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Parasitic Contamination of Fruits and Vegetables Collected from Selected Local Markets in Abuja, North Central Nigeria

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Abstract:
A cross-sectional study was conducted between July and September 2019 to determine the parasites associated with common fruits and vegetables collected from selected markets in Abuja. 105 fruit and vegetable samples bought from three selected markets in Abuja were examined by sedimentation concentration after washing using 0.09% normal saline. The overall prevalence of parasitic contamination was 33.3%. Eggs of Ascarislumbricoides (42.9%) was the most frequent helminth detected followed by larvae of hookworm and eggs of Trichuristrichiura (17.1%), Strongyloidesspp (11.4%), while Taeniaspp (12.9%) was the least occurring helminth. Among the protozoans, cysts of Diphyllobothriumlatum (5.7%) were the most commonly detected protozoan parasite followed by Entamoebahistolytica (2.9%). This study has shown that fruits and vegetables sold in the selected markets in Abuja Metropolis 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.

Keywords: *Fruits, vegetables, contamination, Geohelminthes, protozoans, Abuja*

1. Introduction

Intestinal parasitic infections are widely distributed throughout the world, endangering public health ((Bekele, Tefera, Biresaw, & Yohannes, 2017).Previous studies have shown that *Ascarislumbricoides, Strongyloidesstercoralis, Cryptosporidium spp., Entamoebahistolytica, Enterobiusvermicularis, Giardia intestinalis, hookworm, Hymenolepis spp., Taenia spp., Trichuristrichiura,* and *Toxocara spp*., can infect humans who consume contaminated, uncooked, or improperly washed vegetables and fruits (T Auta, Bawa, & Suchet, 2017). Intestinal parasitic infections are widely distributed throughout the world causing substantial havoc to the public health, economy, and physical and cognitive development particularly among children in developing countries like Nigeria (Tefera, Biruksew, Mekonnen, & Eshetu, 2014). Many outbreaks of Protozoan infections in humans have been linked to raw fruits and vegetables(T Auta et al., 2017). These infections can cause serious medical and public health concerns, such as malnutrition and growth retardation in children, which can lead to a significant number of morbidity and mortality annually (Taheri, Namakin, Zarban, & Sharifzadeh,

2011). Millions of people suffer from parasitic infections in developing countries because of the shortage of personal health services and poor sanitation (Damen, Banwat, Egah, & Allanana, 2007).

Most times, fruits and vegetables are often eaten raw or lightly cooked to retain the natural taste and to preserve heat-labile nutrients. However, the consumption of raw and/or not properly washed fruits and vegetables play a major epidemiological role in the transmission of parasitic food-borne diseases(Berger et al., 2010). Fruits and vegetables act as vehicles for the transmission of parasitic infections when contaminated throughout the process from planting to consumption(Adenusi, Abimbola, & Adewoga, 2015). Epidemiological studies have indicated that the number of reported cases of foodborne illnesses due to consumption of raw fruits and vegetables has been increasing and continues to be a common and serious threat to public health in endemic areas(Eraky, Rashed, Nasr, El-Hamshary, & Salah El-Ghannam, 2014). The use of human and animal excreta as a natural fertilizer and untreated wastewater for irrigation during cultivation are the main contributing factors in the pre-harvesting phase(Alemu, Nega, & Alemu, 2020). In developing countries, the majority of local farmers use untreated human or animal dung as fertilizer and polluted or untreated water for irrigation which contributes to increased transmission of intestinal parasites(Theophilus Idahosa, 2011). Furthermore, factors in the post-harvesting phase including storage, transportation, and marketing conditions as well as hygienic practices during processing for consumption in foodservice or home settings also increase the rate of parasite contamination(Alhabbal, 2015).

2. Materials and Methods

2.1. Study Area

The study was carried out in Karmo market, Kado fish market, and Dei-dei market in Abuja metropolis. Abuja is a Federal Capital Territory (FCT) of Nigeria. It was found in 1976 from parts of the state of Nasarawa, Niger, and Kogi. The territory is located just north of the confluence of the Niger River and Benue River. Abuja is bordered by the states of Niger to the West and North, Kaduna to the Northeast, Nasarawa to the East and South, and Kogi to the Southeast. Lying between latitude $8^0$25 and $9^0$20 North of the equator and longitude $6^0$45 and $7^0$39 East of Greenwich meridian, Abuja is geographically located in the center of the country. The FCT has a landmass of approximately 7,315km^2 and it is situated within the savannah region with moderate climatic conditions. Abuja's vegetation is mainly savannah with limited forest areas. They produce crops like yam, beans, maize, millet, and sorghum.

