



ASSESSMENT OF INTESTINAL PARASITIC CONTAMINATION AND FOOD SAFETY PRACTICES AMONG FRUIT AND VEGETABLE VENDORS IN KANO

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ABSTRACT

Intestinal parasitic infections remain a significant public health concern in developing countries, often transmitted through the consumption of contaminated raw fruits and vegetables. This study investigated the prevalence of intestinal parasites in 160 fruit and vegetable samples collected from three major markets in Kano Metropolis, Nigeria: Kasuwar Yankaba, Kasuwar Naibawa Yanlemu, and Kasuwar Tarauni. Using standard parasitological techniques, an overall contamination rate of 8.7% was observed. *Ascaris lumbricoides* was the most frequently identified parasite (3.1%), followed by *Strongyloides stercoralis* (2.5%) and *Entamoeba histolytica* (2.5%). Contamination rates varied significantly by produce type ($p = 0.026$), with tomatoes, carrots, and cabbage showing the highest prevalence (15% each). Furthermore, the study assessed vendor awareness and practices, revealing that while 51.3% were aware of parasitic risks, 76.9% utilized well water for washing produce. These findings underscore the urgent need for enhanced food safety regulations and hygiene education for vendors to mitigate the risk of foodborne parasitic diseases in urban Nigerian settings.

Keywords: Intestinal parasitic contamination, Intestinal parasites, Food safety practices, Vegetable vendors

INTRODUCTION

Intestinal parasitic infections (IPIs) constitute a major global health burden, particularly in sub-Saharan Africa, where environmental conditions and socio-economic factors often facilitate their transmission (Ayeh-kumi *et al.*, 2025, Tagipour *et al.*, 2021). Globally, it is estimated that over 3.5 billion people are affected by intestinal parasites, leading to significant morbidity including malnutrition, anemia, and growth retardation (Stephenson *et al.*, 2000, Ahmed 2023, Haihay *et al.*, 2010). The fecal-oral route remains the primary pathway for transmission, with raw fruits and vegetables serving as critical vehicles for infective stages such as cysts, oocysts, eggs, and larvae (Abdelkerem *et al.*, 2022).

In Nigeria, the rapid urbanization of cities like Kano has led to an increased reliance on open-air markets for fresh produce (Takeshima *et al.*, 2023, Maziya-Dixon *et al.*, 2021, Fadairo *et al.*, 2019). Kano Metropolis, a major commercial hub in Northern Nigeria, hosts several large-scale markets that supply fruits and vegetables to millions of residents. However, the safety of these food items is often compromised by poor irrigation practices, inadequate sanitation during transport, and unhygienic handling at the point of sale (Ibrahim *et al.*, 2024, Posthumus *et al.*, 2018, Garba & Yahaya 2025, Pingault *et al.*, 2017). Previous studies in various parts of Nigeria have reported varying degrees of parasitic contamination in fresh produce, highlighting a persistent public health risk (Karshima, 2018, Osafo *et al.*, 2022, Uneke 2007, Ojo, 2023, Agbalaka *et al.*, 2019).

Despite the importance of these markets, there is a paucity of recent data regarding the specific parasitic profiles and the associated vendor practices in Kano's major trading centers (Balarabe & Sahin 2020). Understanding the current prevalence and the factors contributing to contamination is essential for developing targeted public health interventions Li *et al.*, 2020, Obebe *et al.*, 2020). Therefore, this study aimed to determine the prevalence of intestinal parasitic contamination in selected fruits and vegetables sold in Kano Metropolis and to evaluate the knowledge, attitudes, and practices of the vendors regarding food safety.

