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Parasitic contamination of fresh fruits and vegetables sold in Ede markets Osun State, Southwest, Nigeria

[1]Odoemene, S.N., [1]Ajibola A.O., [1]Adelowo J.M., [1]Ademola R.A., [2]Oluwole, A.S., [3]Bayegun A.A., [3]Olaitan O.O., [4]Adegbola V.M., [5]Mogaji H.O and [3]Ekpo, U.F

[1]Department of Basic Science, Adeleke University Ede, Osun State, Nigeria
[2]The COUNTDOWN project Department of Neglected Tropical Diseases, Sightsavers, Nigeria Country office, Kaduna, Nigeria
[3]Department of Pure and Applied Zoology Federal University of Agriculture, Abeokuta, Nigeria
[4]Department of Science Laboratory Technology, Federal Polytechnics Ede, Nigeria
[5]Department of Animal and Environmental Biology, Federal University Oye-Ekiti, Ekiti Nigeria

Corresponding author: odoemenesimon@gmail.com

Abstract

Background: Fruits and vegetables are a good source of nutrients or supplements needed for body growth and development; it is a major source of vitamins and minerals, which promote good health and reduce the risk of contracting chronic diseases. Eating raw or unwashed fruits and undercooked vegetables have been implicated as one of the major means by which people are infected with intestinal parasites. Hence, this study, therefore, determines the prevalence of intestinal parasites on fresh fruits and vegetables sold in local markets of Ede North/South LGA of Osun State, Nigeria.

Methods: A total of 245 fruits and vegetable samples were purchased from five (5) different markets in Ede towns, the samples were microscopically examined for the presence of medically important intestinal parasites. The samples were washed with 500ml normal saline and allow for up to 18-24hrs sedimentation, 15ml of the sediment was centrifuged at 3000rpm for 5min. After centrifugation, the supernatant was decanted carefully without shaking. Then the sediment was agitated gently by hand for redistributing the stages of the parasite. Finally, the sediment was examined under a light microscope for the detection of protozoan and helminths parasites.

Results: Out of 245 fresh fruits and vegetables examined, 51(20.82%) were found to be contaminated with intestinal parasites. *Ascaris lumbricoides* (8.16%) ova/eggs were most frequently detected ova/eggs in this study. Other medically important parasites ova/eggs detected are *Trichuris trichiura* (4.48%), *Entamoeba histolytica* (3.27%), *Gairdia lamblia* (2.86%), and *Strongyloides stercoralis* (2.047%). Pepper (*Capsicum anuum*) 8(32%) were mostly contaminated with parasitic ova/eggs.

Conclusion: Findings from this study showed that fresh fruits and vegetables sold in the local markets are contaminated with helminth and protozoan ova/eggs, this plays a vital role in parasitic disease transmission. Therefore, effort should be made by appropriate agencies to ensure that vendors/households are educated on how to properly wash fruits and vegetables before selling and consumption.

Key Word: Parasites, contamination, Fruits, Vegetables, Ede

Background

Locally sold fruits and vegetables in markets and roadsides in rural areas of Nigeria are cultivated through substance farming or by peasant farmers who depend mainly on runoff water, rain, or irrigation water. Consumption of fruits and vegetables are highly nutritious and beneficial in the development, maintaining good health, and preventing infectious diseases of the body (1, 2). Regular consumption of fruits and vegetables as part of meals in families will likely reduce the risk of some chronic diseases such as stroke, cardiovascular diseases, and protection against certain types of cancers (2, 3). Moreover, they are vital sources of energy that are dependent upon by all levels of humans as food supplements or nutrients (4). They substantially improve food quality as rich sources of water, vitamin C, carotene, mineral elements such as iron, and vitamins including thiamine (vitamin B12), niacin, and riboflavin (5, 6, 7).

