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Analysis of Geohelminths Contamination in Raw Fruits and Vegetables Sold in Ebonyi State Nigeria

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Abstract

Background: Geohelminth infections are among the major global public health problems in Ebonyi State, Nigeria. This study of geohelminths infection was carried out in some common fruits and vegetables from an international market, Ebonyi State Nigeria.

Methodology: A total of 146 samples of fruits and vegetables were secured directly from Lot 1 and Lot 2 of the international market and were examined in the laboratory for the presence of geohelminths by the sedimentation technique after washing with normal saline and centrifugation at 1,500 rmp for 5 minutes.

Results: 103 samples of fruits and vegetables were contaminated. The overall geohelminths prevalence for vegetables was 69.9%, the highest of geohelminths contamination was fluted pumpkin (Telfairia occidentalis), while garden egg leaf (Solanum marcrocarpon) was the least contaminated, for fruits, garden egg fruit (Solanum melongena) was the most contaminated. The least contaminated was cucumber (Cucumis sativus). Ascaris Lumbricoides larvae was the most frequent geohelminth contamination of fruits and vegetables, followed by hookworm larvae and Ascaris lumbricoides ova. Other parasites identified were mites, protozoa and Balantidiumcoli. The highest number of geohelminths contamination was found in Lot 1 with 78.9% contamination of vegetables and 60.0% of fruits.

Conclusion: The findings have implications for human health and emphasize the importance of raw fruits and vegetables in threatening public health. Producers ought to be aware of raw fruits and vegetables contamination and observe proper cultivation and sanitation and consumers should follow sound hygiene prior to their use.

Introduction

Geohelminths also referred to as soil-transmitted helminths (STHs) are parasitic worms that infect humans when they come into contact with soil containing the worms, eggs or larvae [1]. Geohelminths infections remain a significant health concern globally [2], especially in developing countries where good sanitation and personal hygiene is poor [3]. Environmental conditions like climate, geography, temperature, soil type, and rainfall significantly influence the spread of intestinal parasitic infections [4]. Vegetables are edible plants commonly cultivated and consumed for their nutritional value [5]. According to the FAO and WHO Organizations of the United Nations, vegetables include all edible parts of a plant, with fruits considered as a subgroup. Fruits are defined as the mature ovaries of plants containing seeds [5], and in some cases, they are the fleshy, seed-associated parts of the plant that can be eaten raw [6]. Raw fruits and vegetables are an important part of the diet of the Nigerian population. They are essential components of a healthy diet as they are rich sources of essential minerals, vitamins, dietary fiber, carbohydrates and phytochemicals, many of which possess strong antioxidants properties that support human health [7-9].

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Despite their health benefits, fruits and vegetables have also been identified as potential carriers of pathogens that can cause diseases in humans [10]. Fruits and vegetables can become contaminated at various points along the supply chain before reaching consumers. From the time of planting until consumption, vegetables are at risk of contamination by parasitic pathogens [11]. Poor hygienic practices during handling and preparation can increase the risk of illness from consuming contaminated produce. Fresh fruits and vegetables may serve as vehicles for transmitting protozoan cysts, helminth eggs and larvae [12-14]. The use of organic fertilizers derived from animal waste is another factor that contributes to the presence of soil- transmitted helminths in vegetables [15].

According to WHO, four main species of soil-transmitted helminths are commonly associated with human helminth infections: Ascaris lumbricoides (roundworm), Trichuris trichiura (whipworm) and the hookworms (Necator Americanus). Sub Saharan Africa, the Americas, China and East Asia report the highest rates of soil-transmitted helminth infections [1]. Nigeria has the highest population infected with soil-transmitted helminths in the African Sub-sahara [17].

Geohelminths infections are among the major global public health problems in Ebonyi State, Nigeria. Many studies conducted in Nigeria have reported a high prevalence of geohelminths Infections [18]. This data is necessary to raise awareness among public health practitioners and to highlight the role played by consumption of raw fruits and vegetables in the transmission of geohelminths Infection. Hence, this study aims to identify the types of soil-transmitted helminths present in raw fruits and vegetables sold at Margaret Umahi International Market in Ebonyi State and to propose simple control measures that would reduce contamination.

Materials and Methods

Area of Study

The study area includes lot 1and lot 2 in international market, Ebonyi State Nigeria. The average annual temperature in this region is around 29.34°C. Ebonyi State is a state in the South-East geopolitical zone of Nigeria, bordered to the north and north east by Benue State, Enugu State to the west, Cross River State to the east and south east, and Abia State to the southwest. Ebonyi State Was created on 1 October 1996, the basic languages used are Igbo and English. The capital city is Abakaliki. The dry season in Abakaliki is hot, muggy, and partially cloudy while the wet season is warm, oppressive, and overcast.

