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PARASITIC CONTAMINATION OF FRESH VEGETABLES SOLD IN SOME MAJOR MARKETS AND FARMS IN ZARIA

Ocholi Yahaya and Henry Gabriel Bishop*

Department of Microbiology, Faculty of Life Sciences, Ahmadu Bello University, Zaria, Nigeria

*Corresponding Author Email Address: gabrielhenrybishop@gmail.com

ABSTRACT
Vegetables are important sources of dietary nutrients, as well as fiber and photochemicals. Many vegetables are eaten raw or partially cooked. However, vegetables are perishable; as such they are at their best when fresh. In the subtropics, different vegetables are readily available but they are prone to faecal contamination due to application of untreated human wastes on farmlands, or the use of unsafe water body for irrigation. The study was aimed at detecting parasites on seven different vegetable types randomly collected from two major markets and different farms in Zaria. A total of 346 samples were collected. The samples were subjected to sedimentation technique: 25 grams of each sample was washed in 225mL of normal saline, and the wash water was allowed to sediment overnight, followed by centrifugation at 3000 rpm for 5 min. Wet mounts of the sediments were examined for parasites on the light microscope using 10x and 40x objectives. Parasitic ova and larvae were identified with help of coloured parasitological atlases. A total of 90(26.0%) out of 346 samples were contaminated with parasites. *Strongyloides stercoralis* was the most occurring parasite (9.5%), followed by *Ascaris lumbricoides* (6.9%), Hookworms (6.1%), *Trichuris trichiura* (1.7%), whereas *Enterobius vermicularis* and *Schistosoma haematobium* were 0.9% each. Vegetable samples collected directly from the farms were significantly more contaminated (38.2%, P=0.001) than those from Sabon-Gari Market (32.9%) and Samaru Market (17.5%). Cabbage (42.0%), lettuce (32.0%) and spring onion (32.0%) significantly harboured more parasites (P=0.012) than rest of the vegetables. Also, hookworms significantly occurred in samples from the farms (11.0%), but samples from Sabon-Gari Market (11.4%) and Samaru Market (7.0%) were most contaminated with *Strongyloides stercoralis.* The high level of parasitic contamination of vegetables from the farms is a direct indication of use of untreated human wastes and contaminated water for irrigation. The vegetables on reaching the market undergo some level of washing before sale, but this practice alone is not enough to make them safe for human consumption.

Keywords: Parasites, vegetables, contamination, farms, markets, Zaria

INTRODUCTION

Vegetables are indispensable in human diet. They constitute good sources of nutrients and water (Mohamed *et al*., 2016). Vegetables can become contaminated by parasites commonly referred to as soil-transmitted helminthes (STHs) or geohelminths (Hall *et al*., 2008), and constitute health risk to man (Bishop and Yohanna, 2018). Contaminated soil due to application of untreated human wastes and the used unsafe water body for irrigation serve as two major sources of contamination of vegetables (Kozan *et al*., 2007; Ofor *et al*., 2009). Contamination can also occur during distribution and handling in the market (Bishop and Yohanna, 2018). Most vegetables are eaten raw or barely cooked. As such, parasitic infections can easily get to man (Mba, 2000). Consumption of raw, unhygienically prepared or improperly washed vegetables can to cause intestinal parasitic diseases (Eraky *et al*., 2014; Nyirenda *et al*., 2021). Utilization of untreated organic fertilizer or use of contaminated water during cultivation of vegetables in gardens or large scale farms can lead to parasitic contamination. When such vegetables are finally consumed, it can lead to intestinal parasitic infections (Al-Megrin, 2010; Faour-Klingbeil *et al*., 2016; Istifanus and Panda, 2018; Nyirenda *et al*., 2021). Some complications like weight loss, anaemia and deformities of the intestinal wall can also occur (Bishop and Yohanna, 2018). Therefore, vegetables should always be cultivated, stored and distributed under safe and hygienic methods. They must be properly washed in running water, and/or cooked before consumption.

MATERIALS AND METHODS

Study area and items

This study on parasitic contamination of fresh vegetables was conducted in two selected major markets and some farms in Zaria. Zaria is located in northern Kaduna State, Nigeria. The area is occupied majorly by farmers, traders, staff and students of various institutions of learning. Farmers in Zaria practice irrigation system during the dry season or to supplement for shortage of rainfall, thereby ensuring constant supply of vegetables all year round. From the various farms, 118 vegetable samples were collected, while 114 samples were collected from each of the two major markets. The samples included 50 each of cabbage, *Caspsicum annum L*. (Bell pepper), lettuce, spinach and tomatoes; others were garden egg (51) and spring onion (45). The samples were randomly collected in each of the selected locations into clean polythene bags and conveyed in cool condition to the laboratory at the Department of Microbiology, Ahmadu Bello University Zaria for parasitic examination.

