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Parasitological Assessment of Ready to eat Fruits and Vegetables at a selected Market in Malete, Kwara state, Nigeria

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ABSTRACT

Food borne illnesses majorly result from poor hygiene practices and unsanitary conditions especially at fruits and vegetable selling points. We aimed to assess the hygiene status as well as parasite contamination in fruit and vegetables sold at Malete in Kwara state, Nigeria. Four (4) samples each of ready-to-eat vended fruits and vegetables which include; water melon, tomatoes, cucumber, carrot, banana and garden egg, and two (2) samples each of orange and pineapple were purchased from different fruits sellers in Malete. The parasite contamination of fruits was examined using standard centrifugal sedimentation methods. The helminth egg, larva, cast, and cyst were identified by using distilled water and saline as a floating medium, staining them with dobell's iodine, and examining them with an x40 objective lens. A total of four (4) parasite worms were identified as: *Ascaris lumbriocoides* (68.63%), *Entamoeba coli* (4.54%), *Entamoeba histolytical* (18.18%) and *Paragonimous westermani* (9.09%) from the fruit samples studied. Carrots and tomatoes show the highest contamination with 91.66% and 83.33%, banana and cucumber show lowest contamination (56.25% and 50%) among the samples, while orange and pineapple show no contamination among samples. Fruits and vegetables that are offered at the vendors are not pathogen-free, as evidenced by the organisms that were isolated from them. Thus, there is a risk of parasite infection if these fruits and vegetables are consumed raw without being thoroughly cleaned. The results and recommendations of this study are anticipated to be put into practice in order to reduce the any risk of contracting parasite infections among the populace

Keywords: Parasites; Helminthes; Soil transmitted; Infection-risk fruits; Vegetables; Food contamination; Food borne diseases; Hygiene practice.

1. Introduction

Fruits and vegetable are essential for a healthy human body, as they form a major component of human diet in every family [1,2]. Fresh vegetables possess medicinal effects and their consumption has been shown to reduce the risk of stroke, cardiovascular diseases and protect against certain type of cancers [3]. Moreover, vegetables and fruits are vital sources of energy that are dependent upon by all levels of human as food supplements or nutrients [4]. Since they are abundant in water, vitamin C, carotene, iron-containing minerals, and vitamins including thiamine (vitamin B12), niacin, and riboflavin, they significantly enhance the quality of food [5].

In many countries, fruits and vegetables are eaten raw or lightly cooked to preserve flavor and nutritional contents, although this practice may favor the likelihood of food-borne parasitic infections. Vegetables become a potential source of human infection like enteric bacterial, viral and parasitic pathogens by contamination during harvest, transportation or processing [6]. The sources of contamination more often are soil, feaces (human and animal origin), water (irrigation, cleaning) [7]. Most still, contamination may also occur when fresh vegetables are rinsed and sprinkled with contaminated water due to the region's temperature and geography, these fruits and vegetables can be grown all year round in southwest Nigeria with irrigation during the dry season and rain during the rainy season [2]. Farmers and consumers of fruit and vegetable products are at significant danger due to the high levels of pollution in these two water sources from human and animal waste. Market-sourced fruits and vegetables are frequently tainted by the eggs of human intestinal nematodes, which are prevalent in areas where waste water,

human and animal excrement are recycled [2]. Due to the rising expense of mineral fertilizer and the increased need for basic fruits and vegetables in Nigerian diets due to the country's low socioeconomic status, this approach is becoming more and more popular [8].

Foods contaminated by microorganisms are responsible for the transmission of disease to humans. These are known as food borne diseases, and they can cause issues like intoxication, protozoa, helminthes, intestinal infections, gastroenteritis, amebiasis, giardiasis, cryptosporidiosis, and toxoplasmosis, among others. Vegetables and fruits are raw natural foods that are widely consumed by the population and can be eaten, in most cases, in their raw form. The quality of human health is significantly related to adequate food conditions that range from nutritional values to favorable hygiene conditions [9].