One of the commonest means of parasitic disease transmission is through consumption of food or water contaminated with the infective stages of the parasites or ingestion of improperly cooked food, meat and the ingestion of contaminated raw fruits and undercooked vegetables (8). Contaminated fruits and vegetables are commonly seen as a risk factor for parasitic infection (8, 9). Fruits and vegetables are contaminated through the application of organic wastes as fertilizer, faecal contamination of wastewaters used for irrigation, direct contamination by livestock, wild animals and birds (9). Contamination can occur during postharvest such as farmer's poor hygiene in handling the produce (9). Some of the streams or rivers used for irrigation in some of the rural areas can also be polluted with parasites with infected excreta, which could lead to recycling of infection (10) and practices which affect hygiene during planting, harvesting, packing, transportation, and storage of fruits and vegetables can easily expose fruits and vegetables to parasitic contamination (11).

In Nigeria, several surveys on the contamination of fruits and vegetables have been documented such as (10, 12, 13, 14, 15, 16), researchers in other countries such as Egypt, Libya, Saudi Arabia, Iraq, Iran, Philippines, Arbaminch and Ethiopia carried out studies assessing the role of eating contaminated fruits and vegetables play in parasitic diseases transmission. Results from this studies showed that fruits and vegetables consumed raw and unwashed play a vital role in the transmission of protozoan cysts or oocysts and helminths eggs or larva. *E. histolytica, Giardia lamblia, E. coli, Balantidium coli, oocysts of Isospora bell, Cryptosporidium spp.* and helminthes eggs and larvae of *Strongyloides stercoralis, T. trichiura, Enterobius vermicularis, Fasciola hepatica, A. lumbricoide, Toxocara spp., Hymenolepis nana, Hymenolepis diminuta*, and *Taenia spp*. of medical importance were detected (11, 17, 18, 19, 20, 21, 22, 23, 24).

Parasitic contamination of fresh fruits and vegetables has also been reported in developed and developing nations (26, 27) due to poor sanitation and inadequate personal hygiene (28, 29). Human infections resulting from eating raw fruits and vegetables have increased at an alarming rate during the past decade (29).

Nigeria is a developing country in Sub-Saharan Africa (SSA), prone to health hazards/risks such as poor personal hygiene and sanitation due to low condition of living, making its inhabitants more vulnerable to parasitic infectious diseases. Ede South and Ede North LGA are developing tremendously due to the presence of three higher institutions (Federal Polytechnic, Adeleke University, and Redeemer's University). The only Military barrack in the state is in Ede community. This has led to an increase in the population of the communities and the consumption of fruits and vegetables has increased drastically.

There is a paucity of information on the parasitic contamination of fruits and vegetables sold and consumed in Osun State, especially Ede communities. Fruits and vegetables in this area are mostly cultivated by peasant farmers. It is also a common practice among vendors to wash fruits and vegetables with water from unclean sources in the markets. Therefore, this study was undertaken to assess the contamination of fruits and vegetables with medically important parasite cyst, ova, or larvae.

Methods

Study area

This cross-sectional survey was conducted between January-April, 2020. Ede is an autonomous community in Osun State Southwest, Nigeria located on Lat 7044'20N and Long 4026'10E, with a total population of 159,866 as of 2006 population census and 330km2 (130 sq mi) total land area. Different types of fresh fruits and vegetables were collected randomly from five different markets in the study area namely Oja Oje market, Owode market, Sekona market, Timi market, and Aisu market. Six different types of fruits were randomly selected African cherry (*Chrysophyllum albidum*), Pineapple (*Ananas comosus*) Watermelon (*Citrullus lanatus*), Banana (*Musa acuminata*), Carrot (*Daucus carota)*, Mango (*Mangifera indica*), and nine different types of vegetables were also randomly selected such as Jute mallow (*Corchorus olitorius*), Fluted Pumpkin (ugu) (*Telfairia occidentalis*), African spinach (*Amaranthus hybridus*), Lagos spinach (*Celosia argentea*), Bitter leaf (*Vemonia amygdalina*), Tomatoes (*Solanum lycopersicum*), Pepper (*Capsicum anuum*), Cabbage *(Brassica oleracea*), Cucumber (*Cucumis sativus*).

Sample collection

A total of 245 different samples of fruits and vegetables were randomly bought from vendors in the five selected markets, 90 fruits, and 155 vegetables which include watermelon, jute mallow, carrot, tomato, pineapple, African cherry, African spinach, Lagos spinach, and bitter leaf, etc. These samples were transported through transporting cold box to the Medical Parasitology Teaching Laboratory of Adeleke University. All the samples were processed and examined for parasitic ova or cyst within 24 hours of collection.

