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Assessment of Parasitic Contamination in Fresh Fruits and Vegetables at Two Major Markets in Akungba-Akoko, Ondo State, Nigeria

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ABSTRACT

Raw fruits and vegetables can serve as potential sources of parasitic diseases. The extent of contamination and the types of parasites present vary based on climatic, ecological, and human factors. Regular monitoring of parasitic contamination in these food items is crucial for preventing the spread of parasitic diseases within the community. The study aimed at detecting intestinal parasitic contamination linked to the consumption of raw vegetables and fruits sold at two major markets in Akungba-Akoko, Ondo State. A total of 120 fresh fruit samples and 120 vegetables were obtained for this study. About 200 g of fruit and vegetable samples were processed and examined microscopically for parasite contamination, utilizing sedimentation concentration techniques in accordance with standard protocols. The overall prevalence of parasitic contamination was 54.2%. The most frequently encountered parasite on fruits and vegetables was *Ascaris lumbricoides* (61.5%), followed by *Entamoeba coli* (20%), Hookworm (6.92%), *Trichuris trichiura* (5.39%), *Strongyloides stercoralis* (4.61%) and the least encountered parasite was *Fasciola gigantica*. Ibaka Market has a slightly higher overall infection rate than Okusa Market. This study has shown that fruits and vegetables sold in the two markets in Akungba-Akoko were contaminated with medically important parasites which are potential sources of disease transmission. Therefore, improved hygiene among the farmers, consumers, and vendors will be paramount in reducing the burden of intestinal parasite infection in the area.

Highlights

- Vegetables had a higher parasite contamination rate (61.7%) than fruits (46.7%).
- *Ascaris lumbricoides* was the most common parasite found in all produce (61.5%).
- Tomatoes had the highest contamination rate among all sampled fruits and vegetables (92.5%).

1. Introduction

Diets rich in fruits and vegetables are commonly recommended because of their numerous health benefits. These foods have long been included in dietary guidelines due to their high levels of vitamins, especially vitamins C and A, as well as essential minerals, particularly electrolytes (Boeing *et al.*, 2012). More recently, fruits and vegetables have also been recognized for their phytochemicals, especially antioxidants. Additionally, they are emphasized as key sources of dietary fiber. Fruits and vegetables play a vital role in maintaining good health and preventing deficiencies due to the fiber, vitamins, and minerals they provide (Boeing *et al.*, 2012).

The World Health Organization (WHO) recommends consuming at least 400 g each day to reap their health and nutrition benefits (WHO, 2023). In 2017, some 3.9 million deaths worldwide were attributable to not eating enough fruit and vegetables (WHO, 2023). Insufficient intake of fruit and vegetables is estimated to cause around 14 percent of deaths from gastro-intestinal cancer worldwide, about 11 percent of those due to ischemic heart disease, and about 9 percent of those caused by stroke (Afshin *et al.*, 2019). Fruits and vegetables are recommended across all dietary guidelines. Moreover, guidelines are increasingly emphasizing that vegetables and fruits should make up a larger share of people's meals than starchy staples (Boeing *et al.*, 2012). Low fruit and vegetable consumption has been linked to poor health and a range of

non-communicable diseases (NCDs) such as coronary heart disease, strokes, type 2 diabetes, and some forms of cancer (Aune *et al.*, 2017).

Intestinal parasites are the second most common cause of outpatient morbidity in the country and are known to cause diarrhea, anemia, stunting, physical weakness, low educational performance, growth retardation and other physical and mental health problems (Alemu *et al.*, 2020). They are primarily transmitted by fecal-oral route, mostly via ingestion with contaminated food and water or during direct hand to mouth contact (Alemu *et al.*, 2020). Intestinal parasitic infections are widely distributed throughout the world causing substantial intimidation to the public health, economy, physical and cognitive development in developing countries like Nigeria (Ajakaye and Obimakinde, 2021).

Food items which are usually consumed raw, like fruits, are potential sources of infection (Alemu *et al.*, 2020). Eating unclean and raw fruits is one of the means by which the transmission of intestinal parasitic infections is propagated (Murinda and Dusabimana, 2024). Fruits serve as vehicles for the transmission of these parasitic infections when contaminated as a result of various associated factors related to planting, such as while they are still on the field, harvesting, transportation, storage, market chain, and even at home (Tefera *et al.*, 2014)..

