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Parasitic Agents in Fresh Fruits and Vegetables Sold in Open Markets in Bauchi, Nigeria

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HIGHLIGHTS

- Parasitic contaminations were found in 14.3% of fruit and 13.8% of vegetable samples.
- *Ascaris lumbricoides* was the most common parasitic contaminant in both fruit and vegetable samples.
- Fresh fruits and vegetables consumed in Bauchi, Nigeria are the major sources of parasitic infections.

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ABSTRACT

Background: Parasitic contamination of fruits and vegetables is one of the major causes of gastroenteritis in many parts of the world. The aim of this study was to determine the parasitic contamination in fruits and vegetables in the Bauchi area, North-East Nigeria.

Methods: From May to July 2017, a total of 776 samples comprising 182 samples of four different types of fruits, and 594 samples of six different types of vegetables were screened by simple floatation and formol-ether concentration techniques. The isolated parasitic ova and cysts were identified on the basis of morphological characteristics with reference to the standard keys. The data were analyzed by chi-square test using SPSS computer software version 21.0.

Results: Totally, 26 out of 182 fruit samples (14.3%), and 82 out of 594 vegetable samples (13.8%) were contaminated with various parasitic ova and cysts. *Ascaris lumbricoides* was the most common parasitic contaminant in both fruits and vegetable samples. The differences were not statistically significant in the prevalence rates of contamination among different types of fruits and vegetables (p>0.05).

Conclusion: This study showed that contaminated fresh fruits and vegetables consumed in Bauchi, Nigeria are the major sources of parasitic infections and may have serious public health implications. It seems that health education with respect to personal hygiene and eating habits is the most practical and useful approach in order to desired control in the studied area. The local people must be effectively trained for proper washing and disinfecting of the fruits and vegetables prior to consumption.

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Introduction

Contamination of fruits and vegetables has been interested in many researches from all over the world (Al-Megrm, 2010; Daryani et al., 2008; Ozlem and Sener, 2005; Fallah et al., 2012; Shafa-ul-Haq et al., 2014; Sunil et al., 2014). This is because of increasing reports on food-borne illnesses related to consumption of parasite-contaminated fresh vegetables (Al-Megrm, 2010). Many studies in different parts of the world reported the vegetables as the main transporter for protozoan cysts and oocysts, including *Giardia*, *Entamoeba*, *Toxoplasma*,

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Cryptosporidium, *Cyclospora*, and *Isospora*; and helminthic eggs and larvae, including *Hymenolepis*, *Taenia*, *Fasciola*, *Toxocara*, *Trychostrongylus*, *Strongyloides*, as well as hookworms (Anwar and McKenry, 2012; Darchenkova et al., 2006; Voung et al., 2007).

Intestinal acute diseases have recently increased in many parts of Nigeria which their real cause have remained underdetermined or very speculative. However, there are few evidences that contaminated fruits and vegetables with parasitic agents may exacerbate the situation (Damen et al., 2007). In Nigeria, there is not enough attention on this subject but a few reports showed some parasitic agents on fruits and vegetables, including Central Nigeria (Jos) by Damen et al. (2007); some parts of Nigeria by Uneke (2007); South-West Nigeria by Ogbolu et al. (2009) and Ogunleye et al. (2010); Central Nigeria (Ilorin) by Alade et al. (2013); and South-West Nigeria (Akure) by Simon-Oke et al. (2014). The study by Adamu et al. (2012) is the only report regarding to parasitic contamination of *Ascaris*, hookworm, *Trichuris*, *Taenia/Echinococcus*, and *Strongyloides* spp. on various vegetables sold in Maiduguri from North-East Nigeria. Therefore, there is little epidemiological information in this area about the parasitic contamination in fruits and vegetables. On the other hand, the consumption of fresh vegetables is common in the North-East Nigeria. In the present study, the prevalence of intestinal parasites isolated from fresh fruits and vegetables sold in open markets in Bauchi, North-East of Nigeria, is reported in order to increase people's awareness towards developing control strategies.

Materials and methods

Sampling

In this cross-sectional survey carried out from May to July 2017, a total of 776 samples comprising 182 samples of four different types of fruits, including banana (*Musa sapientum*), mango (*Mangifera indica*), orange (*Citrus sinensis*), and guava (*Psidium guajava*); and 594 samples of six different vegetable types, including cabbage (*Brassica oleraceae*), spinach (*Spinacia oleraceae*), carrot (*Daucas carota*), lettuce (*Lactuca sativa*), onion (*Allium cepa*), and tomato (*Lycopersicum esculentum*) were randomly obtained from different open markets in Bauchi metropolis. Each sample was transported in separate sterile polythene bags to the laboratory for next examination.

