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Parasitic Contamination of Fruits Grown in National Veterinary Research Institute, Vom and Environs, Jos South Local Government Area, Plateau State, Nigeria

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ABSTRACT

Background: Fruits are essential dietary components but can act as vehicles for transmitting parasitic infections, particularly in areas with inadequate sanitation. We investigated the parasitic contamination of mangoes, pawpaw, and avocados grown in the National Veterinary Research Institute (NVRI) and its environs in Vom, Plateau State, Nigeria.

Methods: Overall, 150 fruit samples, comprising mangoes, pawpaw, and avocados (50 each), were randomly collected from five locations within NVRI and its environs. Samples were analyzed using the ordinary centrifugation method and iodine preparation. Data were statistically evaluated using Chi-square analysis, with a significance level set at $P \leq 0.05$.

Results: Parasitic contamination was detected in 64% of the fruit samples. Four parasite species were identified: *Entamoeba histolytica* (52.4%), *E. coli* (26.6%), *Strongyloides stercoralis* (20.2%), and *Giardia lamblia* (0.8%). Mangoes exhibited the highest contamination rate (42.7%), followed by avocados (31.5%) and pawpaw (25.8%). Among the sampling locations, the Vaccine Complex recorded the highest contamination rate (25.0%). The results revealed significant associations between fruit types, contamination rates, and location ($P<0.05$).

Conclusion: The findings underscore a high prevalence of parasitic contamination, indicating poor environmental hygiene and public health risks. Rigorous washing and proper handling of fruits are recommended to prevent parasitic infections. Public health education and observing strict regulations in agricultural practices are vital to mitigating these risks.

Keywords: Fruits; Parasites; Contamination; Hygiene; *Entamoeba histolytica*; Infection.

Introduction

Intestinal parasitic infections are widely distributed throughout the world causing substantial harm to public health, economy, and adverse effects to cognitive development, particularly among children in developing nations like Nigeria. The poor personal and environmental hygiene compounded with poor health system in developing countries amplifies parasitic prevalence (1).

The nutritional benefits, which range from vitamins, minerals, protein, and fibers, obtained from consumption of fruits help protect human body from a number of

diseases. The nutrients from fruits positively impact on body-weight and regulation of other health conditions including diabetes and hypertension (2). Consumption of fruits unwashed or improperly washed, especially as they are mostly eaten raw without shedding the back acts as potential sources for the spread of various parasitic agents which are capable of initiating infections. The rate of contamination by species of parasites varies based on climatic condition, ecology, and various human factors (3,4).

Intestinal parasitic infections are considered to be one of the most common diseases in humans (5). About two billion individuals globally are infected with intestinal parasites (4). Most common among the various parasitic agents are protozoan such as *Entamoeba histolytica and Giardia lamblia* which are capable of causing serious diseases in unhygienic individuals both in developing and developed countries (6).

Possible parasites that can be found on fruits are *Cryptosporidium* species, *Cyclospora* species, *S. stercoralis, G. lamblia, E. histolytica, E. coli, Ascaris lumbricoides* (7). Fruits become contaminated with different parasitic stages by means of some fundamental pathways, through flooding which brings various agents to cultivated lands, unethical mode of harvesting, through irrigation, washing process using fecal contaminated water, and through carriers as fruits handlers (8). Other sources of fruit contamination include wind carrying dust and parasitic agents, untreated manure, and activities of some insect such as flies which transport pathogens from night soils to fruits. Contamination can also occur using inadequate storage facility and wrong handling from harvesting, transportation and marketing (9).

Materials and Methods

Study area

The study was conducted within the vicinity of NVRI quarters, Vom, which is located at Jos south Local Government Area, Plateau state, North-central part of Nigeria. It has a weather forecast between 24-28ºC, 3 mph wind, 52-58 humidity, compassed with varying height of Rocky Mountains. It is 1.3 km near the National Institute for Policy and Strategic Studies (NIPSS), 7.6 km from Jos South LGA secretariat, Bukuru. Within NVRI vicinity are one primary school, one secondary school, two higher institutions with students and staff of various levels. The various activities carried out within this environment include mild farming activities and livestock production and cattle grazing.

Sample size

Sample size was calculated using the Yamane's formula (10).

$$n = \frac{Z^2 x\ p\ x\ q^2}{d^2}$$

Where:

n = minimum sample size

z = standard error at 95% confidence limit (1.96)

p = local prevalence (13%) = (0.13)

q = 1-p

d = degree of accuracy (25%) = (0.0025)

$$n = \frac{1.96^2 \times 0.13 \times 0.87^2}{0.05^2}$$

$$n = \frac{3.8416 \times 0.13 \times 0.7569}{0.0025}$$

$$n = 151.2$$

One hundred and fifty (150) samples were examined, 50 each of mango, pawpaw and avocado's pear). These fruits were harvested from different location, in NVRI and its environs.

Sample collection

Samples were collected from various locations within NVRI and environs; Nigerian Institution for Trypanosomiasis Research (NITR), Vaccine complex, NVRI Auditorium, Taylors quarters and Henderson Drive. The fruits were collected from different trees at these locations. Sterile gloves were used in collecting fruit samples to prevent contamination. The fruits were placed in clean polythene bags, appropriately labeled, sealed and transported to the Parasitology laboratory of Federal College of Veterinary and Medical Laboratory Technology Vom for analysis.