Laboratory Examination

A portion (200g) of each fruit and vegetable was washed separately in 500ml of normal saline for detaching the parasitic stages (ova, larvae, cysts, and oocysts) of helminths and protozoan parasites commonly assumed to be associated with vegetable contamination. After overnight sedimentation of the washed solution, 15ml of the sediment was then transferred to a centrifuge tube using a sieve to remove undesirable matters. For concentrating the parasitic stages, the tube was centrifuged at 3000rpm for five minutes. After centrifugation, the supernatant was decanted carefully without shaking. Then the sediment was agitated gently by hand for redistributing the parasite stages. A drop of the sediment was placed on a clean slid and examined under a light microscope using X10 and X40 objectives. Modified Zeihl-Neelsen staining technique was also used for identification of oocysts of *Cryptosporidium* and *Cyclospora spp* as described elsewhere30.

Statistical Analysis

Data collected from the questionnaire and results of laboratory investigations were entered and analyzed using SPSS version 20.0. The percentage of fruits and vegetables contaminated with medically important parasites was calculated and recorded. Chi-square tests were used to identify factors associated with parasitic contamination of samples. Association between variables was considered statistically significant only if P-value ≤ 0.05 at 95% confidence level.

Results

Out of 245 fresh fruits and vegetables sampled, 51(20.82%) were found to be contaminated with parasitic ova/cyst. The most contaminated vegetable was *Celosia argentea* (Lagos spinach) 9(17.65%), by 8(15.69%), 6(11.77%), 6(11.77%), 5(9.80%), 4(7.84%) for Capsicum anuum (pepper), *Chrysophyllum albidum* (African cherry), *Solanum lycopersicum* (Tomatoes), *Mangifera indica* (mangoes), *Corchorus olitorius* (Jute mallow) respectively were also contaminated (Table 1).

Ascaris lumbricoides 20(39.22%) has the highest frequency of occurrence among the parasitic species found on fresh fruits and vegetables, followed by *Trichuris trichiura* 11(21.87%), *Entameba histolytica* 8(12.69%), *Giardia lamblia* 8(15.69%), and *Strongyloides stercoralis* 4(7.84%) (Table 2). There was no significant difference (P= 0.0984) seen in the types of parasitic contamination on fresh fruits and vegetables in this study. *Amaranthus hybridus* 9(22.50%) and *Capsicum anuum* 7(28.00%) were the most contaminated vegetables while *Prunus Africana* 6(30.00%) and *Mangifera indica* 5(50.00%) were the most contaminated fruits (Table 3). *Ascaris lumbricoides* were found to be the highest occurring parasites on *Prunus Africana, Ananas comosus,* and *Capsicum anuum* while *Trichuris trichiura* was found to be the highest parasitic species contaminating *Solanum lycopersicum.*

The result from this study indicates that fruits and vegetables sold in Timi market 16(31.37%), were mostly contaminated followed by those sold at Aisu market 12(23.53%) and Owode market 10(19.61%) respectively. The least infestation was recorded in fruits and vegetables sold in Oja Oje market 5(9.80%) (Table 4). There was no significant difference (p=0.141) observed in

parasitic contamination of fresh fruits and vegetables sold in the selected markets. Fruits and vegetables bought directly from farmers in the markets had the highest prevalence of parasitic contamination 32(31.68%) while 13.19% of the contamination was recorded in samples bought from retailers. There was no significant difference (P = 0.143) observed in the source of purchase (Table 5).

Findings from this study show that 60% of the fruits and vegetables were not washed by vendors before displaying them for sale while 40% were washed. A total of 35(23.81%) of the unwashed fruits and vegetables were found to be contaminated with parasites while 16 (16.33%) of the washed samples were also found to be contaminated with parasites, but no significant association ((P=0.126) was observed between unwashed, washed samples and parasitic contaminations (Table 5).