Parasitological examination

At first, each sample of fruit and vegetable was thoroughly washed in distilled water. Subsequently, the contaminated water was processed through simple brine floatation as well as formol-ether concentration techniques in accordance with the procedure outlined by Cheesbrough (2006). Samples were then examined for ova and cysts. The recovered ova and cysts were identified based on their morphological characteristics with reference to the standard keys (Cheesbrough, 2006). In order to differentiate the intestinal nematodes, larvae were cultured and subsequently harvested using the Baerman's method. Larvae were then differentiated mainly by the bases of the length of the esophagus, protected sheath, sheath tail, and genital primordium.

Statistical analysis

The data were analyzed by chi-square test using SPSS computer software version 21.0.

Results

Out of 182 fruit samples, 26 (14.3%) were contaminated with various helminthic ova and protozoan cysts (Table 1). All positive cases were multiple contaminants with at least three to four parasites. Apparently, *Ascaris lumbricoides* was the most common parasitic contaminant in three out of the four fruit types; *Ancyclostoma*, *Giardia*, and *Strongyloides* were the rarest ones. Orange was the most contaminated fruit with four different ova, while banana and mango were followed with three different contaminants. However, the differences were not statistically significant in the prevalence rates of contamination among different types of fruits ($p>0.05$).

Out of 594 vegetable samples, 82 (13.8%) were contaminated with various parasitic ova and cysts (Table 2). Notably, in all six vegetable types, *A. lumbricoides* was the most common parasitic ova; and *Strongyloides* and *Giardia* were the rarest ones. Cabbage and onion were the most contaminated vegetables with five different parasites followed by lettuce and tomato with four different parasites. However, there was no significant difference ($p>0.05$) in prevalence of parasites among the various types of vegetables.

Discussion

The parasites detected in the present survey were pathogenic to humans with various clinical symptoms. This study revealed parasitic contamination levels of 14.3% for fruits and 13.8% for vegetables which were lower than the rates reported by previous similar reports (from 30.3 up to 68.8%) in Nigeria (Damen et al., 2007; Ogbolu et al., 2009; Ogunleye et al., 2010). The prevalence rates of parasitic agents in the vegetable samples in the current survey were also lower than similar finding in

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Table 1: Prevalence of parasitic ova/cyst in fruits sold in Bauchi, Nigeria

Fruit type	Samples No.	Observed parasites	No. of infected samples
Banana	42	*Ascaris lumbricoides*	3
		Giardia intestinalis	1
		Hymenolepis nana	1
Mango	35	*Ascaris lumbricoides*	3
		Ancylostoma duodenale	1
		Hymenolepis nana	1
Orange	89	*Ascaris lumbricoides*	7
		Ancylostoma duodenale	4
		Taenia spp.	4
		Strongyloides stercoralis	1
Guava	16	-	0

Table 2: Prevalence of parasitic ova/cyst in vegetables sold in Bauchi, Nigeria

Vegetable type	Samples No.	Observed parasites	No. of infected samples
Cabbage	86	*Ascaris lumbricoides*	4
		Ancylostoma duodenale	4
		Strongyloides stercoralis	3
		Taenia spp.	3
		Entamoeba coli	2
Carrot	187	*Ascaris lumbricoides*	3
		Ancylostoma duodenale	4
		Taenia spp.	5
Lettuce	82	*Ascaris lumbricoides*	13
		Ancylostoma duodenale	3
		Taenia spp.	9
		Entamoeba coli	3
Onion	68	*Ascaris lumbricoides*	2
		Ancylostoma duodenale	2
		Strongyloides stercoralis	3
		Hymenolepis nana	1
		Taenia spp.	2
Spinach	38	*Ascaris lumbricoides*	1
		Giardia intestinalis	1
Tomato	133	*Ascaris lumbricoides*	7
		Ancylostoma duodenale	2
		Giardia intestinalis	4
		Taenia spp.	1