The other important geographical features are the Cross River and its tributary, the River Aloma, which flows along Ebonyi's southeastern and eastern borders, respectively, while the Cross River tributaries, the Abonyi (Aboine), Asu, and Eze Aku rivers run through the state's interior. Ebonyi state has beaches and a great river at the Cross river Basin that is just less than 28 nautical miles to the Atlantic Ocean.

The international market, where samples were collected, is a first class market located in the heart of Abakaliki, Ebonyi State, Nigeria. The market is situated at approximately 6.324° latitude and 8.113° longitude. The average annual temperature in this region is around 29.3°C. The market was opened in 2019 and it is ranked among the largest and busiest markets in the south east and beyond.

Ebonyi State is known for its ferrallitic (lateritic) soils, which are predominantly red or reddish-brown due to iron and aluminum oxides. These soils are typical of tropical rainforest and savanna regions, characterized by high iron and aluminum content, clayey and sandy texture, acidic to neutral pH, and rich in alluvial deposits. Some parts of Ebonyi have fertile floodplain soils that support agriculture.

Agrarian Nature of the People in the Ebonyi State

Ebonyi is an agrarian society, with most of its population engaged in farming, fishing, and agro-based trade. The International Market in Abakaliki plays a crucial role in agricultural trade, serving as a hub for the distribution of farm produce to other states. Key Features of the Agrarian Economy Include:

- Dominance of subsistence and small-scale commercial farming.
- Major stable crops cultivated are rice (Abakaliki rice is famous), yam, cassava, maize, and sweet potatoes. Major fruits and vegetables grown are: garden eggs, fluted pumpkin (ugwu), waterleaf, scent leaf, cucumber, and watermelon. Cash crops include: oil palm, cashew, cocoa, and groundnut.
- A rice production hub the Ebonyi State is often referred to as the "rice bowl of Nigeria" due to its extensive rice farming and processing.
- Livestock farming farmers rear mostly goats, poultry, and pigs.
- Traditional farming methods many farmers still use manual labor, cutlasses, hoes, and local irrigation techniques; however, mechanization is gradually increasing.

The Margaret Umahi International Market serves as a major outlet for selling these agricultural products, connecting local farmers to buyers from within and outside the Ebonyi State.

Collection of Fruit and Vegetable Samples

Three fruits and four leafy vegetables were purchased from lot 1 and lot 2 of the international market. Fruit samples were garden egg fruit (Solanum melongena), watermelon (Citrullus lanatus), and cucumber (Cucumis sativus).

The collected vegetables were: garden egg leaves (Solanum marcrocarpon), fluted pumpkin commonly called as ugwu (Telfairia occidentalis), water leaf (Talinum triangulare), and African basil (commonly called scent leaf) (Ocimum gratissimum). Each fruit and vegetable sample was collected into a sterile labeled polythene bag and transported to the laboratory and checked for the presence of helminths within a few hours of collection.

Method of Examination

The analysis was done in the Applied Biology laboratory of Ebonyi State University Abakaliki, Nigeria. The sedimentation method was used in the laboratory, in which the fruit and vegetable samples were examined. One gram of each finely chopped fruit and vegetable was washed in a clean bath with 250 ml of normal saline and allowed to sediment for 2 hours.

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After sedimentation, the upper and lower portions of the sediment were carefully separated, transferred into a clean beaker, and then centrifuged in tubes at 1,500 rpm for 5 minutes. The two layers from each tube were discarded, to leave only the sediment. Each sediment was poured with normal saline until it was filled and gently placed a glass slide on the top of the tube and held for 3 min to allow the egg clot to the glass slide and gently viewed under a lightmicroscope using a magnification power of (×40) and (×10).

Results

Parasitic Contamination of Vegetables

Data of parasitic contamination of vegetables in collected samples are shown in [Table 1]. Provides valuable insights into the extent of contamination of common vegetables. A total of 104 samples were examined. Fluted pumpkin had the highest contamination rate at 88.5%, which suggests that fluted pumpkin is particularly susceptible to parasitic contamination. Water leaf followed closely with a contamination rate of 76.9%. Scent leaf, with an infection rate of 73.08%, also showed a significant level of contamination, while garden egg leaf had the lowest infection rate among the four vegetables, at 65.4%.

Vegetables	No. of Sample	No. of Sample
	Examined	Infected (%)
Garden egg leaf	26	17 (65.4)
Fluted pumpkin	26	23 (88.5)
Water leaf	26	20 (76.9)
Scent leaf	26	19 (73.9)
Total	104	79 (76.0)

Table 1: Parasitic contamination of vegetables from the international market in Ebonyi State.