Sample Analysis

Samples were analyzed at the Parasitology Laboratory of Federal College of Veterinary and Medical Laboratory Technology Vom, using ordinary centrifugation method and iodine preparation according to Cheesbrough (11). Samples were stored in a clean and contamination-free environment before analysis. 70% ethanol was used to clean laboratory surfaces and equipment before and after each experiment. The samples were washed with 20 ml of normal saline in a universal container, and were allowed to sediment for 20 min undisturbed. With a pipette, 10 ml was removed leaving 10 ml. The sediment was transferred into a centrifuge tube and was centrifuged at 3000 rpm for 5 min. The supernatant was decanted; the deposit was transferred unto a clean grease-free slide, and was emulsified with a drop of lugol's iodine. The slide was covered with cover slip avoiding air bubbles and over-floating. It was examined with X10 objective lens and confirm with x40 objective lens microscopically.

Statistical analysis

The Chi-square (χ^2) analysis was used to determine association between parasitic contamination rate and types of samples. *P*-values less than or equal to 0.05 were considered significant.

Results

Overall, 150 fruit samples, consisting of mangoes, avocado, and pawpaw (50 each), were analyzed for parasitic contamination. Ninety-six (96) samples (64.0%) were positive for parasitic contamination. Among the detected parasites, *E. histolytica* was the most prevalent, accounting for 65(52.4%) positive cases, followed by *E. coli* 33 (26.6%), *S. stercoralis* 25 (20.2%), and *G. lamblia* 1 (0.8%) (Table 1).

Table 1: Overall prevalence of fruits contamination in the study area

Kind of Fruit	***Number examined***	***Number Positive (%)***	***χ^2***	***P-value***
Mango	50	38(76.0)	6.25	0.0439
Avocado pear	50	32(64.0)		
Pawpaw	50	26(52.0)		
Total	150	96(64.0)		

Mangoes had the highest contamination rate with 53 (42.7%) positive samples, followed by avocado 39 (31.5%), and pawpaw 32 (25.8%). The result showed a significant association between fruit type and contamination rates (χ^2 = 6.25, *P*=0.0439) (Table 2). *E. histolytica* was the most frequently detected parasite in mangoes, accounting for 35 cases (66.0%), followed by 15 cases (38.5%) in avocado and 15 cases (46.9%) in pawpaw. *E. coli* was also common, with mangoes showing 14 cases (26.4%), avocado 13 cases (33.3%), and pawpaw 6 cases (18.8%). *S. stercoralis* was found in 3 mangoes (5.7%) and was more prevalent in avocado and

pawpaw with 11 cases each (28.2% and 34.4%, respectively). *G. lamblia* was the least detected parasite, observed in only 1 mango sample. This result revealed significant differences among fruit types (χ^2 = 16.24, *P*=0.0125) (Table 3). Contamination rates varied across the five sampled locations. Fruits collected from the Vaccine Complex had the highest contamination rate of 29 cases (25.0%), followed by Taylor's Quarters with 25 cases (21.6%), the Auditorium Premises with 24 cases (20.7%), the Nigerian Institute for Trypanosomiasis Research (NITR) with 23 cases (19.8%), and Henderson Drive with the lowest rate of 15 cases (12.9%) (Table 3).

Table 2: The fruit(s) with the most parasitic contamination in the study area

Parasites	***Fruits examined***			***Total***	***χ^2***	***P-value***
	Mango (%)	Avocado pear (%)	Pawpaw (%)			
Entamoeba coli	14(26.4)	13(33.3)	6(18.8)	33 (26.6)	16.24	0.0125
Entamoeba histolytica	35(66.0)	15(38.5)	15(46.9)	65(52.4)		
Giardia lamblia	1(1.9)	0(0.0)	0(0.0)	1(0.8)		
Strongyloides stercoralis	3(5.7)	11(28.2)	11(34.4)	25(20.2)		
Total	53(42.7)	39(31.5)	32(25.8)	124		

Table 3: Distribution of Parasitic Contamination on fruits from different locations in the study area

Location	***E. histolytica (%)***	***E. coli (%)***	***G. lamblia (%)***	***S. stercoralis (%)***	***Total (%)***	***χ^2***	***P-value***
VC	14 (48.3)	8 (27.6)	0 (0.0)	7 (24.1)	29 (25.0)	10.01	0.6152
NITR	13 (56.5)	7 (30.4)	0 (0.0)	3 (13.0)	23 (19.8)		
ADP	11 (45.8)	7 (29.7)	0 (0.0)	6 (25.0)	24 (20.7)		
HD	8 (53.5)	1 (6.7)	0 (0.0)	6 (40.0)	15 (12.9)		
TQ	13 (52.0)	7 (28.0)	1 (4.0)	4 (16.0)	25 (21.6)		
Total	59 (48.7)	23 (19.0)	24 (19.8)	15 (12.4)	116 (48.9)		

Keys: VC: Vaccine Complex, NITR: Nigerian Institution for Trypanosomiasis Research, ADP: Auditorium Premises, HD: Henderson Drive, TQ: Taylors Quarter

Discussion

This study provides critical insights into the parasitic contamination of fruits in Vom, Plateau State, Nigeria, emphasizing the public health implications of consuming improperly washed or handled produce. The findings reveal a high overall contamination rate of 64.0% out of the 150 samples examined, with significant variation among fruit types and sampling locations. Mango recorded the highest prevalence of 76% in comparison with Avocados pear with 64% and Pawpaw with 52%, making it a high-risk fruit for parasitic transmission.

