Parasitic Profile of Fresh Vegetables Sold in Selected Markets of the Cape Coast Metropolis in Ghana

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ABSTRACT

Background: Vegetable consumption is a major source of vitamins, minerals and dietary fibre for the body. While fresh vegetables play a key role in the prevention of some chronic diseases, cancers, and alleviation of micronutrient deficiencies, some have been associated with foodborne parasitic infections.
Objectives: We investigated the parasitic contamination of fresh vegetables sold in three marketplaces in the Cape Coast Metropolis in Ghana.

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Materials and Methods: In this study conducted over a period of three (3) months, a total of one hundred and twenty-six (126) vegetable samples were obtained from three (3) selected markets in the Metropolis. Six (6) different species of vegetables namely tomato (*Solanum lycopersicum*), cabbage (*Brassica oleracea var capitata*), carrot (*Daucus carota*), lettuce (*Lactuca sativa*), spring onion (*Allium fistulosum*) and green pepper (*Capsicum annuum*) were subjected to parasitological examination for the detection of parasite forms such as larvae, ova and cysts.
Results: The overall prevalence of parasitic contamination of vegetables in this study was 52.4%. Five different parasites were detected namely *Strongyloides spp*, Hookworm, *Trichuris trichiura*, *Ascaris lumbricoides* and *Entamoeba coli*. The prevalence of parasitic contamination was higher in leafy vegetables such as spring onions (90.5%), lettuce (76.2%) and cabbage (66.7%). Multiple parasitic contaminations were a common feature of leafy vegetables than smoothly surfaced ones such as green pepper and tomatoes.
Conclusion: The study revealed that most vegetables purchased from the markets in the metropolis were highly contaminated with intestinal parasites. It is therefore recommended that vegetables should be subjected to thorough disinfection processes before being served for food to reduce the transmission of intestinal parasites.

Keywords: Fresh vegetables; intestinal parasites; contamination; Cape Coast.

1. INTRODUCTION

Fruits and vegetables are important for a healthy diet and help in preventing certain diseases and cancers [1]. There are reports that the consumption of fruits and vegetables provides some protection against cardiovascular diseases, diabetes, obesity, stroke, Alzheimer disease, and cataracts among others [2-6]. Fruit and vegetable consumption also promotes health in diverse ways as they are rich in vitamins, minerals, phytochemicals especially antioxidants as well as a reliable source of dietary fibre to the extent that some developed countries have dietary recommendations for them [7-9].

Foodborne diseases due to infectious agents are still common and continue to pose serious threat to public health all over the world. Vegetables have become potential sources of human infections such as those caused by enteric bacteria, viruses and parasitic pathogens and an important source of foodborne outbreaks in some countries [10, 11]. Foodborne microbes including pathogenic ones are known to infest vegetables on the field or by the wash water used by handlers as well as their ineffective hygiene practices [12]. The presence of intestinal parasites on vegetables therefore is a reflection of the quality of the overall process of cultivation, irrigation, transportation and post-harvest handling [13, 14]. A significant contributory factor for foodborne infections is the consumption of raw or lightly cooked fresh vegetables [14].

Several studies over the world have shown that intestinal protozoan parasites, and helminths can infect humans who consume contaminated, uncooked, or improperly washed fresh vegetables and fruits [15-18]. Recent studies in Ghana, Nigeria, Iran and other countries have all implicated vegetables as vehicles for the transmission of intestinal parasites [14,19-22]. In spite of the numerous reports that have been made concerning the contamination of vegetables by parasites in Ghana and elsewhere, no published report to our knowledge has been made regarding the occurrence of parasites in vegetables sold in the Cape Coast metropolis. In the current study, we assessed the parasite contamination of fresh vegetables sold in three markets of Cape Coast metropolis in Ghana.

2. MATERIALS AND METHODS

2.1 Study Area/Sites

The study was conducted in three (3) selected markets of the Cape Coast Metropolis in the Central Region of Ghana. The metropolis has a population of 169,894 people [23]. It is geographically situated within latitudes 50.07' to 50.20' north of the Equator and between longitudes 1˚.11' to 1˚.41' west of the Greenwich Meridian covering a total land area of approximately 122 sq. km. The climate is tropical with wet rainy and dry harmattan seasons. The Kotokuraba and Abura markets are large markets that serve the southern and northern parts of the metropolis respectively, while the University of Cape Coast (UCC) science market is a smaller one which serves the university community and environs.

2.2 Vegetable Samples and Collection

Sample collection was done between January and March 2017. A total of 126 fresh vegetable samples were obtained for the study. Twenty-one (21) samples of each vegetable namely *Solanum lycopersicum* (tomato), *Brassica oleracea var capitata* (Cabbage), *Daucus carota* (carrot), *Lactuca sativa* (lettuce), *Allium fistulosum* (spring onion) and Capsicum annuum (green pepper) were examined in this study. These vegetables were selected because they are usually eaten in their raw states, commonly available and sold in the metropolis all year round. The six types of (6) vegetables in their fresh states were purchased from each of the 3 selected markets once weekly from vegetable retailers and vendors who were randomly selected. The sample type, source and other relevant data were recorded for each sample. The samples were then placed in separate plastic bags, given a unique number and transported to the laboratory of the University of Cape Coast School of Medical Sciences for analysis. Forty-two (42) samples were obtained from each market.