2. Materials and Methods

Study area

Akungba-Akoko is located in Ondo State, in southwestern Nigeria, with its capital at Akure. Akungba-Akoko is situated between latitudes 7°28 and 5°0E of the Greenwich meridian; it is bounded by Etioro-Akoko to the south and Ikare-Akoko to the north, while to the east and west by Supare-Akoko and Iwaro-Akoko (Figure 1). The climate of the study area is equatorial, with two peak periods of rainfall. The first peak comes up between April and July, while the second peak falls between late August and October. These two peaks are marked by heavy rainfall, with a mean annual rainfall of 1500–2000 mm. The people of Akungba-Akoko were known for agricultural activities, and only a few were engaged in some commercial activities like trading, weaving, and artisanship. Some are civil servants. Akungba-Akoko is important in the history of Ondo State due to the presence of the Adekunle Ajasin University, Akungba-Akoko. There are two major markets in Akungba town namely Ibaka and Okusa markets.

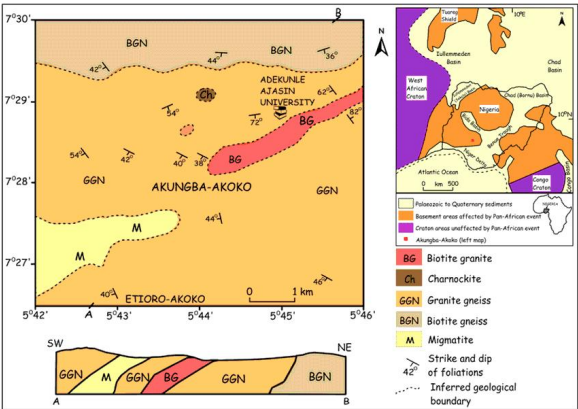


Figure 1: Map Showing Akungba-Akoko (Ogunyele *et al.*, 2019).

Sample collection

Two hundred and forty (240) freshly harvested fruits and vegetables were purchased from the two major markets in Akungba town. Three different types of fruits namely tomato (*Solanum lycopersicum*), Cucumber (*Cucumis sativus*) and orange (*Citrus sinensis*) were obtained. Vegetables for the study included African spinach (*Spinacia oleracea*), pumpkin leaf (*Telfairia occidentalis*) and water leaf (*Talinum triangulare*).

Parasitological analysis of the samples

The samples were transported to the Parasitology Laboratory of Animal and Environmental Biology, Adekunle Ajasin University, Akungba-Akoko, within one hour of collection in order to ensure proper identification of parasites (WHO, 2003). The parasites on the fruits and vegetables were checked using sedimentation method. A portion (200 g) of each fruit and vegetable was washed separately in 500 mL of normal saline to detach the parasitic stages (ova, larvae, cysts, and oocysts) of helminths and protozoans. After overnight sedimentation of the washing solution, 15 mL of the sediment was sieved into a centrifuge tube, to remove undesirable matter. In order to concentrate the parasitic stages, the tube was centrifuged at 3,000 rpm for five minutes (Idahosa, 2011). After centrifugation, the supernatant was decanted carefully without shaking and the sediment was examined under a light microscope using x10 and x40 objectives

Data analysis

The data generated from the study were analysed using SPSS version 21.0. The descriptive analysis of the data was done using frequencies and percentages. Chi-square was used to check the level of significance of contamination of fruits and vegetables at different markets. Statistical significance was set at $p < 0.05$.

3. Results

A total of 240 samples comprising 120 fruits and 120 vegetables were examined in the study. One hundred and thirty (54.2%) samples of fruits and vegetables were positive for various parasites. Vegetables were more contaminated (61.7%) than fruits (46.7%). The highest contamination was in tomatoes (*Solanum lycopersicum*) (92.5%) while oranges (*C. sinensis*) had the lowest contamination (7.5%), both belongs to fruit (Table 1).

