostly via ingestion with contaminated food and water or during direct hand-to-mouth contact [16]. Vegetables usually consumed raw are potential sources of infection. Empirical data have explicitly implicated *A. lumbricoides, E. histolytica, E. vermicularis, Fasciola gigantica, Giardia lamblia, Hymenolepis nana*, *Cryptosporidium parvum, Taenia saginata/solium, Trichuris trichiura*, and species of hookworms, *Cyclospora* and *Toxocara* to infect humans who consume contaminated vegetables without cooking or proper washing [17,18]. Delta State, Nigeria is a state where many intestinal parasites abound due to poor hygiene and sanitation practices [15,9,10,19,20,21]. There is a paucity of data on vegetable parasites in Ethiope East, Delta State, Nigeria, despite their role in the transmission of pathogens. Specifically, this study is aimed to: ascertain the association of parasites and vegetables sold in Ethiope East, Local Government Area; and to determine the spatial prevalence of vegetable parasites in Abraka, Eku and Okpara water-side communities.

2.0 MATERIALS AND METHODS

2.1 Brief Description of Study Area.

This study was carried out in September 2021 in Abraka, Eku and Okpara water-side situated between latitude 5^0 54^I and longitude 5^0 40^I (Fig. 1) Abraka, Eku and Okpara-water side are three major towns in Ethiope East, Delta State, Nigeria. The inhabitants are mainly farmers and traders together with civil servants. Sellers from Abraka, Eku and Okpara-water side markets mostly get their vegetables supplies directly from the local farmers and traders from Northern Nigeria. The inhabitants of Delta and neighbouring State usually patronizes these three (3) markets for vegetables. Toilet amenities are absent in most of the markets, hence traders resort to the use of open defecation, especially for children and disposed of within the markets. Sewage disposal is also poor and there is a hip of refuses where faeces are

often deposited in the markets. These faecal matters are washed during a heavy downpour of rain to the surroundings.

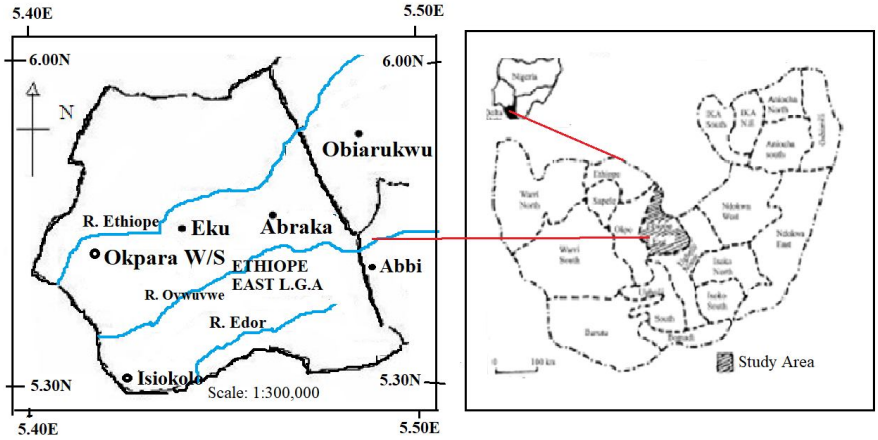

Fig. 1: Map of Ethiope East L.G.A, Delta State, Nigeria showing study locations (Source: Ito Ed.' E, 2023; Department of Animal and Environmental Biology, DELSU, Abraka)

3.2 Sample collection

The collection of samples was carried out with slight modifications to the method described by Endale *et al.* [14]. Two hundred and seventy (270) samples of nine different types of vegetables (*Talinium triangulare* (water leaf), *Cucumis sativum* (cucumber), *Daucus carota* carrot), *Amaranthus spinosus* (spinach), *Brassica oleracea* (cabbage), *Lactuca sativa* (lettuce), *Corchorus olitorius* (white jute), *Telfairia occidentalis* (Fluted pumpkin leaf) and *Celosia argentia* (quail grass) were purchased from farmers and vendors in three local markets, namely; Abraka, Eku and Okpara-water-side market in Ethiope East LGA, Delta State, Nigeria. Five (5) of each sample was collected randomly per week in each market from ten (10) places randomly selected. The samples were collected separately in a properly labeled plastic bag and transported to the laboratories Centre for Advance Research Delta State University, Abraka for parasitological examination.