MATERIALS AND METHODS

Sample Size Determination, and Sampling Method

The sample size for this cross-sectional study was determined to ensure the findings would be representative of the fruit and vegetable vending situation in Kano Metropolis's major markets. Due to the absence of a recent, directly comparable prevalence rate for parasitic contamination in produce specifically from the targeted Kano markets, the calculation was based on a standard statistical formula for estimating a single proportion. The sample size (n) was calculated using the formula:

$$n = \frac{Z^2 P(1 - P)}{d^2}$$

Where:

Z = the Z-score corresponding to the 95% confidence level (1.96).

p = Estimated proportion (prevalence) of parasitic contamination. Based on a review of previous studies in similar Nigerian urban settings which reported prevalence rates ranging from 15% to 40% (Karshima, 2018), a conservative prevalence proportion of 15.0% (0.15) was assumed to maximize the required sample size.

d = the desired margin of error (precision), set at 5.5% (0.055).

Applying these values:

$$n = \frac{1.96^2 \times 0.15(1 - 0.15)}{0.055^2}$$

This calculation yielded a minimum sample size of approximately 162 samples. To account for potential issues with sample processing or data collection, a final target of 160 samples was adopted for this study.

Study Area and Design

A cross-sectional study was conducted between March to September, 2025 in Kano Metropolis, the capital of Kano State, Nigeria. Three major markets were purposively selected based on their high volume of fruit and vegetable trade: Kasuwar Yankaba, Kasuwar Naibawa Yanlemu, and Kasuwar Tarauni (Madugu, 2019).

Sample Collection

A multi-stage sampling approach was then employed. First, three major markets—Kasuwar Yankaba, Kasuwar Naibawa Yanlemu, and Kasuwar Tarauni—were purposively selected based on their high volume of fruit and vegetable trade as documented by Madugu (2019). Using a systematic random sampling technique vendors from whom samples were purchased were selected. Finally, eight commonly consumed fruits and vegetables (Tomato, Guava, Carrot, Garden egg, Apple, Cabbage, Lettuce, and Date palm) were purposively chosen for analysis, with 20 samples of each collected across the three markets to ensure a balanced representation.

A total of 160 samples of fruits and vegetables were examined. These included 20 samples each of Tomato (*Lycopersicon esculentum*), Guava (*Psidium guajava*), Carrot (*Daucus carota*), Garden egg (*Solanum melongena*), Apple (*Malus domestica*), Cabbage (*Brassica oleracea*), Lettuce (*Lactuca sativa*), and Date palm (*Phoenix dactylifera*). Samples were purchased directly from vendors and transported in sterile polythene bags to the laboratory for immediate analysis.

Laboratory Analysis

Each sample (approximately 200g) was processed using standard sedimentation techniques. The produce was washed in physiological saline (0.85% NaCl), and the resulting wash-water was allowed to sediment. The sediment was then centrifuged at 3000 rpm for 5 minutes. Microscopic examination of the sediment was performed using direct wet mount (saline and Lugol's iodine) to identify parasite eggs, cysts, and larvae (Peller *et al.*, 2022). After the concentration steps, the final sediment was carefully examined under a microscope using the direct wet mount method. This involved preparing two types of wet mounts:

- Saline Wet Mount: A small portion of the sediment was mixed with a drop of physiological saline on a clean glass slide. This mount is for detecting motile trophozoites and observing the morphology of helminth eggs and protozoan cysts without staining.

- Lugol's Iodine Wet Mount: Another portion of the sediment was mixed with a drop of Lugol's iodine solution for species identification, and also for highlighting the features of helminth eggs.

Microscopic examination was performed systematically to identify and differentiate various parasite eggs, cysts, and larvae based on their characteristic morphological features, size, and internal structures (Peller *et al.*, 2022).

Assessment of Vendor Practices

Structured questionnaires (developed and structured in Hausa language by the researchers and reviewed by supervisors for face validity before administration) were administered to the vendors (n=160) to collect data on demographic characteristics, level of awareness regarding parasitic contamination, and their hygiene practices, including the source of water used for washing produce and display methods.