Parasitic Contamination of Fruits

Data of parasitic contamination of fruits are shown in [Table 2]. The results revealed varying levels of parasitic contamination across the different types of fruits. A total of 42 fruit samples were examined. Garden egg showed the highest rate of contamination, with an infection rate of 85.7% which suggests that garden egg is particularly prone to parasitic contamination. In contrast, cucumber had the lowest contamination rate at 35.7%, while watermelon with an infection rate of 42.6%, exhibited a moderate level of parasitic contamination.

Vegetables	No. of Sample	No. of Sample
	Examined	Infected (%)
Garden egg	14	12 (85.7)
Fruit		
Cucumber	14	5 (35.7)
Watermelon	14	6 (42.9)
Total	42	23 (54.8)

Table 2: Parasitic contamination of fruits from international market in Ebonyi State.

Most Frequently Encountered Parasites of Vegetables

Detailed data of the most frequently encountered parasites of vegetables are shown in [Table 3]. Ascaris Lumbricoides larvae were the most common parasites found on the vegetables sampled while Protozoa was the least encountered parasite. Other parasites identified were Ascaris Lumbricoides eggs, Hookworm eggs, Mites, Hookworm larvae, Strongyloides stercoralis larvae, Trichuris trichiura larvae. The total infection rate across all four vegetables was 76.0%, with a total of 79 out of 104 samples infected.

Vegetables	No.exa.	No.infec (%)	Asc.L egg	Hookw egg	Mite	Protoz.	Asc.l lar	Hkw. lar.	stro. lar.	Trich lar.
GL	26	17 (69.2)	3 (11.5)	1 (3.84)	3 (11.5)	0	4 (15.4)	2 (7.7)	3 (11.5)	1 (3.8)
FP	26	23 (88.5)	3 (11.5)	2 (7.7)	5 (19.2)	1 (3.8)	7 (26.9)	2 (7.7)	2 (7.7)	1 (3.8)
WL	26	20 (76.9)	2 (7.7)	1 (3.84)	2 (7.7)	0	3 (11.5)	4 (15.4)	5 (19.2)	3 (11.5)

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SL	26	19 (72.0)	1 (3.8)	8 (30.8)	0	3 (11.5)	3 (11.5)	2 (7.7)	1 (3.8)	1 (3.8)
Total	104	79 (76.0)	9	12	10	4	17	10	11	6

Table 3: Most frequently encountered parasites on vegetables from international market in Ebonyi State.

GL = Garden egg leaf, FP = Fluted pumpkin, WL = Water leaf, SL = Scent leaf. No.exa.= Number examined, No.infec%= Number infected %, Asc.L egg= Ascaris lumbricoides egg, Hookw egg = Hookworm egg, Mites= Mites, Protoz=Protozoa, Asc.L lar= Ascaris lumbricoides Larvae ,Hkw lar= Hookworm Larvae , stro. Lar = Strongyloides strercoralis Larvae, Trich. Lar=Trichuris trichiura Larvae.

Most Frequently Encountered Parasites of Vegetables

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Fruit	No.exa.	No.infec (%)	Asc.L egg	Hookw egg	Mite	Asc.l lar	Hkw. lar.	Stro. lar.	Trich lar.	B.coli
GF	14	12 (85.7)	2 (14.3)	2 (14.3)	0	3 (21.4)	2 (14.3)	2 (14.3)	0	1 (7.1)
CU	14	5 (35.7)	1 (7.14)	0	0	2 (14.3)	2 (14.3)	0	0	0
WM	14	6 (42.8)	3 (21.4)	0	0	1 (7.14)	1 (7.14)	1 (7.1)	0	0
Total	42	23 (54.7)	6	2	0	6	5	3	0	1

Table 4: The most frequently encountered parasite on fruits from international market Ebonyi State.

GF = Garden egg fruit, CU = Cucumber, WM = Water Melon. No.exa. = Number examined, No.infec%= Number infected %, Asc.L egg= Ascaris lumbricoides egg, Hookw egg = Hookworm egg, Mites= Mites, Asc.L lar= Ascaris lumbricoides Larvae ,Hkw lar= Hookworm Larvae , stro. Lar = strongyloides strercoralis Larvae, Trich. Lar=Trichuris trichiura Larvae, B.Coli= Balantidium Coli.