Table 1: Frequency of distribution of different infected fruits and vegetable leaves consumed in Akungba-Akoko ($\chi^2 = 5.438$ and $P\text{-value} = 0.020$)

Fruits/Vegetable	Botanical Name	Number examined	Number positive (%)
Fruits			
Tomato	<i>Solanum lycopersicum</i>	40	37(92.5)
Cucumber	<i>Cucumis sativus</i>	40	16(40)
Orange	<i>Citrus sinensis</i>	40	3(7.5)
Sub total		120	56(46.7)
Vegetables			
Pumpkin leaf	<i>Telfaria occidentalis</i>	40	26(65)

African spinach	<i>Spinacia oleracea</i>	40	28(70)
Water leaf	<i>Talinum triangulare</i>	40	20(50)
Sub total		120	74(61.7)
Total		240	130(54.2)

Table 2: Percentage survey of parasite genus in contaminated fruits and vegetable leaves

Fruits/Vegetables	Tomatoes	Cucumber	Oranges	Pumpkin Leaf	African Spinach	Water Leaf	Number of Parasites (%)
<i>Ascaris lumbricoides</i>	22	10	0	18	20	10	80(61.5)
Hookworm	3	1	1	2	1	1	9(6.92)
<i>Fasciola</i> spp	0	0	0	0	1	1	2(1.54)
<i>Entamoeba coli</i>	8	2	1	4	5	6	26(20)
<i>Strongyloides stercoralis</i>	3	2	0	0	0	1	6(4.61)
<i>Trichuris trichiura</i>	1	1	1	2	1	1	7(5.39)

Table 2 highlights the varying prevalence of different parasites in fruits and vegetables. The most frequently encountered parasite on fruits and vegetables was *Ascaris lumbricoides* (61.5%), followed by *Entamoeba coli* (20%), Hookworm (6.92%), *Trichuris trichiura* (5.39%), *Strongyloides stercoralis* (4.61%) and the least encountered parasite was *Fasciola gigantica* (egg) (1.54%).

Table 3: Comparison of parasitic contamination from two local markets in Akungba-Akoko ($X^2 = 79.37$ P-value = 0.0001)

Fruits	Ibaka Market		Okusa Market	
	No Examined	No Infected (%)	No Examined	No Infected (%)
Tomatoes	20	19(95)	20	18(90)
Cucumber	20	10(50)	20	6(30)
Oranges	20	1(5)	20	2(10)
Sub total	60	30(50)	60	26(43.3)
Vegetables				
Pumpkin leaf	20	15(75)	20	11(55)
African spinach	20	12(60)	20	16(80)
Water leaf	20	10(50)	20	10(50)
Sub total	60	37(61.6)	60	37(61.6)
Grand Total	120	67(55.83)	120	63(52.50)

Ibaka market had a higher infection rate for fruits (50%) compared to Okusa market (43.3%). The highest infection was seen in tomatoes in both markets, with Ibaka market having a slightly higher infection rate for tomatoes (95%) than Okusa Market (90%). Both markets had the same infection rate for vegetables (61.6%). Ibaka market had the

highest infection rate in pumpkin leaf (75%), whereas Okusa market had the highest infection rate in African spinach (80%) (Table 3).

Table 4: Types of parasites genus in the two local markets ($X^2 = 39.36$ P-value = 0.0002)

Parasites	Ibaka markets (No of Parasites %)	Okusa markets (No of Parasites %)
<i>A. lumbricoides</i>	42(61.76)	38(61.29)
Hookworm	4(5.88)	5(8.06)
<i>Fasciola gigantica</i>	0	2(3.23)
<i>E. coli</i>	18(26.47)	8(12.90)
<i>S. stercoralis</i>	2(2.94)	4(6.45)
<i>T. trichuria</i>	2(2.94)	5(8.06)
Total Positive	68	62
Total Negative	52	58
Grand Total	120	120

Table 4 presents data on the presence of different parasites found in produce from Ibaka market and Okusa market. Ibaka market has a slightly higher overall infection rate than Okusa market (68 positive cases vs. 62 positive cases). Both markets show high levels of *A. lumbricoides* infection, but Okusa market reports higher rates of hookworm, *S. stercoralis*, and *T. trichuria*. *E. coli* infection is notably higher at Ibaka market, while *F. gigantica* infections were detected only at Okusa market.

4. Discussion

The infestation of fruits and vegetables with intestinal parasitic stages has become a significant area of global research, alongside the contamination of soils with the eggs of these geo-helminths (Joanne and Beate, 2012). Investigating parasites on fruits and vegetables is crucial for evaluating the prevalence of certain intestinal parasites within a population. The presence of these foodborne parasites poses a public health threat to vulnerable individuals who purchase and consume contaminated produce. This study aimed at assessing the extent of contamination and the prevalence of various intestinal parasites in fruits and vegetables sold at two markets in Akungba town.