2.3 Laboratory Procedure

About 100g of each vegetable was washed with distilled water (200ml) in a plastic container. The suspension was strained through a sterile sieve to remove undesirable materials. It was then allowed to stand for 5 hours. The supernatant was discarded leaving an aliquot of 15 ml with the sediments which were centrifuged at 2500 rpm for 10 minutes. The supernatant was again discarded. The remaining sediment was used for the preparation of 2 stained (iodine) and 2 unstained smears on microscope slides. The slides were examined by light microscopy to detect parasite forms which were recorded as contamination [24]. Multiple parasites species were also taken note of during the examination of the slides.

2.4 Data Analysis

The data obtained were entered into Microsoft excel sheet and analysed. The Wilcoxon sign ranked test was used to test the ranking of distribution of the parasites on the vegetables as well as their contamination. Significance was considered at $p < 0.05$. Data are expressed in frequencies and percentages.

3. RESULTS

The study shows that out of the 126 samples of vegetables obtained from the three markets in the metropolis and examined, 66 were contaminated with at least one intestinal parasite, giving an overall rate of 52.4 % (Table 1). The highest number of contaminated vegetable samples with parasitic elements was detected on samples obtained from the Abura market (54.8%). The University of Cape Coast (UCC)-Science and Kotokuraba markets recorded contamination rates of 52.3% and 50.0% respectively.

The highest contamination rates were detected on leafy vegetables such as the spring onion (90.5%), lettuce (76.2%) and cabbage (66.7%) while green pepper and tomato recorded lower contamination rates of 28.6% and 9.5% respectively (Table 2).

Five different intestinal parasites were detected on the vegetables in the current study (Table 3). *Strongyloides spp* were the most prevalent intestinal parasite with a contamination rate of 43.7% while hookworm was the least detected parasite contaminating vegetables (7.1 %). Other parasites detected in the study included *Trichuris trichiura*, *Ascaris lumbricoides* and *Entamoeba coli* with contamination rates ranging between 7.9% and 10.3%. The contamination rate of *Strongyloides spp* varied significantly among the selected vegetables (*P=0.0156*). Also, *Trichuris trichiura's* rate of contamination was significant among the vegetables with more on carrots than lettuce (*P=0.0313*) (Table 3). Single parasite species contamination of vegetables was also detected such as in the case of tomato while other vegetables particularly the leafy ones were contaminated with one or more parasite species.

Table 1. Distribution of parasitic contamination of vegetables in markets of Cape Coast metropolis

Market	Number of samples	Number contaminated	Prevalence of contamination (%)
UCC-Science	42	22	52.3
Kotokuraba	42	21	50.0
Abura	42	23	54.8
Total	126	66	52.4

Table 2. Contamination levels of vegetables with intestinal parasites

Vegetable	Number examined	Number contaminated (%)	*P value*
Lettuce	21	16 (76.2)	
Cabbage	21	14(66.7)	
Tomato	21	2(9.5)	0.0156
Green pepper	21	6(28.6)	
Spring onion	21	19(90.5)	
Carrot	21	9(42.9)	
Total	**126**	**66(52.4)**	

Table 3. Distribution of parasites on different vegetables and contamination rates

Vegetables	No. of contaminated vegetables (%)				
	Strongyloides spp	**Hookworm**	***Trichuris trichiura***	***Ascaris lumbricoides***	***Entamoeba coli***
Lettuce	16(55.1)	3(10.3)	1(3.4)	4(13.8)	5(17.2)
Cabbage	10(47.6)	1(4.8)	3(14.3)	2(9.5)	5(23.8)
Tomato	1(50.0)	0 (0)	0 (0)	1(50.0)	0(0)
Green pepper	2(33.3)	1(16.7)	3(50.0)	0(0)	0(0)
Spring onion	18(58.1)	4(12.9)	2(6.5)	3(9.7)	4(12.9)
Carrot	8(66.7)	0(0)	4(33.3)	0 (0.0)	0(0)
Contamination rate	55(43.7)	9(7.1)	13(10.3)	10(7.9)	14(11.1)
P value	0.0156	0.0625	0.0313	0.0625	0.0125

4. DISCUSSION

The study shows that the overall prevalence of intestinal parasitic contamination of vegetables sold in the selected markets of the Cape Coast Metropolis was 52.4%. This is an indication that approximately one out of every two samples of vegetables sold in the area is contaminated with intestinal parasites(s). There have been reports on varying levels of parasitic contamination of vegetables elsewhere which suggests good handling of vegetables is crucial to reduce parasitic infections. For example, it was reported that 58% of the green vegetables meant for the wholesale and retail markets in Tripoli, Libya were contaminated with intestinal parasites which was higher than our current report [25] while in alexandria in egypt, and also in a suburban markets in hanoi , vietnam, prevalence of contamination were 31.7% and 26% respectively which were all lower than the current report [1, 26].