Most Frequently Encountered Parasites of Fruits

Data of the most frequently encountered parasites of the 3 types of fruits are presented in [Table 4]. The most commonly encountered parasites across all the fruit samples were ascaris larvae, hookworm larvae, and ascaris eggs. Other parasites identified included mites, Trichuris trichiura larvae, and Strongyloides stercoralis larvae. The total infection rate across all three fruit types was 54.8%, with 23 out of 42 samples infected.

	No.exa.	No.infec (%)	Asc.L egg	Hookw egg	Mite	Protoz.	Asc.l lar	Hkw. lar.	Stro. lar.	Trich lar.	B.coli
Vegetable	104	79 (76.0)	9	12	10	4	17	10	11	6	0
Fruit	42	23 (54.8)	6	2	0	0	6	5	3	0	1

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Total	146	102 (69.9)	15	14	10	4	23	15	14	6	1
Total (%)		69.90%	14.7	13.6	9.7	3.8	22.3	14.7	13.6	5.8	10

Table 5: Parasitic Contamination of Vegetables and Fruits from International Market in Ebonyi State

Combined Parasitic Contamination of Fruits and Vegetables

The combined total for both vegetables and fruits [Table 5] resulted in an overall contamination rate of 69.0%, with 102 out of 146 samples infected. The most commonly encountered parasites across both vegetables and fruits were ascaris larvae (22.3%), hookworm larvae (14.6%), and Ascaris eggs (14.6%). Other parasites such as mites, Strongyloides larvae, and protozoa were also present but to a lesser extent.

Market	Vegetables		Asc.L egg	
	No.exam	positive%	No.exam	positive%
Lot1	52	41 (78.9)	20	12 (60.0)
Lot2	52	38 (73.0)	22	11 (50.0)
Total	104	79 (76.0)	42	23 (54.8)

Table 6: Relationship between parasitic contamination in fruits and vegetables sampled and market source.

Relationship between Parasitic Contamination in Fruits and Vegetables and Market Source

The relationship between parasitic contamination in vegetables and fruits sampled from two different market sources, Lot 1and Lot 2, are presented in [Table 6]. A total of 104 vegetable samples and 42 fruit samples were examined, with the data indicating varying levels of contamination across both vegetables and fruits from the two lots. In Lot 1, vegetables showed an infection rate of 78.9%, with 41 out of 52 vegetable samples testing positive for parasitic contamination. For fruits, the infection rate was slightly lower at 60.0%, with 12 out of 20 fruit samples found to be infected. In Lot 2, the contamination rate in vegetables was lower at 73.0%, with 38 out of 52 vegetable samples testing positive for parasites. Similarly, the contamination rate in fruits from Lot 2 was also lower than in Lot 1, at 50.0%, with 11 out of 22 fruit samples being contaminated. This result indicates a higher level of contamination in lot 1 compared to lot 2.

Discussion

The contamination of fruits and vegetables by geohelminths has emerged as a significant topic in global research due to its important role in the spread of soil-transmitted helminths (STHs) infections [19].

revealed that 76.0% of studied vegetables and 54.8% of studied fruits had some geohelminths contaminants. This correlates with the findings of Okemadu et al., 2021 [20], which stated that the closeness of vegetables to the soil surface than fruits makes them more prone to contamination. In Emmy-Egbe et al., 2012 [21], it was also stated that the low height of vegetables above the ground level increases their susceptibility to geohelminth and gastrointestinal protozoan infections especially during flooding and heavy rain splashes. Fluted pumpkin was observed to be the most contaminated vegetable. This agrees with the findings of Abe et al., 2016 [22] and Okemadu et al., 2021 [20]. Fluted pumpkin is often found in uncultivated soils, particularly in areas with poor sanitation, including those contaminated with sewage and human waste [20].

Cucumbers was observed to have the least level of geohelminth contamination. This is consistent with the findings of Usman et al., 2024 [11] and Agbalaka, 2019 [23], that cucumbers are parasite free. The difference could be attributed to the hygiene practices in different locations where these cucumbers are grown and the hygiene practices of the vendors. The results in table 1and 2 agree with previous studies [9]. It also agreed with Usman et al., 2024 [11] that raw fruits and vegetables serve as vehicles in the transmission of soil borne parasites to new hosts.

