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PREVALENCE AND PUBLIC PERCEPTION OF GASTROINTESTINAL PARASITES IN SELECTED EDIBLE FRUITS AND VEGETABLES SOLD IN EKPOMA MARKETS, EDO STATE

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ABSTRACT

Fruits and vegetables are essential components of healthy diet because of their high nutritional and antioxidative properties, but could also constitute risk to human health when consumed unclean. This study assessed the prevalence and public perception of gastrointestinal parasites in commonly consumed fruits and vegetables sold in Ekpoma Markets, Edo State, from September to December 2024. A Total of 150 fruits and vegetable samples were randomly purchased from three selected markets (Ekpoma Main Market, Iruekpen Market and Opoji Market). The samples were analysed using sedimentation technique and examined microscopically for parasitic contamination. Structured questionnaires were administered to gather data on knowledge, hygiene practices and healthcare-seeking behaviour of the vendors. Data were analysed using descriptive statistics and Chi-square tests. The results revealed an overall prevalence rate of 64.7%, with vegetables exhibiting a higher contamination rate (70.7%) compared to fruits (58.7%). Iruekpen Market recorded the highest contamination rate (76.0%). Five gastrointestinal parasites were detected: Ascaris lumbricoides, hookworm, Strongyloides spp., Trichuris trichiura and coccidia, with hookworm being the most prevalent (31.3%). Public awareness of the potential for contamination was high, with 93.33% of respondents acknowledging the risk. However, many of the participant still relied on traditional treatment methods rather than seeking medical care. More than half of participants, (56.7%), reported regular deworming every few months. This study highlights the need for improved public health education on produce hygiene and emphasize the use of medical care over traditional remedies. Implementation of better sanitation practices in produce markets and encouragement of regular deworming are crucial steps toward reduction of parasitic contamination.

Keywords: Prevalence, Gastrointestinal parasites, Fruits, Vegetables, Ekpoma

INTRODUCTION

Fruits and vegetables play a vital role in human nutrition and are crucial part of any healthy diet worldwide. This is due to their rich nutritional, antioxidative and pharmacological properties (Tefera *et al*., 2014; Tchounga *et al*., 2017). They are low in calories but high in vitamins, minerals, fibre and some proteins (Karshima, 2018; Ola-Fadunsin *et al.,* 2022). They improve immunity, reduce oxidative stress and prevent chronic diseases (diabetes, cancer and obesity). Fibre in fruits promotes gut health by improving bowel movement and maintaining gut flora (Fagbenro *et al*., 2016; Tchounga *et al*., 2017). World Health Organization (WHO) and Food and Agriculture Organization (FAO) recommend at least 400g daily intake of fruits and vegetables a guideline that has contributed to increased consumption globally (WHO, 2004). In many developing countries like Nigeria, fruits and vegetables are often eaten raw or undercooked to retain nutrients. This practice increase the risk of parasitic food-borne infections, especially when the produce is unwashed or poorly handled (Eraky *et al*., 2014). Contamination can occur at multiple points starting from the farm due to the use of untreated manure, contaminated irrigation water and poor hygiene (Karshima, 2018; Okunlola, 2020; Ola-Fadunsin *et al.,* 2022). Additional risks arise during harvesting, handling, packaging, transport and food preparation (Simon-Oke *et al*., 2014; Adejayan & Morenikeji, 2015; Bekele *et al*., 2017).

Gastrointestinal parasites are among the most concerning contaminants of fresh produce, transmitted primarily via the faecal-oral route. These include protozoans and helminths such as *Ascaris lumbricoides, Giardia lamblia, Cryptosporidium spp., Taenia spp., Trichuris trichiura* and others (Alemu *et al*., 2020; Okunlola, 2020). The consumption of contaminated fruits and vegetables can cause a wide range of health problems such as diarrhoea, abdominal pain, anaemia and malnutrition. These symptoms are more pronounced in children, the elderly and immunocompromised individuals (Bekele *et al*., 2017; Luz *et al*., 2017; Pukuma *et al.,* 2023).