The means of displaying fruits and vegetables before selling in the markets is another factor associated with parasitic contaminations. A total of 112(45.71%) of the samples were displayed on the tables, 122(49.80%) were displayed on the floor while 11(4.49%) were displayed on the wheelbarrows. A total of 19(16.96%) of the fruits and vegetables displayed on tables were contaminated with parasites, 28(22.95%) of the samples displayed on the floor, and 4(3.63%) of the samples displayed on the wheelbarrow were contaminated with parasites respectively. A significant difference (P=0.001) was observed between means of display and parasitic contamination as seen in table 5.

Table 1: Prevalence and Distribution of Parasites among contaminated fruits and vegetables

Kind of Fruits/Vegetables	**Scientific Name**	**Number sampled**	**Number Infected**
African cherry	*Chrysophyllum albidum*	20	6(30.00)
Pineapple	*Ananas comosus*	10	3(30.00)
Watermelon	*Citrullus lanatus*	10	2(20.00)
Banana	*Musa acuminate*	15	2(13.33)
Carrot	*Daucus carota*	25	3(12.00)
Mango	*Mangifera indica*	10	5(50.00)
Jute mallow	*Corchorus olitorius*	20	4(20.00)
Ugu (Pumpkin leave)	*Telfairia occidentalis*	10	3(30.00)
Lagos spinach	*Celosia argentea*	40	10(25.00)
Better leaf	*Vemonia amygdalina*	20	0(0.00)
Tomatoes	*Solanum lycopersicum*	25	6(24.00)
Pepper	*Capsicum anuum*	25	7(28.00)
Cabbage	*Brassica oleracea*	5	0(0.00)
Cucumber	*Cucumis sativus*	10	0(0.00)
Total		**245**	**51(20.82)**

Table 2: Frequency of Parasites in Fruits and Vegetables

Detected Organisms	Frequency	Prevalence (%)
Ascaris lumbricoides	20	39.22
Trichuris trichiura	11	21.87
Entameba histolytica	8	15.69
Giardia lamblia	8	15.69
Strongyloides stercoralis	4	7.84
Total	**51**	**100**

p>0.005

Table 3: Prevalence of parasitic contamination according to types of fruits and vegetables in the study area

Fruits/Vegetables	NE	*Ascaris lumbricoides* ova (%)	*T. trichiura* ova (%)	*E. histolytica* cyst (%)	S. stercoralis ova (%)	*G. lamblia* cyst (%)	Total (%)
Prunus Africana	20	3(15.00)	2(10.00)	1(5.00)	0.0	0.0	6(30.00)
Ananas comosus	10	3(30.00)	0.0	0.0	0.0	0.0	3(30.00)
Citrullus lanatus	10	0.0	0.0	1(10.00)	0.0	1(10.00)	2(20.00)
Musa acuminate	15	0.0	0.0	1(6.67)	0.0	1(6.67)	2(13.33)
Daucus carota	25	1(4.00)	1(4.00)	1(4.00)	0.0	0.0	3(12.00)
Mangifera indica	10	2(20.00)	1(10.00)	0.0	0.0	2(20.00)	5(50.00)
Corchorus olitorius	20	0.0	1(5.00)	0.0	0.0	3(15.00)	4(20.00)
Telfairia occidentalis	10	1(10.0)	1(10.00)	0.0	1(10.00)	0.0	3(30.00)
Amaranthus hybridus	40	5(12.50)	1(2.50)	1(2.50)	2(5.00)	1(2.50)	10(22.50)
Vemonia amygdalina	20	0.0	0.0	0.0	0.0	0.0	0.0
Solanum lycopersicum	25	2(8.00)	3(12.00)	1(4.00)	0.0	0.0	6(24.00)
Capsicum anuum	25	3(12.00)	1(4.00)	2(8.00)	1(4.00)	0.0	7(28.00)
Brassica oleracea	5	0.0	0.0	0.0	0.0	0.0	0.0
Cucumis sativus	10	0.0	0.0	0.0	0.0	0.0	0.0
Total	245	20(8.16)	11(4.49)	8(3.27)	4(1.63)	8(3.27)	51(20.82)

*NE (Number Examined)

Table 4: Prevalence of parasitic infections on fruits and vegetables sold at different markets