The contamination rate observed in this study aligns with reports from several Nigerian studies. Ogbulu et al. reported 68.8% contamination of fruits in southern Nigeria, which is comparable to our findings (12). Similarly, Istifanus and Panda documented 41.5% contamination in Bauchi (13), underscoring the widespread nature of parasitic contamination of fruits grown across different regions of Nigeria. In markets across Jos, Plateau State, Ojemudia found similar contamination trends in fresh vegetables, which highlights the significant role of environmental hygiene and agricultural practices (3). Globally, the contamination rates vary widely, with a

study in Ethiopia reporting a much higher prevalence of 100% (14), likely due to differences in sanitation infrastructure and agricultural practices.

E. histolytica emerged as the predominant parasite, detected in 52.4% of contaminated samples. This finding aligns with a study in Egypt where *E. histolytica* was found to be one of the most common parasites in raw produce in Alexandria, Egypt (2). Within Nigeria, studies have revealed similar findings, linking the prevalence of *E. histolytica* to poor water quality and fecal contamination in agricultural settings (7,8). The high prevalence of *S. stercoralis* (20.2%) in avocado and pawpaw supports findings by Amuta et al. who noted similar parasite burdens in contaminated food items in Nasarawa State (15). These helminthes are known for their environmental resilience and capacity to adhere to fruit surfaces, posing serious health risks to consumers (4).

G. lamblia, though less common in this study (0.8%), has been reported at higher rates in other Nigerian studies. For example, a study in Benue state found *G. lamblia* as a frequent contaminant in food items (16). The low detection rate in this study could be attributed to variations in the distribution of this parasite or methodological differences in detection.

Mangoes exhibited the highest contamination rate (42.7%), with *E. histolytica* being the most frequently detected parasite. This observation is consistent with findings that attributed the high contamination of mangoes to their tendency to fall to the ground during ripening, increasing exposure through contaminated soil (17). Similarly, a study in Jos, Nigeria found mangoes to be among the most contaminated fruits in the markets (3). The relatively lower contamination in pawpaw (25.8%) and avocado (31.5%) may reflect differences in their surface texture, which affects parasite adherence (7).

The variability in contamination rates across locations highlights the impact of environmental and human factors. Fruits from the Vaccine Complex exhibited the highest contamination rate (25.0%), likely due to high human and livestock activity in the area, as noted in similar studies in Nasarawa and Bauchi (8, 13). Conversely, Henderson Drive recorded the lowest contamination (12.9%), possibly due to its relatively low human/grazing activities, and cleaner environment.

While contamination rates in developed countries are generally lower due to stringent agricultural and food safety regulations (6), the situation in developing regions like Nigeria remains concerning. Studies by the WHO emphasized the role of untreated manure, contaminated irrigation water, and poor post-harvest practices in driving high contamination rates in sub-Saharan Africa (9).

The findings of this study underscore the health risks associated with consuming unwashed or improperly handled fruits. Parasites on raw produce can cause severe gastrointestinal infections, especially in vulnerable populations such as children and immune-compromised individuals (3,8). Implementing proper washing practices, education campaigns, and stricter regulations on agricultural practices are crucial steps toward mitigating these risks. This study focused on a limited number of fruit types and locations, which may not fully represent the diversity of contamination risks in Nigeria.

Future research should include more fruit types and regions to develop a comprehensive understanding of parasitic contamination of fruits. Additionally, public health authorities must prioritize training for farmers and vendors on proper hygiene practices and promote the use of clean water for irrigation and washing of fruits.

Conclusion

The presence of these parasites is indicative that consumption of fresh fruits is capable of transmitting parasitic infections to the consumer host. This study highlights the importance of unwashed fruits as a potential source of transmission of intestinal parasites to humans. The fruits contaminated with pathogenic parasites pose high risk to public health if hygiene practices are compromised and the public orientation on hygiene is not positively influenced. Particularly mango fruit which is a ready to eat or pick-up and eat fruit is most contaminated and should be properly washed with sponge and running water for safe consumption.

Hence, prevention with high hygiene practices remains the key factor of reducing fruit-borne parasitic infection. These studies should also be conducted in different regions to compared global safety in fruit consumption and enhance control of parasitic infections. The high prevalence of parasitic contamination observed in this study reflects significant lapses in hygiene and poor agricultural practices. Collaborative efforts among public health authorities, farmers, and vendors are essential to reduce contamination risks and ensure food safety for consumers in Nigeria and beyond.

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Conflict of interest

The authors declare that there is no conflict of interests.

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