The overall parasitic contamination rate of fruits and vegetables was found to be 54.2%, which was slightly lower than 55.1% reported by Umeanaeto *et al.* (2021) in Awka-North and Awka-South Local Government Areas. This overall prevalence rate was found to be lower than 65.1% and 61.5% documented by Usman (2023) and Ajakaye and Obimakinde (2021), both of which were conducted in Nigeria. This level of parasitic contamination poses significant public health risks, a concern mirrored by the findings of our current study. The parasitic contamination of fruits and vegetables observed in this research may be attributed to several factors, including the contaminated water used for washing or wetting the produce. Other potential sources of contamination include the use of organic manures, such as animal or human feces, in cultivation, or the indiscriminate defecation by both humans and animals.

Tomatoes were the most contaminated fruits (92.5%) in this study. This result is consistent with the findings of Gboeloh and Sounyo (2021)

in Port Harcourt, Bekele *et al.* (2020) in Ethiopia, and Ajitha *et al.* (2020) in Tiruchirappalli. In contrast, it differs from the observations of Mbata *et al.* (2017) in Port Harcourt, as well as those of Abe *et al.* (2016), who reported that tomatoes were among the least contaminated samples. Runoff from livestock and poultry farms is a frequent cause of contamination in produce. Additionally, if the water used to wash tomatoes contains the pathogen, bacteria can adhere to the surface or penetrate the tomato through the stem scar.

Among the vegetables examined, African spinach showed the highest prevalence rate at 70%, followed by pumpkin leaf at 65%, while waterleaf had the lowest at 50%. This result is consistent with the findings of Mbata *et al.* (2017), who also identified pumpkin leaf as having the highest level of contamination. Fumilayo *et al.* (2021) further explained that parasite eggs and trophozoites tend to adhere more easily to the surfaces of leafy vegetables compared to certain fruits and other types of vegetables.

In this study, *A. lumbricoides* was the most frequently detected parasite with a prevalence of 61.5%. This dominance might be associated with this parasite's ubiquitous distribution, the high number of eggs produced by the fecund female parasite which contributes to the parasite widespread distribution, and the strong and resistant nature of the eggs that enables them to survive unfavorable conditions. The eggs can survive in the absence of oxygen, live for two years at 5–10 °C, and be unaffected by desiccation for two to three weeks.

All the fruit and vegetable types sampled were contaminated with one or more parasites, in like manner, there had been reports of parasitic contamination in all fruits and vegetables studied in Nigeria (Ola-Fadunsi *et al.*, 2022) and other parts of the world (Bekele *et al.*, 2020). This suggests that parasitic contamination of fruits and vegetables poses a global health concern, highlighting the urgent need for effective control measures to mitigate its negative impacts. In this study, vegetables were found to have higher levels of parasitic contamination compared to fruits, a trend also reported by Ajakaye and Obimakinde (2021) and Usman (2023) in their respective studies. The higher prevalence of parasitic contamination in vegetables may be due to the rough surfaces and leaf folds of vegetables which may retain dirt that cannot be easily washed off. Contamination with multiple species was observed in all types of fruits and vegetables examined in this study. This might indicate the possibility of a high-level contamination of fruits and vegetables, which perhaps may result in multiple parasitic infections in humans.

5. Conclusion

This study identifies raw vegetables and fruits as potential vectors for intestinal parasite transmission in Akungba-Akoko, Nigeria, posing a significant threat to ongoing NTD control and elimination strategies. The high prevalence of raw produce in local diets increases exposure risk among residents. These findings underscore the urgent need to evaluate and improve WASH conditions in the community to reduce environmental contamination with human waste and curb the spread of infections.

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Competing Interest

The author of the study titled "Assessment of Parasitic Contamination in Fresh Fruits and Vegetables at Two Major Markets in Akungba-Akoko, Ondo State, Nigeria" declares that there are no financial or personal relationships that could be perceived as a conflict of interest in the conduct or publication of this research. All data were gathered in an objective and unbiased manner, and results presented in this paper are based solely on the findings derived from the research.

Data Availability Statement

Available upon request.

Ethics Approval

This study did not involve the use of human or animal subjects.

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