Ola-Fadunsin *et al.* (2022) and Zeynudin *et al.*(2024) highlighted that the growing number of food-borne illness cases is primarily associated with the consumption of fresh fruits and vegetables. Significant outbreaks of intestinal parasitic infections linked to produce have been documented in both developed and developing nations (Okunlola, 2020). Studies conducted in Nigeria have also shown that fruits and vegetables serve as major vehicles for the transmission of protozoan cysts, oocysts, helminth eggs and larvae (Sounyo & Gboeloh, 2021; Ola-Fadunsin *et al.,*2022).

Data on contamination of fruits and vegetables in Edo State remain scarce, with only one study available (Akinbo, and Ajulor, 2015), and just one (Okpala *et al.,* 2016) conducted in Ekpoma nearly a decade ago. Ekpoma Market, a major source of fresh produce, operates under poor sanitary conditions, contributing to daily contamination with intestinal parasites. No research has assessed both the current prevalence of contamination and public perception of produce safety in the area. This study therefore assessed the parasitic contamination of commonly consumed fruits and vegetables and the perception of their safety among vendors in Ekpoma.

MATERIALS AND METHODS

Study Area

Ekpoma is the headquarters of Esan West Local Government Area, Edo State, Nigeria. The town lies at approximately 6.7430° North latitude and 6.1421° East longitude (Turay *et al.,* 2015). occupying a land area of 502 km². The region experiences a tropical rainforest climate with distinct wet and dry seasons. The heaviest rainfall typically occurs in July

(344.7 mm) and September (457.2 mm), while December has the least rainfall (7 mm). The highest temperatures, ranging between 36°C and 38°C, are recorded in March, while the lowest temperatures, around 24°C, occur between June and July (Siloko and Siloko, 2023). The town is surrounded by several neighbouring communities such as Uhiele, Emuhi, Illeh and Ujemen, with nearby towns including Iruekpen, Irrua, Uromi and Ubiaja. The primary occupations of residents include farming, trading, civil service and academic activities. The fresh fruits and vegetables sold in the selected markets are sourced from various rural communities across Esan West LGA.

Study Design

This cross-sectional study was conducted in three market areas (Ekpoma Market, Iruekpen Market, and Opoji Market) in Ekpoma (Figure 1), from September to December 2024.

Sample collection

A total of 150 fresh vegetables and fruits samples, including ten different types that are frequently consumed in the area were randomly purchased from vendors in three selected open-air markets. The fresh raw vegetable and fruit samples used in this study (Plate 1) included Orange (*Citrus sinensis*), Carrot (*Daucus carota*), Banana (*Musa paradisiaca*), Garden egg (*Solanum aethiopicum*), Tomato (*Lycopersicon esculentum*), Bitter leaf (*Vernonia amygdalina*), Scent leaf (*Ocimum gratissimum*), Water leaf (*Talinum triangulare*), Green leaf (*Amaranthus hybridus*) and Pumpkin leaf (*Telfairia occidentalis*)

An equal number of samples (15 each, totalling 75 vegetables and 75 fruits) were collected from the three open-air markets. Each sample was placed in a sterile polythene bag, properly labelled and immediately transported to the Parasitology Laboratory of the Department of Zoology, Ambrose Alli University, Ekpoma, for parasitological analysis.