2.2. Study Sample/Technique

Eight different varieties of fruits and vegetables including pumpkin leaf (*Telfariaoccidentalis-ugu*), ora leaf (*Pterocarpusmildraedii*), waterleaf (*Talinumtrangulare*), cabbage (*Brassica deracea*), garden egg leaf (*Solanumelongena*), lettuce (*Lactucasativa*), guava (*Psidiumguajava*), and oranges (*Citrus sinesis*) were purchased from retailers in the selected markets in the morning hours between 8:00 am – 9:00 am. The samples were collected, put in plastic bags, properly labeled, and brought to the Medical Parasitology Laboratory, Microbiology and Biotechnology Departments of National Institute for Pharmaceutical Research and Development (NIPRD) for parasitological analysis.

Each sample of fruit and vegetable was washed separately in 150ml of 0.09% normal saline for detaching the parasitic stages (ova, larvae, cysts, and oocysts) of helminths and protozoan parasites. Each resultant suspension was transferred to a centrifuge tube using a sieve to remove debris. The tube was centrifuged at 2,000 rpm for five minutes. After centrifugation, the supernatant was decanted carefully without shaking. Then the sediment was agitated gently by hand for redistributing the parasitic stages. Finally, the sediment was examined under a light microscope using ×10 and ×40 objectives. The whole area under the coverslip was checked for eggs and larvae of parasites. The process was systematically repeated until the sediment in each centrifuge tube was examined.

2.3. Data Analysis

Data were compiled in a spreadsheet (Microsoft Excel) and analyzed using descriptive statistics. Pearson chi-square (X^2) test was used to determine whether any relationship exists between parasite ova/larvae/cyst among different categories. A P-value ≤ 0.05 at 95% confidence level was considered as significant.

3. Results

Out of the 105 fruit and vegetable samples bought from three selected markets in Abuja metropolis, 35 (33.3%) were contaminated with at least a single parasite species. Among the fruits and vegetables, waterleaf (80%) was the most contaminated vegetable followed by garden egg leaf (50%), then Cabbage (40%), pumpkin leaf (30.4%), Oranges (30%), Ora leaf, and Guava (20%), while guava (18.2%) was the least contaminated item. There was no significant difference in the distribution of parasitic contaminants in fruits and vegetables ($p > 0.05$, 95% CI) (Table 1).

From this study, the sampled fruits and vegetables both contained protozoan (8.6%) and helminth (91.4%) parasites. Eggs of *Ascarislumbricoides* (42.9%) were the most frequent helminth detected followed by larvae of hookworm and eggs of *Trichuristrichiura* (17.1%), *Strongyloidesspp* (11.4%), while *Taeniaspp* (12.9%) was the least occurring helminth. Among the protozoans, cysts of *Diphyllobothriumlatum* (5.7%) were the most commonly detected protozoan parasite followed by *Entamoebahistolytica* (2.9%). Table 2 The study showed that fruits and vegetables collected from the three selected markets were contaminated with parasites. Higher contamination (40%) was observed in fruits and

vegetables bought from Kado fish market, followed by Karmo market (35.6%), while Dei-Dei market (23.3%) was the least contaminated. However, there was no significant difference in the Prevalence of parasitic contamination of fruits and vegetables according to markets (p >0.05, 95% CI) (Table 3).

Type of Fruit and Vegetable	Number examined	Status	
		Positive (at least one parasite)	Negative
Lettuce	22	4 (18.2%)	18 (81.8%)
Pumpkin leaf	23	7 (30.4%)	16 (69.6%)
Guava	10	2 (20%)	8 (80%)
Oranges	10	3 (30%)	7 (70%)
Waterleaf	10	8 (80%)	2 (20%)
Cabbage	10	4 (40%)	6 (60%)
Garden egg leaf	10	5 (50%)	5 (50%)
Ora leaf	10	2 (20%)	8 (80%)
Total	105	35 (33.3%)	70 (66.7%)

Table 1: Frequency of Distribution of Parasitic Contaminations among Fruits and Vegetables Sold in Local Markets of Abuja Metropolis

Detected parasite		Lettuce	Pumpkin leaf	Guava	Oranges	Waterleaf	Cabbage	Garden egg leaf	Ora leaf	Total (%)
Helminths	*Ascarislumbricoides*	2	2	0	1	4	2	3	1	15 (42.9)
	Hookworm	1	1	0	1	2	0	1	0	6 (17.1)
	Strongyloidesspp	1	0	0	0	1	1	1	0	4 (11.4)
	Trichuristrichiura	0	2	0	1	1	1	0	1	6 (17.1)
	Taeniaspp	0	0	1	0	0	0	0	0	1 (2.9)
Protozoa	*Diphyllobothriumlatum*	0	2	0	0	0	0	0	0	2 (5.7)
	Entamoebahistolistica	0	0	1	0	0	0	0	0	1 (2.9)
Overall Distribution		4	7	2	3	8	4	5	2	35