Infections	Owode Markets	Aisu Markets	Oja Oje Markets	Sekona Markets	Timi Markets	Total
As	4(20.00)	4(20.00)	2(10.00)	3(15.00)	7(35.00)	20(100)
Tt	1(9.09)	4(36.36)	1(9.09)	1(9.09)	4(36.36)	11(100)
Eh	3(37.50)	1(12.50)	1(12.50)	2(25.00)	1(12.50)	8(100)
Gl	2(25.00)	1(12.50)	1(12.50)	1(12.50)	3(37.50)	8(100)
Ss	0(0.0)	2(50.00)	0(0.0)	1(25.00)	1(25.00)	4(7100)
Total	10(19.61)	12(23.53)	5(9.80)	8(15.69)	16(31.37)	51(100)

P>0.005

As: *Ascaris lumbricoides*; Tt: *Trichuris trichiura*; Eh: *Entamoeba histolytica*; Gl; *Giardia lamblia*; Ss: *Strongyloides stercoralis*

Table 5: Factors Associated with parasitic contaminations of fruits and vegetables in the study area

	Parasitological Investigation			
Variables	**NE (%)**	**NI (%)**	**X^2**	**P-value**
Source of purchase				
From Farmers	101(41.22)	32(31.68)		
Retailers	144(58.78)	19(13.19)		
Total	245(100)	51(20.82)	6.434	0.143
Wash before display				
Yes	98(40.00)	16(16.33)		
No	147(60.00)	35(23.81)		
Total	245(100)	51(20.82)	11.546	0.126
Means of display				
On the table	112(45.71)	19(16.96)		
On the floor	122(49.80)	28(22.95)		
On wheel barrow	11(4.49)	4(3.63)	7.691	0.001
Total	245(100)	51(20.82)		

*NE (Number Examined), *NI (Number Infected)

Discussion

This present study assessed the contamination of fruits and vegetables with parasitic ova/cyst in five randomly selected markets in Ede, Osun State, Nigeria. The prevalence of contamination of fruits and vegetables with human pathogenic parasites as recorded in this survey was 51(20.82%) out of 245 samples collected and examined. This is in similitude with the findings of (25, 31, 32) who recorded 17.59%, 14%, and 13.5% prevalence cases of parasite contamination of fresh fruits

and vegetables sold at different markets in Kogi, Zaria, and Kaduna states respectively. This result is quite lower than the reports of 33 and 34 who recorded 36.0% and 54.3% parasitic contamination of fresh fruits and vegetables sold in Jos, Nigeria, and Manila, Philippines.

The difference observed in these results might be due to differences in environmental factors in the study areas where the fruits and vegetables were cultivated and also it may be connected to different methods of handling and displaying the products at the point of sale by farmers and vendors. This shows that contamination of fruits and vegetables with ova/cyst of parasites varies in different regions and countries, the quality of fruits and vegetables sold in places with high contamination can still be improved if these differences are taken care of by all the stakeholders (35).

The most prevalent parasite recorded in this survey is *A. lumbricoides*, this may be as a result of the viability of their eggs in the soil for months and being the commonest parasite in the tropics (36, 37, 38). This result agrees with the works of Dauda (31), Nasiru (39), and Ohaeri (40) who in their separate findings reported *A. lumbricoides* as the most prevalent parasitic helminth observed on fruits and vegetables (80.6%, 65.8%, and 24%) in Kaduna, Umuahia, and Gusau respectively. Dauda also reported that people consuming vegetables irrigated with raw wastewater are exposed to the risk of infection with *Ascaris lumbricoides, Entamoeba histolytica,* and *Giardia lamblia* (31). The contamination of fruits and vegetables with helminthes and protozoan ova/cyst in this study has a significant public health implication. Some of the fruits are not washed and few vegetables are eaten uncooked, this could lead to infection on consumers.

Amaranthus hybridus was found to be the most contaminated sample followed by *Capsicum anuum, Solanum lycopersicum,* and *Chrysophyllum albidum* while *Citrullus lanatus* and *Musa acuminata* had the least parasitic contamination. The difference in parasitic contamination between the samples in this survey might be because vegetables are closer to contaminated soil because of their short stem while most fruits fall to the ground before the farmers pick them up for sale. Parasitic ova/cyst attaches easily to vegetables due to their large and broad surfaces while most fruits such as cucumber, mango, and African cherry have smooth surfaces which could reduce the rate of parasitic attachment on their body.