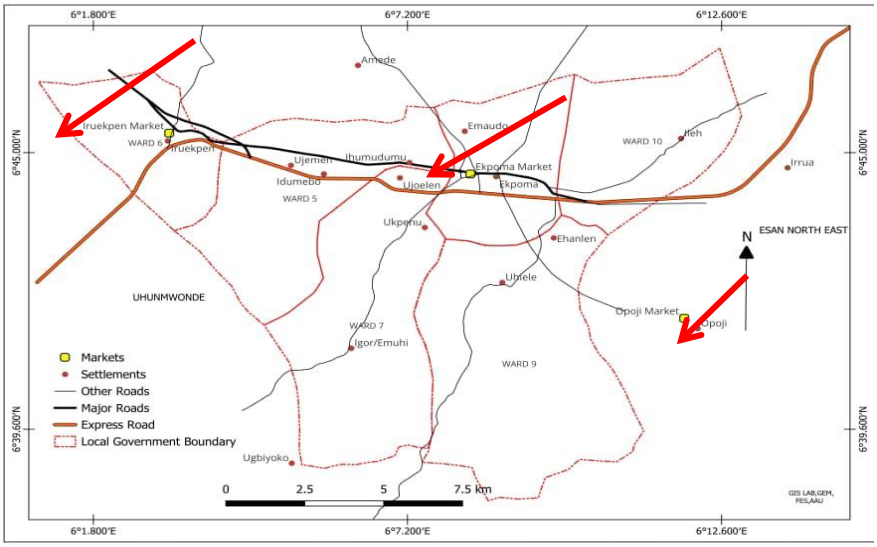

Figure 1: Study Area

Plate 1: Some fruits and vegetables sampled in the study. A. Orange B. Garden egg C. Carrot, D. Tomato, E. Water leaf F. Pumpkin leaf

Questionnaire design and administration
Well-structured open-ended questionnaires were used to collect data on perceptions of parasitic contamination of vegetables and fruits from the vendors at local markets.

Laboratory Analysis
Each fruit and vegetable were washed in 450 ml of distilled water in a clean plastic container. The mixture was allowed to settle for 30 minutes, after which the top water was carefully decanted without disturbing the sediment. The remaining mixture was strained through a clean sieve to remove sand and debris. Fifteen millilitres of 10% formalin was added to the strained liquid, and the mixture was stirred thoroughly to ensure proper homogenization. The solution was then transferred into a centrifuge tube and centrifuged at 3000 rpm for 5 minutes. After centrifugation, the supernatant was carefully decanted, after which the bottom of the centrifuge tube was gently tapped to re-suspend and mix the sediment. A drop of the sediment was placed on a clean glass slide, and one drop of Lugol's iodine was added to enhance easy identification of parasite. The slide was gently covered with a coverslip to prevent air bubbles and over-flooding. The prepared slide was examined under a microscope using X10 and X40 objectives. Parasite eggs, larvae and cysts were observed and recorded. The parasites were identified based on their morphological characteristics, using the reference descriptions provided by Arora and Arora (2009).

Data Analysis
The data obtained from the study were analysed using the Statistical Package for the Social Sciences (SPSS) version 21.0. Descriptive statistics, including frequency and percentage distributions, were used for result presentation. The Chi-square (χ^2) test was applied to assess the statistical significance of differences in prevalence rates of fruits and vegetables across the different markets. A p-value of less than 0.05 ($p < 0.05$) was considered statistically significant.

RESULTS AND DISCUSSION
The presence of intestinal parasites on fruits and vegetables indicates contamination with faecal matter, often from human or animal sources, especially in tropical regions like Nigeria. Where warm, moist conditions and poor sanitation facilitate parasite survival (Dawet *et al.*, 2019). This study assessed the prevalence of intestinal parasites in selected edible fruits and vegetables sold in Ekpoma Markets.
A total of 150 fruits and vegetable samples were examined for gastrointestinal parasites, out of which 97 samples were contaminated, representing a 64.7% prevalence (Table 1). This rate is higher than figures reported in previous studies conducted across Nigeria. Adejayan and Morenikeji (2015) reported a prevalence of 11% in Ibadan, while Okpala *et al.* (2016) documented a contamination rate of 42.4% in Ekpoma Market. Similarly, lower prevalence rates of 41.85%, 37.4% and 33.3% were reported by Dawet *et al.* (2019), Okunola (2020), and Fumilayo *et al.* (2020) in Jos, Ede and Ilorin respectively.
Similar studies conducted in other parts of the world also reported lower contamination levels. Eraky *et al.* (2014) recorded a prevalence of 29.6% in Egypt, Balarak *et al.* (2016) found 30.0% in Iran, Vizon *et al.* (2019) reported 40.3% in the Philippines and Bekele *et al.* (2020) documented 36.3% in Ethiopia. However, the prevalence in this study is lower than prevalence rate of 73.5% and 82.69% reported by Fagbenro *et al.* (2016) and Ozor *et al*., (2024) in Abeokuta and Jos respectively The variation in prevalence reported in studies from other regions may be attributed to differences in sample sizes, the techniques used and level of sanitation.
The highest prevalence (76.0%) occurred in Iruekpen market followed by Opoji market (62.0%) while the lowest prevalence was recorded in Ekpoma main market (Table 1). This might be because Iruekpen market is not as developed as the two other markets located within Ekpoma town, which are relatively more urbanized and may benefit from better infrastructure, improved sanitation and access to safer water sources. In contrast, Iruekpen market, being situated in a more rural setting, may experience limited access to clean water, poorer waste disposal systems and less regulatory oversight on hygiene practices.