Table 2: Prevalence of Intestinal Parasites in Selected Fruits and Vegetables Sold at Selected Markets in Abuja Metropolis

Markets	Number of Vegetables And Fruits Screened	Number Contaminated	% Contamination
Kado	30	12	11.4
Dei-dei	30	7	6.7
Karmo	45	16	15.2
Total	105	35	33.3

Table 3: Prevalence of Parasitic Contamination of Fruits and Vegetables According to Markets

4. Discussion

The habit of eating raw unwashed and improperly processed fruits and vegetables plays a critical epidemiological role in the transmission of parasitic diseases. Our study findings revealed that fruits and vegetables sold in various markets of Abuja were contaminated with protozoan and helminth parasites. These intestinal parasites have become a major public health concern in the developing countries of the world, especially tropical and subtropical countries. Like many other tropical countries, the burden of intestinal parasitosis in Nigeria has been greatly encouraged by the favorable

climatic conditions, lack of awareness on the need for prevention and control of parasitic diseases, and the poor sanitary practices amidst these fruits and vegetable farmers and vendors.

The present study strived to assess the level of contamination and prevalence of protozoan and helminth parasites in various fruits and vegetables sold in selected markets of Abuja, North Central Nigeria. This study revealed parasitic contamination levels of 33.3% for both fruits and vegetables. This finding was similar to previous reports in Alexandria, Egypt(El Said Said, 2012), and in Ardabil, Iran (Daryani, Ettehad, Sharif, Ghorbani, & Ziaei, 2008), where the contamination rates were (31.7%)and (29%), respectively. Lower rates of contamination in the Middle East were detected in Riyadh, Saudi Arabia (16.2%) (Al-Megrin, 2010); and Burdur, Turkey (6.3%) (Adanir & Tasci, 2013).Higher contamination rates were detected in Bahir Dar City, Northwest Ethiopia(39.1%) (Alemu et al., 2020); Dire Dawa, Eastern Ethiopia (Endale, Tafa, Bekele, & Tesfaye, 2018); Arba Minch, Southern Ethiopia (54.4%) (Bekele et al., 2017); Kogi state, Nigeria(Omowaye & Audu, 2012); Jimma town, southwest Ethiopia (Tefera et al., 2014); and Jimma Town, Southwest Ethiopia (Tefera et al., 2014); Ghana (36%) (Amoah, Drechsel, Abaidoo, & Ntow, 2006); Jos, Nigeria (36%) (Damen et al., 2007); Tripoli, Libya (58%) (Abougrain, Nahaisi, Madi, Saied, & Ghenghesh, 2010); and Kisli, Kenya (75.9%) (Nyarango *et al.,* 2008) (Nyarango, Aloo, Kabiru, & Nyanchongi, 2008); and the highest rate was detected in Khorramabad, Iran (79%) (Ezatpour, Chegeni, Abdollahpour, Aazami, & Alirezaei, 2013).

Using human feces as fertilizers in farms is another probable way for parasitic contamination of vegetable samples(Al-Binali, Bello, El-Shewy, & Abdulla, 2006)(Kozan, Gonenc, Sarimehmetoglu, & Aycicek, 2005). The discrepancy between the current study and previous reports might be attributed to variations in geographical locations, climatic and environmental conditions, the kind of sample and sample size examined, the sampling techniques, methods used for the detection of the intestinal parasites, and socioeconomic status (Tefera et al., 2014). Moreover, the disparity in the prevalence of contamination with other reports corroborates the point that the prevalence of specific parasites in food supplies varies between countries and regions and show that the pattern of quality could be improved for fruits and vegetables sold in places where contamination is still high (Anantaphruti, 2001). The various prevalence rates of the contamination may also be due to the date of studies, the application of different examination methods, and different epidemiological factors such as climatic conditions of the region, type of water and fertilizer used for growing vegetables, contamination after harvest, and other influential factors (Khadije *et al.,* 2017)(Rahmati, Fallah, Maghsood, Shamsi-Ehsan, & Matini, 2017). Furthermore, the difference could be a result of variations in the time the study was carried out. The fruits and vegetables screened during this present study were bought in the dry season. This could also be a possible cause of the low contamination rate reported in this study.