In the world, an intestinal infection caused by helminthes and protozoa affects approximately 3.5 billion people, with significant records in Africa [3]. The main clinical manifestations apparent in infected peoples are malnutrition, diarrhea, anemia, cognitive delay, and irritability [3]. On average, there are 107 known parasite species that may be from food source, that is, they may be present in food or water, making it possible for the individual through the ingestion of these ones [4].

Intestine parasitic diseases are spread through ingestion of larvae, eggs, oocysts, or cysts. The high incidence and diversity of clinical symptoms of intestine parasitic diseases pose a global public health concern [3]. Nyarango confirms that intestinal parasite infections are considered a serious public health concern in many communities, particularly in developing nations [14]. Further epidemiological research revealed that populations in parts of southwest Nigeria where raw, untreated waste water is used to irrigate fruits and vegetables are prone to endemic Helminthes diseases. Consumption of these waste-irrigated fruits, which are typically consumed raw and uncooked, can result in parasite infestation [15,16,17].

This study was designed to conduct a parasitological assessment of samples of ready to eat fruits and vegetables sold in Malete markets in Ilorin, Kwara state, Nigeria to further ascertain the risk status of the situation, and determine the prevalence of parasites on these food samples using effective laboratory examination methods.

1.1. Study Objectives

(i) To determine the prevalence of parasite of fruits and vegetables using effective laboratory examination.

(ii) To determine the effect of washing of fruits and vegetables on parasite elimination.

(iii) To determine the safety of fruits and vegetables for consuming without washing them.

2. The Study Area

This study was conducted on fruits from four different fruit sellers in Malete market, under the Kwara state University, Malete, Kwara state. Malete is located at an elevation of 308 meters above sea level and it’s with a human population of 102,780 as projected from 2006 National population Census. Malete is populated by people of Yoruba, Hausa and Fulani ethic groups.

3. Methodology

3.1. Sample Collection

A total of 136 Samples consisting of fresh fruits and vegetables were purchased from different fruits sellers in Malete which includes water melon (Citrullus lanatus), Tomatoes (Solanum lycopersicum), cucumber (Cucumis sativus), Carrot (Daucus carota) Orange (Citrus sinensis), pineapple (Ananas comosus), Banana (Musa acuminata) and Garden egg (Solanum aethiopicum). From each of the sellers four diffremt samples were collected except for Orange (Citrus sinensis), and pineapple (Ananas comosus) which two sample were being collected. Cover plastic bucket which is sterilized by dusting with cotton wool dipped in 70% ethanol were used to receive the samples from the sellers and transported to Central Research Laboratories in university of Ilorin for processing and examination.

3.2. Identification of Parasites on Selected Edible Fruits and Vegetables

Parasitological examination of the fruits and vegetables using different solvents [distilled water and normal saline solution (0.09% NaCl)] to assay the samples. In the laboratory, 100g of each of the samples were weighed and put into a clean beaker containing 100ml of the normal saline solution (0.9% Nacl) for the removal of parasitic ova, cysts and larva. The protocol involved soaking the fruits and vegetables in the sterile distilled water and saline solution and agitating 5 times within 30 minutes; this is to dislodge eggs, larva and cysts from the fruits and vegetables. The suspension was strained through a clean and sterile sieve to remove large particles. After removing the fragments of the sample from the washing solution using clean forceps; it was kept for 24 hours to allow sedimentation to take place. The same experiment was carried out using 100 ml of distilled water for each sample. After 24 hours of sedimentation, the top layer of the washing solvents was carefully discarded leaving 5ml of the sediments. The filtrate was centrifuged at 5,000 rpm for 5 minutes.

After discarding the supernatant into disinfectant jar, the residue was mounted on slides carefully and systematically stained with Dobell's iodine solution and examined under the compound light microscope for the presence of egg, cysts and larvae of parasites. The deposit was examined directly on a slide by covering a drop of the deposit with cover slip and examined under x10 and x40 objectives. To facilitate better visualization iodine (Dobell's iodine) preparation was done by adding a drop of Dobell's iodine in the saline preparation before examination under microscope [18].