Table 1: Prevalence of Gastrointestinal Parasites in Selected Edible Fruits and Vegetables sold in Ekpoma, Market

Markets	N (Examined)	N (Positive)	Percentage (%)	p-value
Ekpoma	50	28	56.0	
Iruekpen	50	38	76.0	0.0998
Opoji	50	31	62.0	
Total	150	97	64.7	

(χ^2cal = 1.76 $\alpha = 0.05$, p val.= 0.0998, $\chi^2tab = 3.84$) Df = 1
Table 2 shows that vegetables had a higher prevalence (70.7%) of parasitic contamination than fruits (58.7%). This aligns with Simon-Oke *et al.* (2014) in Akure, Nasiru *et al*. (2015) in Zamfara, Auta *et al*. (2017) in Katsina and Ola-Fadunsin *et al.* (2022) in Kwara. Vegetables are more prone to contamination than fruits due to the fact that vegetables have uneven/rough surfaces which enable parasites to attach more easily and overcome the effects of washing (Ismail, 2016). Moreover, due to the softness and fragility of vegetable leaves, most vendors do not thoroughly wash them before display (Duedu *et al*., 2014) On the contrary, the smooth surface of fruits might reduce the rate of parasitic attachment and can be washed easily.

Table 2: Prevalence of Gastrointestinal Parasites in Different Categories of Edible Produce (Fruits vs. Vegetables) Sold in Ekpoma, Nigeria

Edible Fruits and Vegetables	N (Examined)	N (Positive)	Percentage (%)	p-value
Fruits	75	44	58.7	
Vegetables	75	53	70.7	0.1718
Total	150	97	64.7	

(χ^2cal = 2.14, α = 0.05, p val= 0.1718*, χ^2tab = 3.84) D f = 1*
Distribution of gastrointestinal parasite species is presented in Table 3. The results show that five parasite species (*Ascaris* sp., hookworm, *Strongyloides* sp., *Trichuris trichiura* and coccidian) were detected in the fruits and vegetables sampled (Plate 2). The identified parasites are consistent with finding of Lawal *et al.,* (2015) in Zaria, and Sounyo & Gboeloh, (2021) in Port Harcourt. These parasites are zoonotic, which are diseases that can be transmitted between animals and human. They represent a significant public health risk due to their potential to cause outbreaks.
Hookworm (31.3%) and *Strongyloides* sp (12.7%) were the most prevalent parasites, while *Ascaris* sp. (6.0%) and *Trichuris trichiura* (3.3%) were the least prevalent parasites (Table 3). Notably, hookworm was present in all ten fruits and vegetables examined, making it the most widely distributed parasite. Most of the parasites identified in this study were Helminth. Helminth have highly resistant eggs or larvae that can survive in harsh environmental conditions for extended periods. Also, Helminth often rely on fecal-oral transmission (e.g., through contaminated food or water), skin penetration (e.g., hookworms), or vector-mediated transmission. These routes make them highly effective at spreading, particularly in areas with poor sanitation (Cairncross *et al*., 2010).