2.3 Parasitological examination

Standard parasitological methods (Sedimentation and zinc sulphate floatation techniques) previously described were used to examine the vegetables collected [8,22].

2.4 Statistical Analysis

Data collected were analyzed using PAST software version 4.11. One-way and Two-way Analysis of Variance (ANOVA) were to determine the association between parasitic contamination rate and types of samples. Values of p less than or equal to 0.05 were considered significant.

3.0 RESULTS

Of the 270 vegetables collected, 184 were infected giving a total prevalence of 68.15%. The prevalence of parasites in the vegetable is presented in Table 1. *T. occidentalis* had the highest prevalence (9.26%), closely followed by *B. oleracea* and *D. carota* with a value of 8.89% and 8.15% respectively. However, the least infected vegetable was *C. sativum* (Table 1). Statistically, no significant difference (p = 0.271; F = 1.56) was observed in the prevalence of vegetable parasites.

Table 1. Prevalence and Distribution of Vegetables Contaminated with Parasites in Ethiope East, Delta State

Vegetables	N. E	N. I [%]	Overall Prevalence
T. triangulare	30	19(63.33)	7.04
C. sativum	30	16(53.33)	5.93
D. carota	30	22(73.33)	8.15
A. spinosus	30	21(70.00)	7.78
B. oleracea	30	24(80.00)	8.89

L. sativa	30	20(66.67)	7.41
C. olitorius	30	19(63.33)	7.04
T. occidentalis	30	25(83.33)	9.26
C. argentia	30	18(60.00)	6.67
Total	270	184	68.15

Table 2 presents the spatial percentage of infections of vegetables in the 3 selected locations. The highest prevalence was obtained in Abraka with a value of 78.89%, followed by Eku with 72.22%. Abraka had its highest prevalence in *D. carota* and *C. sativum* with a prevalence of 11.11 and 10.00% respectively. Similarly, Eku had its prevalence peak for *T. occidentalis* at 11.11% while its least prevalence (4.44%) was observed in *C. sativum*. However, *C. sativum* was the least contaminated vegetable in the Okpara water-side location (Table 2). Statistical ANOVA revealed that there was no significant difference in the prevalence of parasites ($p > 0.05$; $p = 0.316$; F = 1.286) but a considerable significant difference was noted in the market locations ($p < 0.05$; $p = 0.0.006$; F = 6.90).

Table 2. Prevalence of Parasites of vegetables sold at different markets in Ethiope East Local Government Area

	Markets					
	Abraka		**Eku**		**Okpara Water-side**	
Vegetables	N. E.	N. I.(%)	N. E.	N. I.(%)	N. E.	N. I.(%)
T. triangulare	10	7(7.78)	10	7(7.78)	10	5(5.56)
C. sativum	10	9(10.00)	10	4(4.44)	10	3(3.33)
D. carota	10	10(11.11)	10	8(8.88)	10	4(4.44)
A. spinosus	10	7(7.78)	10	9(10.00)	10	5(5.56)
B. oleracea	10	8(8.89)	10	9(10.00)	10	7(7.78)
L. sativa	10	8(8.89)	10	6(6.67)	10	6(6.67)
C. olitorius	10	7(7.78)	10	7(7.78)	10	5(6.56)
T. occidentalis	10	8(8.89)	10	10(11.11)	10	7(7.78)
C. argentia	10	7(7.78)	10	5(5.56)	10	6(6.67)
Total	90	71(78.89)	90	65(72.22)	90	48(53.33)

The highest percentage occurrence of parasites was *A. lumbricoides* with a cumulative percentage occurrence of 23.49%. This was followed by *E. histolytica* with 17.46%. this study showed that there was a total of 481 individual parasites (Table 3).