In the present study, we examined six different species of vegetables sold in the Cape Coast metropolis. High levels of contamination by parasites were detected in leafy vegetables samples such as spring onion (90.5%), lettuce (79.2%) and cabbage (66.7%), while smooth surfaced vegetables recorded lower rates. This is consistent with reports from a similar study in Ghana which recorded high contamination rate for lettuce samples (61%) and lower rate for tomato (18%) [19]. However, studies in the khartoum state in sudan and ogun state in nigeria reported relatively lower prevalence of contamination of these vegetables [27,28]. The high levels of contamination detected in leafy vegetables in this study may be due to the complex and uneven surfaces of these vegetables which facilitates attachment and persistence of the parasites. Parasites are able to attach firmly to these surfaces either on the field when contaminated water is utilised for irrigation on the farms unlike smooth surfaced vegetables such as tomatoes and green pepper [29] which recorded lower levels of contamination. The variation in contamination rates recorded in different studies may also be due to geographical location, seasonal variation, irrigation practices, type of manure used and vegetable handling practices from the farm to the vendors [30-32].

Out of the five (5) different parasites species that were detected in the present study, *Strongyloides spp* were most prevalent. This finding is similar to an earlier study in Ghana which also recorded a high prevalence of *Strongyloides stercoralis* on examined vegetable samples [19]. There have been studies in Ethiopia, Sudan, Malaysia and Saudi Arabia which have also reported varied prevalence of *Strongyloides stercoralis* on vegetables [33-35].

While *Strongyloides stercoralis* is known to infect humans and dogs, there are other species such as *S ratti, S fuelleborni, S papillosus* and *S ransomi* which infects mammals such as rats, sheep, goats and pigs which we were unable to distinguish in this study [36-37]. This may account for the seemingly high numbers of *Strongyloides spp* recorded. It may also be as a result of the complex life cycle of *Strongyloides* species with a free-living stages in the soil. It has been reported that some vegetables and herbs growing on grounds with high humidity and good drainage usually harbour the parasite ova and are a reservoir for infection [38]. The present observation nevertheless may not pose any significant danger to consumers because human infection by this nematode is mainly acquired by skin penetration of larval forms in barefoot individuals and not by ingestion. On the other hand if there is a predominance of *S stercoralis*, then the risk of infection to the vegetable farm workers and handlers will be high in the area.

Entamoeba coli was also detected among the parasitic contaminants in our study (11.1 %). The most heavily contaminated vegetables with *Entamoeba coli* were the leafy ones. However, the parasite was not detected in tomato, green pepper and carrot samples. Similar results have been reported in Benha, Egypt with a few sampled vegetables positive for *Entamoeba coli* [39]. It must be noted however that *Entamoeba coli* is a commensal protozoan species of the human gut and therefore a good indicator of contamination by human waste.

Ascaris lumbricoides, Trichuris trichiura and hookworms which are common intestinal helminths of man were also detected mostly on cabbage, lettuce and spring onion samples. A study in Ghana, identified *Ascaris* eggs in 60% of vegetables obtained from urban markets [14,40] while in India [14] eggs of *Ascaris* species were reported as the most predominant parasite in 36% of examined samples. Detection of ova of *Trichuris trichiura* occurred in 10.3% of the vegetable samples with most contaminated vegetable being carrot. This level of contamination is higher compared to a similar study in an urban market in Ghana where the parasite was detected in only in 2% of vegetable samples examined [40]. *Trichuris trichiura* is a soil transmitted helminth whose ova requires a period of time to develop in the soil before becoming infective. It is therefore not surprising to find out that carrot recorded a high prevalence of contamination with this parasite. Hookworms were the least detected parasite contaminating green vegetables. Reports from previous studies in Maiduguri in Northern Nigeria indicated a prevalence of 1.2% of the total samples examined while that in West Bengal, India [31] revealed 6.4% hookworm contamination of examined vegetable samples. However other studies in Ethiopia, Libya, and Vietnam [15,25,33] reported no hookworm parasites in vegetable samples examined.

Multiple species contamination of vegetables with parasites in the current study was more associated with the leafy vegetables than with smooth surfaced ones. This may be attributed to the rough and leafy nature of such types of vegetables with their overall large surface area which allows parasite forms to adhere and persist. Tomato and green pepper were mostly contaminated with single parasites possibly because of their smooth surfaces. Multiple species contamination has been reported in similar studies [41]. It may be a reflection of the high prevalence and also the persistence of intestinal parasites in such areas which was likely to facilitate transmission of multiple species to consumers.

The inability of the current study to utilise varied methodology in detection of parasites may have led to an underestimation of the types of parasites detected and their contamination levels. Other techniques such as floatation, Ziehl–Neelsen and trichrome staining would have led to the detection of Giardia and intestinal coccidian parasites.

5. CONCLUSION

There is a high rate of parasite contamination of vegetables sold at the three selected markets of the Cape Coast metropolis in Ghana. Five different intestinal parasites were detected on the vegetables in this study, with the leafy types recording higher levels of contamination. There is the need for consumers to adopt a thorough process of disinfecting fresh vegetables to reduce the risk posed to their health.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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