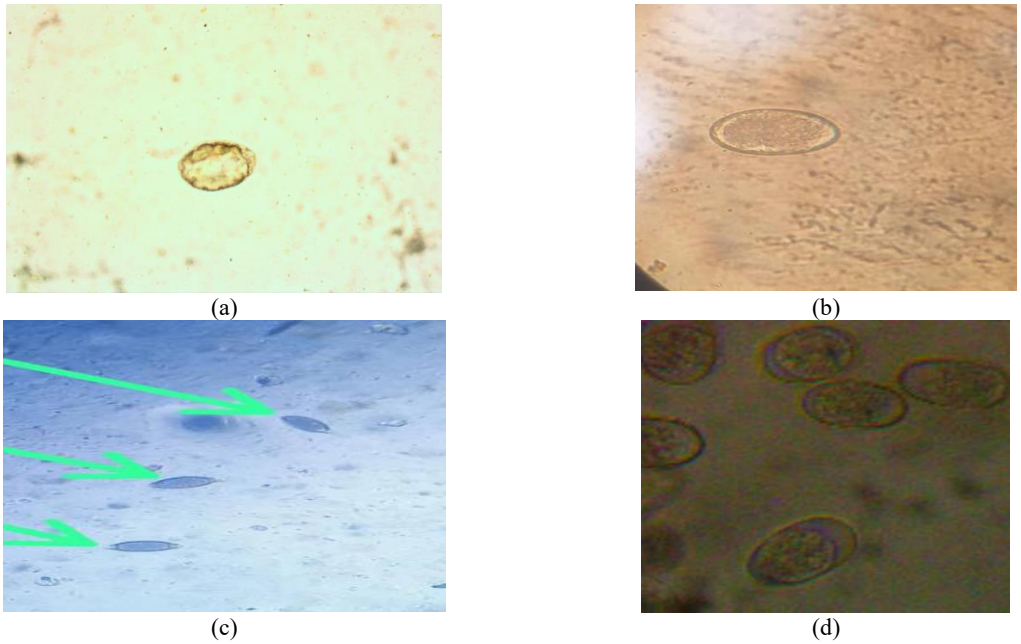

Plate 2: Some parasites Identified in the study. A. *Ascaris* sp. B. Hookworm, C. *Trichuris trichiura* D. Coccidian

All the fruit and vegetable types sampled were contaminated with one or more parasites (Table 3). There had been reports of parasitic contamination in all fruits and vegetables studied in Nigeria (Fagbenro *et al.,*2016; Dawet *et al.,*2019) and other parts of the world (Luz *et al.,*2017; Kudah *et al.,*2018; Bekele *et al.,*2020). This implies that parasitic contamination of fruits and vegetables is a global threat, and so calls for immediate efforts to control it.

Table 3: Distribution of Gastrointestinal Parasite Species in Selected Edible Fruits and Vegetables sold in Ekpoma Markets

Fruit and Vegetables	No of Sample Examined	*Ascaris sp*	Hookworms	*Strongyloides sp*	*Trichuris trichiura*	Coccidia	Total
Orange	15	1 (6.67)	9 (60.00)	0 (0.00)	0 (0.00)	1 (6.67)	11 (73.33)
Banana	15	0 (0.00)	5 (33.33)	0 (0.00)	0 (0.00)	0 (0.00)	5 (33.33)
Carrot	15	2 (13.33)	1 (6.67)	2 (13.33)	0 (0.00)	4 (26.67)	9 (60.00)
Garden egg	15	0 (0.00)	2 (13.33)	1 (6.67)	0 (0.00)	2 (13.33)	5 (33.33)
Tomatoes	15	2 (13.33)	5 (33.33)	5 (33.33)	1 (6.67)	1 (6.67)	14 (93.33)
Pumpkin leaf	15	1 (6.67)	5 (33.33)	1 (6.67)	1 (6.67)	2 (13.33)	10 (66.67)
Scent leaf	15	0 (0.00)	7 (46.67)	2 (13.33)	0 (0.00)	2 (13.33)	11 (73.33)
Water leaf	15	1 (6.67)	3 (20.00)	2 (13.33)	2 (13.33)	2 (13.33)	10 (66.67)
Green leaf	15	0 (0.00)	8 (53.33)	1 (6.67)	0 (0.00)	0 (0.00)	9 (60.00)
Bitter leaf	15	2 (13.33)	2 (13.33)	5 (33.33)	1 (6.67)	3 (20.00)	13 (86.67)
Total	150	9 (6.00)	47 (31.33)	19 (12.67)	5 (3.33)	17 (11.33)	97 (64.67)

The socio-demographic characteristics, knowledge and hygiene practices of vendors are presented in Table 4. Female respondents constituted a higher proportion (60.0%) compared to males (40.0%). This may be attributed to the fact that females are more commonly involved in the retail of fruits and vegetables, while men tend to engage in farming.