Iran as 32% (Daryani et al., 2008), India as 44.2% (Gupta et al., 2009), Pakistan as 31% (Shafa-ul-Haq et al., 2014), and Vietnam as 36% (Uga et al., 2009). However, Adamu et al. (2012) revealed that only 3.5% of vegetable samples in Maiduguri, North-East, Nigeria were contaminated with parasitic agents which were obviously lower than our results. The socio-cultural practices in the various geographical areas are likely the main causes of different levels of contamination rates between our study and those reported in other regions of Nigeria and the other parts of the world. The other reason may also be related to the sensitivity of the experimental methods employed by the other workers in comparison with the procedure adopted in the present study. Furthermore, the other causes may be associated with the type of water used for irrigation of the vegetables. There are some documents in different parts of the world that reported the use of untreated wastewater as the major causes of parasitic contamination of vegetables (Al-Binali et al., 2006; Gupta et al., 2009; Kozan et al., 2005; Shafa-ul-Haq et al., 2014; Srikanth and Naik, 2004). Hence, contamination may occur during transportation of fruits and vegetables. It was often reported that fruits and vegetables are conveyed early in the morning from farms to the markets

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with either by motor-cycles, tri-cycles, or in dirty rickety pick-up vans which sometimes are loaded with passengers. The occurrence of such parasitic contaminations highlights the roles of these foods in the transmission of parasitic diseases.

Among the parasites that we found in different edible fruits and vegetables in the Bauchi area, *A. lumbricoides* was more prominent. This finding is consistent with the similar reports of Uneke (2007) in Nigeria, Gupta et al. (2009) in India, and Shafa-ul -Haq et al. (2014) in Pakistan. This seems to be due to the epidemiological factors that make the spread of the parasite especially in poor sanitary conditions and practices, poor housing and high population density, and illiteracy in the developing world. Detection of some parasites such as *Ascaris*, *Ancylostoma*, *Strongyloides*, and *Giardia* in our samples presents poor hygienic standard in the studied area. The isolated parasites have mainly fecal origin implying fecal contamination of the samples. Such contamination is increased by poor sanitary conditions and hygienic habits (Damen et al., 2007; Daryani et al., 2008; Slifko et al., 2000). Thus, intestinal parasitic infections are expected in this area where there is low standard of personal hygiene and poor sanitary conditions. This issue emphasizes the role of poor hygiene and sanitation in the epidemiology of parasitic disease transmission (Gupta et al., 2009). Contamination may also be through insects contaminated with infected human feces. There are some studies that reported a similar phenomenon in the transmission of intestinal parasites in Ibadan and Espuma in Nigeria by the housefly (*Musca domestica*) *(*Adeyeba and Okpala, 2000; Nmorsi et al., 2006). Using human feces as fertilizers in farms is another probable way for parasitic contamination of vegetable samples (Al-Binali et al., 2006; Gupta et al., 2009; Kozan et al., 2005; Srikanth and Naik, 2004). Although in our studied area, the use of untreated wastewater and raw human feces as fertilizer has been limited, but some vegetables sold in open markets in Bauchi were imported from other areas and the neighboring states of our country, particularly Plateau State, Nigeria where the use of untreated wastewater and raw human feces as fertilizer was previously reported by Damen et al. (2007).

Although we found no significant relation between parasitic contaminations and vegetable types, but the contamination rates of cabbage and lettuce were higher than the other vegetable types. This finding could be attributed to the nature of their foliage which offers greater surface area for parasitic contaminants either in farm, during transition or in the market which showed by some other researchers (Amoah et al., 2006; Avcioglu et al., 2011; Kozan et al., 2005; Shafa-ul-Haq et al., 2014).

It has been showed that standard washing procedures of vegetables prior to consumption, which described previously by Bier (1991), can effectively eliminate the parasites. Therefore, proper washing and disinfecting of vegetables is too important for preventing of the parasitic illnesses by immersion in water containing 200 ppm of active calcium hypochlorite for about 30 min (Fallah et al., 2012).

Conclusion

This survey showed that contaminated fresh fruits and vegetables consumed in Bauchi, Nigeria are the major sources of parasitic infections and may have serious public health implications. It seems that health education with respect to personal hygiene and eating habits is the most practical and useful approach in order to desired control in the studied area. The local people must be effectively trained for proper washing and disinfecting of fruits and vegetables prior to consumption.

Author contributions

W.A.I. designed the study; S.M.P. conducted the experimental work; W.A.I. and S.M.P. analyzed the data and wrote the manuscript. All authors revised and approved the final manuscript.

Conflicts of interest

The authors declare that they have no conflict of interest with respect to publishing of this article.

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