Source of purchase was found to be a risk factor of infection as fruits and vegetables bought directly from farmers had more parasitic ova/cyst contamination (31.68%) which could be attributed to farmers irrigating their farmlands with contaminated wastewater which could expose the fruits and vegetables to pre-harvest infections and the use of infected animal waste as manure. Wastewater and animal waste used in most developing countries for agricultural purposes as manure constitute a public health risk to consumers due to lack of treatments. Displaying fruits and vegetables without washing and display on the contaminated floor might increase the level of a parasitic contamination. The result from this survey corroborates with the findings of other studies from different regions. It was reported by (41) that flies can act as vectors for a different number of pathogenic microorganisms including parasites like *Cryptosporidium parvum* and *Toxoplasma gondii.* The fruits and vegetable samples displayed on the floor had little or no protection from contamination of pathogenic microorganisms; most of

the fruits were displayed directly on the floor which could expose them to a high risk of infections.

Though washing fruits and vegetables with ordinary water alone is not enough to remove all the parasitic ova/cyst as reported by (7), which washed fruits and vegetables using saline, phosphate-buffered saline, and tap water respectively, saline solution was more effective in recovering of contaminated parasites ova/cyst. Vegetables were more contaminated than fruits due to their rough/folded surfaces, there is a need to wash vegetables thoroughly with saline solution to properly recover the parasitic cyst/ova. *A. lumbricoides* and *T. trichiura* were the most prevalent parasites recorded to contaminate fruits and vegetables in this study; this reflects the poor sanitary conditions of the study area, which might be a result of open defecation as practiced in the area. The contamination of fruits and vegetables sold in this study shows that consumers are at a very high risk of being exposed to parasitic infection from eating fresh fruits and vegetables, this calls for a public health concern. Though fruits and vegetables are very important in our daily food intake (diet), eating fruits without proper washing with saline solution, clean water or undercooking vegetables contaminated with pathogenic parasites poses a serious health risk to the public.

Conclusion

Fresh fruits and vegetables are very important to the body, it is an essential human diet that cannot be removed from our diet, but can be prevented from the cycle of parasitic transmission by farmers, vendors, and consumers. It is recommended that farmers maintain simple personal and environmental hygiene by avoiding the use of untreated human and animal wastes as manure. Vendors should always wash their product properly with water before selling and always display their product in a transparent container to prevent flies from contaminating the fruits; they should avoid the washing of fruits and vegetables with unclean and contaminated water. Consumers on the other hand should always wash fruits and vegetables thoroughly with saline solution before eating or cooking and Government agencies and market management authorities should make an adequate provision of amenities such as safe water for washing of fruits and vegetables in the markets and good toilet facilities for proper disposal of waste. Further researches should be conducted on parasitic contamination of fruits and vegetables in this area and other regions.

List of Abbreviations

Eh: *Entamoeba histolytica*

As: *Ascaris lumbricoides*

Tt: *Trichuris trichiura*

Gl: *Giardia lamblia*

Ss: *Strongyloides stercoralis*

SSA: Sub-Sahara Africa

NE: Number Examined

Spp: Species

DECLARATIONS

Ethics Approval and Consent to Participate

This survey was approved by the market leaders in the various markets selected for this study and only the vendors who consented were recruited into the survey.

Consents for Publications

No data, images, or video of an individual is included in this manuscript.

Availability of Data and Materials

The dataset during and/or analyzed during the current study is available from the corresponding author on a reasonable request

Competing Interest

The authors have declared that they have no competing interest in this study.

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Authors Contributions

OSN conceived, designed, coordinate the study and prepare the manuscript. OAS, MHO, and AJM took part in the analysis and interpretation of the work. BAA, ARA, OOO, and AMV participated in the data collections and statistical analysis; also they took part in conducting the literature search. EUF supervised and critically review the paper. All authors read and approve the final draft

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