Majority of respondents were within the age group of 35–44 years (31.7%), followed by those aged 25–34 (26.7%) and 45–54 (25.0%). This age distribution suggests that middle-aged individuals dominate the fresh produce market, possibly due to their experience and financial stability. A significant number of respondents had only primary education (46.7%), followed by those with secondary (20.0%) and tertiary education (16.7%). This finding is similar to the study by Zeynudin *et al.* (2024) in Ethiopia, which also reported a low level of education among produce vendors. Limited education may contribute to poor knowledge of gastrointestinal parasite symptoms, inadequate hygiene practices and low deworming rates observed in this study.

A significant number of participants (93.3%) were aware that fruits and vegetables could be contaminated with parasites (Table 4). All respondents recognized at least one symptom of infection, indicating a basic level of awareness. However, limited knowledge of symptoms may delay medical care, increasing the risk of complications. Most participants used water mixed with salt or vinegar to clean produce, though the hygienic quality of the water remains a concern. Salt due to its natural antimicrobial properties, was commonly used to reduce surface contaminants. While 56.7% reported deworming regularly every few months, ongoing exposure to contaminated produce highlights the need for improved hygiene practices alongside deworming. Participants showed a near-equal preference for clinics and traditional healers, indicating reliance on both modern and traditional healthcare, which may lead to delays in effective treatment and underscores the need for better health education and access.

Table 4: Socio-demographic Characteristics, Knowledge, Perception, and Hygiene Practices of Respondents Regarding Parasitic Contamination of Fruits and Vegetables in Ekpoma Markets, Nigeria

Variable	Category	Proportion (%)	Chi-square
Gender	Male	24 (40.0)	0.842
	Female	36 (60.0)	
Age	15–24	5 (8.3)	18.511
	25–34	16 (26.7)	
	35–44	19 (31.7)	
	45–54	15 (25.0)	
	55–64	5 (8.3)	
	65+	0 (0.0)	
Education Level	No Formal Education	10 (16.7)	6.264
	Primary Education	28 (46.7)	
	Secondary Education	12 (20.0)	
	Tertiary Education	10 (16.7)	
Knowledge and Perception			
Do you know that fruits and vegetables can be contaminated with parasites?	Yes	56 (93.33)	45.07
	No	4 (6.67)	
If yes, which parasites do you think can be found on fruits and vegetables?	Worms	32 (53.33)	47.73
	Bacteria	4 (6.67)	
	Fungi	0 (0.00)	
	Don’t know	24 (40.00)	
What do you think are the possible symptoms of parasitic infections?	Stomach pain	24 (40.00)	23.73
	Vomiting	14 (23.33)	
	Diarrhoea	22 (36.67)	
How can parasitic infections be prevented when eating fruits/vegetables?	Proper washing with water	26 (43.33)	2.80
	Using salt or vinegar	18 (30.00)	
	Cooking before consumption	16 (26.67)	
Knowledge, Perception			
How do you wash vegetables before consumption?	Tap water	32 (53.33)	90.67
	Salt water	28 (46.67)	
	Chemical (vinegar, etc.)	0 (0.00)	
	Parboiling	0 (0.00)	
	Do not wash	0 (0.00)	
How often do you deworm?	Every few months	34 (56.67)	39.73
	Once a year	14 (23.33)	
	More than a year ago	12 (20.00)	
	Never	0 (0.00)	
Where do you usually seek treatment for intestinal worms?	Clinic/hospital	28 (46.67)	30.40
	Traditional healer	32 (53.33)	
	Do not seek treatment	0 (0.00)	

CONCLUSION

This study highlights the high prevalence of intestinal parasites infestation of fruits and vegetables sold in Ekpoma Markets. The contamination of these produce items with pathogenic parasites poses a significant health risk to consumers if consumed without proper washing or cooking. Given the zoonotic potential of the detected parasites, it is crucial to implement preventive measures, including proper washing techniques and public health education. There is a need for regular deworming practices and enhanced monitoring of fruit and vegetable markets to mitigate public health risks. Efforts should focus on promoting medical care over traditional remedies to ensure timely and effective treatment. Future research should focus on conducting long-term surveillance to monitor seasonal variations in parasitic contamination of fruits and vegetables within Ekpoma Markets.

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