Waterleaf (80%) was found to be the most frequently contaminated product, while lettuce (18.2%) was found to be the least contaminated. The high prevalence of parasitic contamination on vegetables compared to fruits is similar to what (Theophilus Idahosa, 2011)(Windows et al., 2014)(Alemu et al., 2020)(Nasiru, Auta, & Bawa, 2015)reported. The variation in contamination between the products might be explained by the fact that vegetables such as pumpkin leaf, waterleaf, and cabbage are planted on larger and uneven surfaces. This enables parasitic stages to easily attach to the surfaces of these vegetables to overcome the effects of washing (Ismail, 2016)(El Said Said, 2012). Moreover, Owing to the softness and fragility of the leaves of vegetables, most vendors do not thoroughly wash them before display (Duedu et al., 2014). Nevertheless, the low contamination rate in lettuce could be attributed to the source of water used in washing the vegetable before selling, improved hygiene of the vendors, and other environmental factors.

Ova of *A.lumbricoides* (42.9%) were the predominant contaminants in this study. This could be credited to the viability of their eggs in the soil for months and being the commonest parasite in the tropics(Timothy Auta, Kogi, Audu, & State, 2013). This corroborated the works of(T Auta et al., 2017)(T Auta et al., 2017)(Nasiru et al., 2015)who reported that *A. lumbricoides* was the most prevalent helminth observed on fruits and vegetables (12.1%; 10.19%, 80.6% and 65.8%, 24%) in Katsina State, Umuahia, Abia State, Gusau, Zamfara State, and Kaduna State respectively, all in Nigeria. Also, it is in line with the work of(El Said Said, 2012)(Ahmed, Nur, Desale, & Zemat, 2018)(Bekele et al., 2017), who reported 20.8%, 12.5%, 20.3%, 56.31% for *A. lumbricoides* respectively in Egypt, Eritrea, Arba Minch, and Tarcha towns of Southern Ethiopia. The difference in the contamination rate of *A. lumbricoides* in these regions might be due to the effect of deworming programs targeting soil-transmitted helminths, improvements in WASH program activities, and health education by the health workers to avoid open defecation in the environment (Alemu et al., 2020). As found in this study, parasitic contamination of fruits and vegetables with hookworm species have been reported in Jos, Nigeria(Damen et al., 2007)(Theophilus Idahosa, 2011)and Southwestern Saudi Arabia (Al-Binali et al., 2006). Both *Entamoebahistolytica* and *Taeniaspp* (2.9%) were the least contaminating parasite in fruits and vegetables observed from this study. The variation of this result and findings of previous researches could be due to the fact that areas of study differ in geographical location, climatic, environmental conditions, soil type, general behavioral attitude to hygiene, and the socio-economic activities of producers, sellers, and consumers.

It was observed that fruits and vegetables collected from Kado fish market harbored the cyst of *Diphyllobothriumlactum* (fish tapeworm). This could be attributed to the fact that both fish and vegetable vendors use the same water source and also stay in close proximity within the market. Furthermore, there's a possibility that the fish and vegetable sellers also share marketing instruments such as knives, tables, and buckets. Therefore, contamination with fish tapeworm must have occurred through their activities. Findings from this study have shown different contamination rates in fruits and vegetables from the selected markets. Fruits and vegetables purchased from Karmo market (15.2%) were the most contaminated, followed by Kado fish market (11.4%), while fruits and vegetables from Dei-Dei market (6.7%) were

the least contaminated. This might be associated with the way the products are displayed and the act of washing produce before display(Bekele et al., 2017). Most of these fruits and vegetables were exposed to flies while it was displayed on tables; some were partly washed while the rest were unwashed before display. Our finding is similar to the works of (Alemu et al., 2020)(T Auta et al., 2017)(Bekele et al., 2017)who reported a significant difference in the contamination rates of fruits and vegetables collected from different markets. Fruits and vegetable contamination by multiple parasite species observed in this study might indicate the possibility of high-level contamination of fruits and vegetables, which perhaps results in multiple parasitic infections in humans (Bekele et al., 2017). It might also indicate the persistence of intestinal parasitic infections in the area (Omowaye & Audu, 2012). The detection of these geohelminth and protozoancysts, ova/ larvae on fruits and vegetables in the studied markets, has a significant public health implication (T Auta et al., 2017). Some of the vegetables and fruits are processed and eaten uncooked, which could lead to infection and disease especially when served to the public(Putignani & Menichella, 2010).

5. Conclusion

This study showed that fruits and vegetables sold in the selected markets in Abuja Metropolis were contaminated with medically important parasites which are potential sources of disease transmission. These findings have shown that producers, marketers, and consumers of these fruits and vegetables stand a high risk of being infected with intestinal parasites. Therefore, improved hygiene among the farmers, consumers, and vendors will be paramount in reducing the burden of intestinal parasite infection.

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