Table 1. Number of fruits and vegetables collected from four different sellers in Malete market

Sample	Total no of Fruits Sellers in Malete Market	Total no of Sample collected from Malete Market	Weight of the test and reagent samples
Banana	4	16	10g
Cucumber	4	16	10g
Water melon	4	16	10g
Tomatoes	4	24	10g
Carrot	4	24	10g
Garden Egg	4	24	10g
Orange	4	8	10g
Pineapple	4	8	10g

3.3. Determination of Concentration Level of Eggs, Larva and Cysts of Intestinal Parasites on Selected Fruits and Vegetables

The concentration levels of eggs, larva or cysts of intestinal parasites on the selected fruits and vegetables were determined by the methods of sedimentation. 100g samples of each fruits and vegetables were washed in 100ml of distilled water and normal saline solution in a sterile beaker for the removal of the parasitic ova, larva or cysts. The suspension was strained through a sterile sieve to remove undesirable materials [13]. The filtrate was centrifuged at 5000 rpm for 5 minutes [18] and the supernatant was discarding into the disinfectant jar. The sediment was mixed up and a drop was applied on the centre of a clean grease-free microscope slide and a clean cover slip was placed gently to avoid air bubbles and over-flooding. The preparation was examined under microscope for parasites using X10 and X40 objectives.

4. Results

4.1. Numbers of contaminated collected fruits and vegetables from each seller

Of the 136 samples of the edible fruits and vegetables examined, 88 samples were contaminated with various protozoan and helminthes parasites. This consists of 9 bananas, 8 cucumbers, 16 watermelons, 24 tomatoes, 24 garden eggs, 8 oranges and 8 pineapples.

Table 2. Number of fruits and vegetables contaminated with parasites from each sellers (n=136)

Fruits & Vegetables	1st Seller	2nd Seller	3rd Seller	4th Seller	No. examined	No. of identified parasites
Banana	4	4	4	4	16	9
Cucumber	4	4	4	4	16	8
Watermelon	4	4	4	4	16	10
Tomatoes	6	6	6	6	24	20
Carrot	6	6	6	6	24	22
Garden egg	6	6	6	6	24	19
Orange	2	2	2	2	8	0
Pineapple	2	2	2	2	8	0
Total	34	34	34	34	136	88

4.2. Numbers of cells, larva and worms on collected fruits

Eight (8) cysts of Amoeba were found in cucumber, thirteen (13) in Garden egg, and fourteen (14) in watermelon. Nine (9) eggs of worms were seen in banana, six (6) seen in garden egg, twenty (20) in tomatoes and eighteen (18) in carrot. No egg, cysts, caste or larva of worms were seen in orange and pineapple.

Table 3. Parasitological examination of fruits and vegetables using iodine solution

Fruits Samples	1 Drop of Iodine	2 Drops of Iodine
Tomatoes	20 eggs of worm was seen	Twenty (20) eggs of worm was seen
Pineapple	No ova of parasite seen	No ova of parasite seen
Garden egg	13 cysts of Amoeba was seen	Thirteen (13) cysts of Amoeba was seen

Garden egg	6 eggs of worm was seen	Six (6) eggs of worm was seen
Water melon	14 cysts of Amoeba was seen	Fourteen (14) cysts of Amoeba was seen
Orange	No ova of parasite seen	No ova of parasite seen
Carrot	18 eggs of worm was seen	Eighteen (18) eggs of worm was seen
Cucumber	8 cysts of Amoeba was seen	Eight (8) cysts of Amoeba was seen

4.3. Frequency of isolated parasites in collected fruits and vegetable samples

A total of eight (8) different types of fruits (overall number of 173 fruits) were examined for parasites contamination Watermelon has the highest contamination rate of 87.5%, followed by tomatoes (83.33%), carrot (75%), banana (56.25%), garden egg (54.16%) and cucumber (50%).