Statistical Analysis

Data generated from the completed questionnaires were entered into a Microsoft Excel spreadsheet. The data were then cleaned and checked for errors before being exported to the Statistical Package for Social Sciences (SPSS) version 22.0 for analysis. Descriptive statistics were used to summarize prevalence rates. The Chi-square test was employed to determine associations between contamination and variables such as market location, produce type, and vendor demographics. A p-value of < 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

Prevalence of Parasitic Contamination

The overall prevalence of intestinal parasitic contamination among the 160 samples examined was 8.7% (14/160). As shown in Table 1, the contamination rate varied across the three markets, with Kasuwar Yankaba and Kasuwar Naibawa Yanlemu both recording 12.5%, while Kasuwar Tarauni recorded 10.0% (p = 0.305).

Table 1: Prevalence of Intestinal Parasitic Contamination by Market and Produce Type

Variable	Positive (%)	Negative (%)	P-value
Market			0.305
Kasuwar Yankaba	5 (12.5)	48 (90.0)	
Kasuwar Tarauni	4 (10.0)	49 (92.5)	
Kasuwar Naibawa Yanlemu	5 (12.5)	48 (90.0)	
Produce Type			0.026
Tomato	3 (15.0)	17 (85.0)	
Carrot	3 (15.0)	17 (85.0)	
Cabbage	3 (15.0)	17 (85.0)	
Lettuce	2 (10.0)	18 (90.0)	
Garden Egg	1 (5.0)	19 (95.5)	
Date Palm	1 (5.0)	19 (95.5)	
Guava	1 (5.0)	19 (95.5)	
Apple	0 (0.0)	20 (100.0)	
Total	14 (8.7)	146 (91.3)	

Statistically significant (p < 0.05)

The type of produce was significantly associated with contamination (p = 0.026). Tomato, Carrot, and Cabbage exhibited the highest contamination rates (15.0% each), whereas no parasites were detected in Apple samples.

Parasite Species Distribution

Four types of intestinal parasites were identified. *Ascaris lumbricoides* was the most prevalent (3.1%), followed by *Strongyloides stercoralis* (2.5%) and *Entamoeba histolytica* (2.5%). Hookworm was the least common, identified in only 0.6% of the samples (Table 2).

Table 2: Distribution of Identified Parasite Species

Parasite Species	Frequency	Percentage (%)
<i>Ascaris lumbricoides</i>	5	3.1
<i>Entamoeba histolytica</i>	4	2.5
<i>Strongyloides stercoralis</i>	4	2.5
Hookworm	1	0.6
Total	14	8.7

Vendor Demographics and Practices

The majority of vendors were male (95.6%). Vendors aged 20-29 years had the highest contamination rate in their produce (13.6%). Regarding education, 13.6% of produce from vendors with non-formal education was contaminated, compared to 6.0% from those with secondary education.

Vendor practices revealed significant hygiene gaps. Although 76.3% of vendors reported washing their produce before display, 76.9% used well water for this purpose. Furthermore, only 23.1% of vendors consistently covered their produce while on display, with 78.1% doing so only occasionally.

Discussion

The findings of this study reveal a significant, albeit relatively low, prevalence of parasitic contamination (8.7%) in raw produce sold in Kano, Nigeria. From an epidemiological perspective, this level of contamination indicates a persistent public health risk, particularly given the high volume of raw vegetable and fruit consumption in densely populated urban centers like Kano. The presence of these parasites in food items that are often consumed without adequate heat treatment suggests a continuous cycle of transmission for intestinal parasitic infections (IPIs) within the community. This risk is compounded by the detection of multiple parasite species, which increases the potential for polyparasitism and its associated morbidity, including malnutrition, anemia, and impaired cognitive development, especially among vulnerable populations.

When compared to other regional studies, the 8.7% prevalence observed in this research is notably lower than

findings from Arba Minch, Ethiopia (39.1%) reported by Alemu et al. (2020), and various other studies across West Africa (Bekele et al., 2017; Makanjoula et al., 2025; Tangi et al., 2023; Abougrain et al., 2010). These disparities in prevalence rates can be attributed to several factors, including differences in geographical location, climatic conditions, and the specific types of produce sampled. For instance, higher humidity and rainfall in other regions may favor the survival and development of parasite eggs and larvae in the soil and on plant surfaces. Furthermore, the variation in contamination levels between studies often reflects differences in irrigation practices, such as the use of untreated wastewater or contaminated surface water, which are known to significantly increase the risk of parasitic transmission (Uneke, 2007; Karshima, 2018).