Table 3. Percentage Occurrence of Parasitic ova and cyst found in all the three markets

Parasites	**Number of parasites (%)**
E. coli	27(5.61)
E. histolytica	84(17.46)
A. lumbricoides	113(23.49)
G. lamblia	34(7.07)
T. trichuria	66(13.72)
F. gigantica	51(10.60)
Hookworm	67(13.93)
Total	481

The highest prevalence in Abraka was observed in *A. lumbricoides* with a value of 45.56%, followed by *E. histolytica* (30.00%). The Highest value in Eku was *A. lumbricoides* with 52.22% (Table 4). Okpara had *A. lumbricoides* as its most prevalent parasite with 27.77%, lower than Abraka and Eku values. ANOVA showed that there was a significant difference ($p < 0.05$) in the prevalence of parasites ($p = 0.0003$; $df = 6$; F = 11.07) and market locations ($p = 0.0019$; $df = 2$; F = 11.01). The PCA cartesian plot showed that the study

locations positively influence the occurrence of parasites with Abraka location accounting for 95.99% of the total variance (Table 4 and Fig. 2).

Table 4. Prevalence of Parasites in Vegetables Sold in selected Markets in Ethiope East

Parasites	**Markets**				
		Abraka	**Eku**	**Okpara Water-side**	**Overall Prevalence**
	N. E	N.I [%]	N.I [%]	N.I [%]	
E. coli	90	6(6.67)	12(13.33)	9(10.00)	10.00
E. histolytica	90	27(30.00)	43(47.78)	14(15.56)	31.11
A. lumbricoides	90	41(45.56)	47(52.22)	25(27.77)	41.85
G. lamblia	90	11(12.22)	13(14.44)	10(11.11)	12.59
T. trichuria	90	24(26.67)	27(30.00)	15(16.67)	24.44
F. hepatica	90	18(20.00)	21(23.33)	12(13.33)	18.89
Hook worm	90	23(25.56)	28(31.11)	16(17.78)	24.81
Eigenvalue		407.89	15.68	1.34	
Variation (%)		95.99	3.69	0.32	

[Note: The overall prevalence observed is based on 270 (90 x 3) vegetables examined]

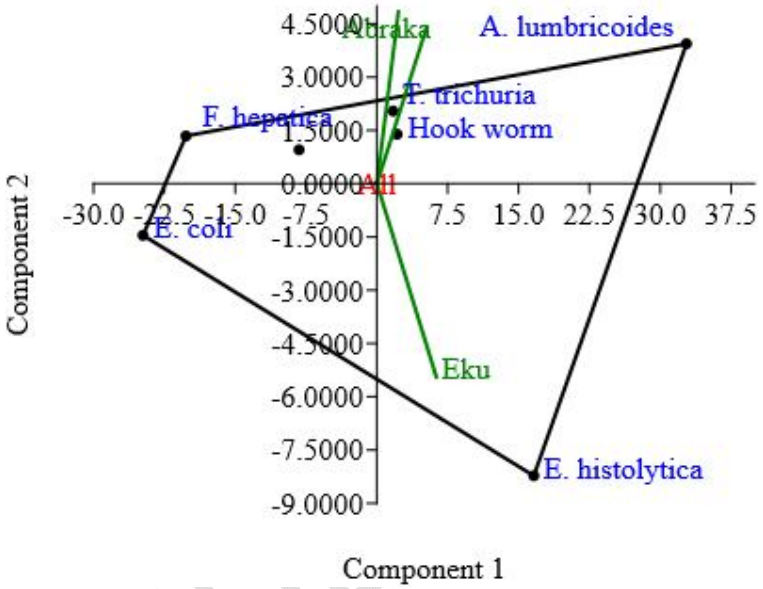

Fig. 2: PCA cartesian plot of the study locations and parasites prevalence.