The most common parasites detected included Ascaris lumbricoides eggs, hookworm eggs, and their respective larvae. Vegetables showed a greater occurrence of these parasites (9 Ascaris eggs and 12 hookworm eggs) compared to fruits (6 Ascaris eggs and 2 hookworm eggs). Ascaris larvae were also prevalent, accounting for 23 detections overall (17 in vegetables and 6 in fruits). This agrees with earlier studies [11, 3] that detected Ascaris lumbricoides as the most common geohelminth in fruits and vegetables. Amaechi et al., 2011 [24], attributed this to it's high infectivity and adaptability. Moreover, Ascaris eggs are known for their strong environmental persistence. Similar studies in various regions have also identified Ascaris lumbricoides as the most prevalent contaminant found on vegetables [20]. Other parasites such as mites (10 occurrences) and protozoa (4 occurrences) were exclusively found in vegetables. fruits showed a unique case of Balantidium coli larvae (1 occurrence), suggesting possible contamination from water sources or inadequate washing practices.

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Numerous studies from countries such as Iran [15], [25, 26], Pakistan [27], India [28] and Nigeria [29-32] have reported that contaminated vegetables are a major source of transmission for protozoan parasites. Earlier studies have also indicated that contaminated water serves as a primary vehicle for transmission of protozoan cysts and that the presence of protozoan parasites may be attributed to the use of contaminated water for irrigation or the practice of rinsing vegetables with unclean water by market vendors [33].

The results of this study reveal significant parasitic contamination in both vegetables and fruits obtained from international market in Ebonyi state, with vegetables showing a higher contamination rate than fruits. Furthermore Lot 1 demonstrated a greater overall level of contamination in fruits and vegetables compared to Lot 2. According to Usman et al., 2024 [11], this could be attributed to a higher concentration of uneducated or undereducated vendors in the area and this may result in poor hygiene practices thereby increasing the risk of contamination. Differences in environmental conditions between the locations could also contribute to the observed difference in contamination levels [33].

Vegetables and fruits are rich in bioactive compounds hence they play a crucial role in reducing the risk of chronic diseases [34]. In Nigeria, particularly in the eastern region, vegetables such as garden egg leaves are commonly used in traditional dishes like Abacha, Ngwo-ngwo, Nkwobi and Isiewu [35]. Vegetables are often consumed raw due to their perceived medicinal properties, as it is believed that cooking may degrade their active compounds, thereby reducing the health benefits [33]. However, raw vegetables may become contaminated with parasitic eggs or larvae due to poor hygiene practices during harvesting, packaging, transportation, storage and market preparation [36], [4]. Parasitic infections continue to pose a significant global public health challenge and are classified as neglected tropical diseases, particularly in tropical regions like Nigeria [33]. Mascarini-serra et al., 2010 [37] observed that consuming vegetables contaminated with geohelminths increased the risk of gastrointestinal infections. They further revealed that geohelminth eggs present on vegetables consumed by humans caused symptoms such as abdominal pain, diarrhea and vomiting. According to a study conducted by Fauziah et al., 2022 [38]. Eating vegetables contaminated with geohelminths is linked to impaired nutrient absorption resulting in deficiencies in essential vitamins and minerals and delay and obstruction of normal growth and development in children.

The findings from this study highlights the need to address parasitic contamination across different market sources as vegetables and fruits pose potential health risks due to identified parasites. Proper food safety measures should be emphasized to minimize the risk of parasitic infections associated with fruits and vegetables.
Overall, 69.9% of the total samples were found to be contaminated with vegetables accounting for majority of infections. These results emphasize the critical need for better agricultural practices such as using clean water for irrigation, proper harvesting methods and thorough washing of fruits and vegetables. Thus, prioritizing efforts to enhance hygiene practices among farmers, vendors and consumers in these areas is necessary [33].

Conclusion

This study reveals a significant public health concern regarding the presence of soil-transmitted helminths in raw fruits and vegetables sold at Margaret Umahi International Market in Ebonyi State. The detection of eggs and larvae of parasites such as Ascaris lumbricoides, Hookworm, and Strongyloides stercoralis, particularly in vegetables like fluted pumpkin and fruits like garden egg and watermelon, highlights the risks posed by poor hygiene and unsafe agricultural practices. To mitigate these risks, it is vital for consumers to wash and cook produce thoroughly, while farmers and vendors adopt safer farming and handling methods. These findings highlight the need for public health awareness and continued research to promote food safety and protect consumer health.

Recommendations

The following points are recommended for the best interest towards public health:

- Improved area where fruits and vegetables are processed.
- Policy makers and fruits and vegetables vendors should improve hygiene and cleanliness of the market area where fruits and vegetables are sold.
- Implementation of proper treatment of wastewater used for irrigation.
- Improved transportation and storage facilities of fruits and vegetables.
- Fruits and vegetables should be carefully washed with clean water and salt to prevent them from being infected with intestinal helminths disease.
- Constant monitoring of parasites contamination of food particularly fruits and vegetables to provide a clean view of the potential risk of food borne parasites in Ebonyi State Nigeria.

Declaration

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