Table 4. Frequency of Isolated Parasites

Parasites	Frequency	Percentage (%)
Ascaris lumbriocoides	60	68.63
Entamoeba coli	4	4.54
Entamoeba histolytical	16	18.18
Paragonimous westermani	8	9.09
Total	88	100

4.4. Prevalence of Parasites on Fruits and Vegetables from Each Seller

The first fruits seller had the highest prevalence of parasite infected edible fruits and vegetables (27 or 79%). Indicating the hyper endemic levels of disease associated with these parasites in Malete especially the first seller. The second, third and fourth seller had significant measures of parasites transmitted via edible fruits and vegetables in the amounts of 24 or 70%, 20 or 58% and 17 or 50% respectively.

Table 5. Prevalence of Parasites on Fruits and Vegetables from Each Seller

Fruit & Vegetables	1st Seller		2nd Seller		3rd Seller		4th Seller	
	Ex	In	Ex	In	Ex	In	Ex	In
Banana	4	3	4	4	4	4	4	3
Cucumber	4	2	4	4	4	3	4	1
Water melon	4	3	4	3	4	3	4	3
Tomatoes	6	6	6	0	6	6	6	3
Carrot	6	4	6	4	6	5	6	3
Garden egg	16	6	16	5	16	6	16	4
Orange	2	0	2	0	2	0	2	0
Pineapple	2	0	2	0	2	0	2	0
Total	34	24	34	20	34	27	34	17

4.5. Frequency of Isolated Parasites

Ascaris lumbriocoides had the highest frequency of 60 (68.63%) in the contamination of 136 sampled edible fruits and vegetables. *E. coli*, 16 (18.18%); *E. histolytical*, 4 (45.45%) and *Paragonimous westermani*, 8 (9.09%) respectively.

Table 6. Frequency of Isolated Parasites (n=136)

Parasites	Frequency	Percentage (%)
Ascaris lumbriocoides	60	68.63
Entamoeba Coli	4	4.54
Entamoeba histolytical	16	18.18
Paragonimous westermani	8	9.09
Total	88	100

4.6. Parasitological Dislodging Effects of Distilled Water and Normal Saline on Ready to Eat Fruits and Vegetables

Overall, normal saline (51) dislodged more parasites than distilled water (37). However, the effect is inversely varied on specific fruits and vegetables sampled. On garden egg, there is wide margin shown in dislodging *Ascaris lumbricoides* using distilled water (10) against normal saline (3). Similarly, the big margin was observed in the number of *E. coli* (8) dislodged when normal saline was used in washing watermelon against the distilled water that dislodged (2) parasites. The number of*Paragonimous westermani* (7) dislodged when normal saline was used on cucumber varied from the number of parasites dislodged when distilledwater was used (1). The two agents applied in washing and dislodging parasites like *Ascaris lumbricoides* (7) from banana and*E. histolytical* (3) from watermelon also equally varied.

Table 7. Parasitological dislodging effects of distilled water and normal saline on ready to eat fruits and vegetables

Fruits & Vegetables	Parasites dislodged	No. of parasites dislodged using	
		Distilled water	Normal saline
Banana	*Ascaris lumbriocoides*	7	2
Cucumber	*Paragonimous westermani*	1	7
Watermelon	*Entamoeba Coli*	2	8
	Entamoeba histolytical	1	3
Tomatoes	*Ascaris lumbriocoides*	10	10
Carrot	*Ascaris lumbriocoides*	9	9
Garden egg	*Entamoeba Coli*	3	10
	Ascaris lumbriocoides	4	2
Orange	-	-	-
Pineapple	-	-	-
Total		37	51

5. Discussion

The result obtained from this study reveals that pathogenic organisms are associated with fruits and vegetables considering the high number of parasitic eggs, larvae and cysts present on the sample examined. Previous studies have revealed that many types of vegetables, purchased at markets in different regions were contaminated with helminth eggs, as well as protozoan oocysts [16, 17]. The result of this study shows that fruits and vegetables from 1st and 3rd sellers in Malete are highly contaminated compared to the 2nd and 4th fruits and vegetables seller.