The PCA further indicated that *A. lumbricoides, T. trichura,* and hookworm prevalence were strongly correlated to Abraka and Okpara water-side community (Fig. 2). The vector planes explicitly revealed that the variations observed in this study were mainly contributed by the three major STH (*A. lumbricoides, T. trichura* and hookworm).

4.0 DISCUSSION

The study recorded the presence of seven (7) parasites associated with 270 vegetables in assent with Bekele and Shumbej, [8]. This number of parasites with contamination of 68.15% is comparatively higher than 42.0% and 42.60% previously documented [6,8]. The relatively high parasitic infections in this present study are a reflection of inadequate sanitation, poor personal hygiene and geographical locations of markets. However, the intestinal parasites in this study differ in specie composition and abundance compared to other research [22,23,24] because some of these vegetables like carrots, cabbage and lettuce were transported from the northern states into the study area for consumption. During the process of harvesting and transportation, some of these parasites might have been destroyed. Despite variation in isolated parasites, *A. lumbricoides* and hookworm had a high occurrence

in vegetables in this study. This could be due to the encystation of these parasites in adverse environmental conditions and their adherence easily to vegetable surfaces [15,16].

The results of this study are in tandem with many studies which reported high lettuce parasitic contamination [24,25]. This may be ascribed to the fact that the leaves are capable of harboring parasites in-between and in addition to its uneven surfaces on which parasites are attached more easily than other vegetables with smooth surfaces i.e., cucumber and this observation is in accordance with Damen *et al.,* [26].

The types of vegetables herein analyzed are widely produced and consumed in Ethiope East, Delta State. Although the contamination rate found among them was statistically similar. The variation detected may be attributed to the anatomical differences of vegetable foliage. Cabbage has a high prevalence of 8.89%. this might be due to its large surface area and compact structure that provides better fixation and permanence of parasitic structures [27]. In addition, the flexibility of the leaves can facilitate contact with the soil with helminth ova probably found on the market floor [28].

According to Falavigna *et al*. [29], the remarkably high number and presence of helminth rather than protozoan structures detected in the present study are probably related to the practice of washing vegetables with the same bowl containing water in the field and, subsequently, at the point of sale before commercialization. These washing steps may be more efficient in the removal of protozoa, since the structure and size of helminths may hinder their removal from the surface of vegetables.

The presence of different parasitic species demonstrates that the population of Abraka, Eku and Okpara water-side is supposedly exposed to several debilitating diseases, such as hookworm infections, ascariasis, giardiasis and amebiasis. Indeed, a survey recently carried out in the city demonstrated that local children were infected with some of these pathogens [15,21]. The closely varied contamination could be due to similarity in parasitic life cycle, especially in relation to the elimination route of potentially contaminant structures, *i.e.* human and animal faeces. In this context, the presence of animals and humans infected with these pathogens in rural areas has been described to be associated with precarious sanitary installations, which could explain possible contamination of soil and water sources used for cultivation of the vegetables [30].

There was a high level of contamination of *E. histolytica* in this present investigation. These findings represent a public health concern since cysts are also eliminated with faeces into the environment. This elevated contamination corroborated the study conducted by Guilherme *et al*. [31] on vegetables marketed in *Maringá, Paraná,* Brazil, and is probably the result of the high viability of amoebic cysts in the environment [32].

Regarding the different markets studied, parasitic structures were detected in all of them, but the samples from the market were significantly more contaminated. Ethiope East open markets are characterized by the sale of agricultural products grown in rural areas close to major centers, where farmers exhibit their products on the floor and consumers move between. Thus, the high percentage of contamination detected at the Eku and Abraka markets reinforces the considerable risk to which the local population is exposed as highlighted by Ito and Egwunyenga, [15].

5. CONCLUSIONS

There is a need for improved surveillance systems on vegetable parasites through appropriate farming procedures, improved transportation and storage facilities in the various market destinations considering the fact that vegetables in the Ethiope East area were highly contaminated by intestinal parasites. This study suggested that inhabitants in the study area are at high risk of getting infections from eating vegetables daily which is of public health concern.

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