The significant variation in contamination among different produce types ($p = 0.026$) highlights the role of physical characteristics in parasite entrapment. Produce with rough surfaces, such as carrots, or complex, folded leaves, such as cabbage, provide ideal niches for the attachment and protection of parasite eggs and cysts from environmental stressors and simple washing. In contrast, the absence of contamination in apples may be due to their smooth, waxy cuticles, which are less conducive to parasite adherence and are easier to clean. Additionally, the "premium" status of apples often leads to more careful handling and better storage conditions by vendors, further reducing the likelihood of contamination.

Table 3: Epidemiological Significance of Parasite Species

Parasite Species	Frequency	Epidemiological Significance
<i>Ascaris lumbricoides</i>	Most Frequent	High environmental resilience; indicator of fecal-oral transmission and poor sanitation.
<i>Strongyloides stercoralis</i>	Present	Potential for chronic infection and autoinfection; risk of severe disease in immunocompromised individuals.
<i>Entamoeba histolytica</i>	Present	Major cause of protozoan dysentery and liver abscesses in tropical regions.

The socio-demographic analysis indicates that younger vendors and those with limited formal education are associated with higher rates of produce contamination. This suggests that experience and education are critical determinants of food safety knowledge and its application in practice. A particularly concerning finding is the heavy reliance on shallow well water (76.9%) for washing produce. In the urban context of Kano, these wells are frequently located in close proximity to pit latrines, making them highly susceptible to fecal contamination. Consequently, the practice of washing produce with such water may inadvertently introduce parasites rather than removing them. Furthermore, the inconsistent use of covers (78.1%) exposes produce to dust and mechanical vectors like houseflies, which are known to transport parasite eggs from contaminated environments to food surfaces.

Despite a moderate level of awareness (51.3%) among vendors, there remains a substantial gap between knowledge

and safe food-handling practices. This disconnect is a common challenge in public health interventions, where awareness alone does not necessarily translate into behavioral change. Addressing this gap requires targeted educational programs and the provision of basic infrastructure, such as access to treated water and improved sanitation facilities, to ensure that vendors can implement the safety measures they are aware of.

Study Limitations

While this study provides valuable insights into the parasitic contamination of produce in Kano, several limitations must be acknowledged. First, the cross-sectional design of the study captures contamination levels at a single point in time and does not account for seasonal variations, which are known to influence parasite prevalence. Second, the reliance on conventional microscopic techniques for parasite identification may have resulted in an underestimation of

prevalence, as these methods may miss low-intensity infections or fail to distinguish between morphologically similar species that require molecular characterization. Third, the data regarding vendor practices were self-reported, which may be subject to social desirability bias, potentially leading to an overestimation of safe handling practices. Finally, the study was limited to selected markets within Kano metropolis, and the findings may not be fully generalizable to other regions or rural settings with different agricultural and sanitation profiles.

CONCLUSION

This study confirms the presence of intestinal parasites on fruits and vegetables sold in major markets of Kano Metropolis, with an overall prevalence of 8.7%. The predominance of *Ascaris lumbricoides* and the significant contamination of vegetables like cabbage and carrots highlight a clear risk to consumers. The widespread use of potentially contaminated well water for washing produce and inconsistent covering practices among vendors are major contributing factors to this public health issue.

RECOMMENDATIONS

To mitigate these risks, the following recommendations are proposed:

- 1 **Vendor Education:** The Kano State Ministry of Health and market authorities should organize regular training sessions for vendors on food hygiene and the risks of parasitic contamination.
- 2 **Infrastructure Improvement:** Providing access to treated tap water in major markets is essential to discourage the use of contaminated well water.
- 3 **Public Awareness:** Consumers should be educated on the importance of thorough washing and, where possible, peeling or cooking fruits and vegetables before consumption.
- 4 **Policy Enforcement:** Market sanitation laws should be strictly enforced, including regular inspections of produce handling and display areas.

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