The isolation of parasitic protozoa from some of the fruits and vegetables confirm reports that fruits and vegetables are possible sources of infection with disease causing pathogens, and the development of food borne illnesses such as gastroenteritis, amebiasis, giardiasis, cryptosporidiosis, toxoplasmosis among others [9]. According to this study, the water used by the vendors to wash the produce or the water sprayed on it to keep it fresh may be the cause of the parasites on the fruits and vegetables. Furthermore, it is well known that the majority of fruits and vegetables are grown using manure made from the feces of animals and humans. The present findings support a prior investigation [19] that discovered fruits and vegetables to be tainted with geohelminth ova and larvae Given that the adult worms found in this study are often found in the intestine of animals, it is possible that the fruits and vegetables were infected with pathogens from feces. However, this is a clear illustration of the unsanitary conditions in our rural fruit and vegetable growing areas, as well as the practice of farmers and sellers utilizing tainted water and night soil as manure to keep produce fresh. This latter possibility could explain the increased frequency of lumbricoides eggs in this investigation. This result is consistent with Elom's findings [1].

Our hypothesis is that the hyperendemic levels of sickness linked to these parasites in the Malete area are the likely cause of the high prevalence of parasitological contamination of fruits and vegetables in this study. The incidence of intestinal illnesses may rise further as a result of farmers and vegetable vendors' inadequate understanding, attitudes, and practices about appropriate hygiene, which are reflected in these statistics. The absence of interaction with polluted water, as previously established, is indicated by the zero frequencies of parasites repeated in the orange and pineapple samples. Before consuming the edible portion of these fruits that is not affected, the peels are removed. Moreover, high frequencies were detected in relation to Ascaris lumbricoides eggs from the fruits and vegetables under investigation. Thus, it is highly likely that people who eat fruit and vegetables in this area could contract Ascariases.

Lastly, distilled water and regular saline were contrasted for their ability to dislodge. While distilled water generally dislodged fewer parasites than normal saline, the result has differed negatively for certain fruits and vegetables. Saline has a role in sustaining a favorable culture environment for different parasitic cells on these fruits and vegetables, which may account for the overall specific differences in the number of parasites identified using distilled water and regular saline. Every isolated organism has the potential to cause a variety of human illnesses, some of which some might even lead to death.

6. Conclusion

The current study demonstrates that eating raw fruits and vegetables from the Malete market carries a risk of contracting parasite infections. Fruits and vegetables that are ready to consume should be regarded as potentially

dangerous sources of parasite illnesses, especially helmenthis contamination. It is recommended that anyone handling fruits and vegetables get education regarding the origins and methods of foodborne illness transmission while in transit, and that preventive measures are put in place. Additionally, a parasite infection survey should be conducted on fruit vendors. The public should be made aware of the importance of properly cleaning or disinfecting raw fruits and vegetables before consuming them. Last but not least, health education about enhancing town and surrounding sanitation may also aid in minimizing contamination and parasite harboring.

The following suggestions should be taken into consideration to avoid any risk of contracting parasite infections among the populace in Nigeria:

[1] Government should ensure that there is provision of effective environmental health workers for monitoring and safety and community penetration to avoid further contaminant of the environment.

[2] Health workers in health education and promotion should organize health program for the farmers on how water used in agricultural production of fruits and vegetables is contaminated with helmenthis and educate the fruits and vegetables seller on how the water used in sprinkling the fruits and vegetables is not hygienic enough.

[3] Farmers should cultivate the habit of planting good and hygienic fruits is crucial for farmers to ensure food safety and meet market demands.

[4] Fruit market sellers should ensure that fruits remain safe, fresh and hygiene from the moment they are harvested, down to transportation to when they reach the consumers.

[5] Individual should develop the habit of washing fruits and vegetables well before eating and they should also ensure good environmental sanitation so as to avoid harboring of parasite.

Declarations

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This study did not receive any grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing Interest and Ethics

The authors declare no competing financial, professional, or personal interests.

Consent for Publication

The authors declare that they consented to the publication of this study.

Authors' Contributions

All the authors took part in literature review, research, and manuscript writing equally.

Availability of data and material

Supplementary information is available from the corresponding author upon reasonable request.

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