Examination for parasites on fresh vegetables

Each of the fresh vegetable samples (25g) was weighed into 225mL of normal saline and washed gently with hands in sterile hand gloves. The mixture was carefully shaken, and then the vegetable was removed while the wash water was allowed to stay overnight. The supernatant was discarded and the sediment was further concentrated by centrifugation at a speed of 3000 revolutions per minute (rpm) for 5 min. The final supernatant was discarded. The residue was transferred unto clean, grease-free glass slide and a cover-slip applied. The wet mount was examined under 10x and 40x objectives of the light microscopes for detection and identification of parasitic ova and larvae, using coloured parasitological atlases as guide.

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Statistical analysis

Data obtained during the sampling together with the laboratory findings were subjected to Pearson Chi-Square ($\chi 2$) test at 95% confidence interval using IBM SPSS version 21. The final results were simplified in a chart and tables below.

RESULTS

The overall parasitic contamination detected on fresh vegetable samples from the selected major markets and farms in Zaria was 90(26.0%) out of 346 samples as shown in Figure 1.

The various parasites recovered from the vegetables (as present in Table 1) included *Strongyloides stercoralis* (9.5%) as the most occurring, followed by *Ascaris lumbricoides* (6.9%) and hookworms (6.1%). The least occurring parasites on the vegetables were *Trichuris trichiura* (1.7%) and 0.9% each of *Enterobius vermicularis* and *Schistosoma haematobium.*

Fresh vegetables from the selected farms significantly had the highest occurrence of parasites 38.1%, followed by those from Sabon-Gari Market (32.9%). Lowest parasitic contamination was on vegetables collected from Samaru Market (17.5%) (P=0.001) as shown in Table 2.

In Table 3, cabbage (42.0%), lettuce (32.0%) and Spinach (32.0%) significantly had parasitic contamination (P=0.012); whereas, *Caspsicum annum L* was the least contaminated (10.0%).

Hookworm's ova significantly occurred in samples from the farms (11.0%). But samples from Sabon-Gari Market (11.4%) and Samaru Market (7.0%) were most contaminated with *Strongyloides stercoralis* (P =0.041) as shown in Table 4

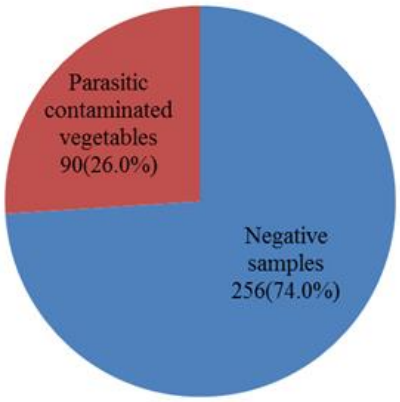

Figure 1: Overall parasitic contamination level of fresh vegetables sold in some major markets and farms in Zaria

Table 1: Prevalence of parasites on various fresh vegetables sold in selected major markets and farms in Zaria

Parasite	Number positive (%) n=346
Ascaris lumbricoides	24(6.9)
Enterobius vermicularis	3(0.9)
Hookworm	21(6.1)
Schistosoma haematobium	3(0.9)
Strongyloides stercoralis	33(9.5)
Trichuris trichiura	6(1.7)

Table 2: Parasitic contamination of fresh vegetables in Zaria based on sampling locations

Sampling location	Number of samples examined	Number positive (%)	Number negative (%)	Statistics
Farms	118	45(38.1)	73(61.9)	χ^2=14.247, df=2, P=0.001
Sabon-Gari Market	114	25(32.9)	89(78.1)	
Samaru Market	114	20(17.5)	94(82.5)	

Table 3: Occurrence of parasites on different fresh vegetables in Zaria, Nigeria

Vegetable	Number of samples examined	Number positive (%)	Number negative (%)	Statistics
Cabbage	50	21(42.0)	29(58.0)	
Caspsicum annum	50	5(10.0)	45(90.0)	
Garden egg	51	11(21.6)	40(78.4)	χ^2=16.442, df=6, P=0.012
Lettuce	50	16(32.0)	34(68.0)	
Spring onion	45	10(22.0)	35(77.8)	
Spinach	50	16(32.2)	34(68.0)	
Tomatoes	50	11(22.0)	39(78.0)	

Table 4: Distribution of various parasitic ova and larvae in fresh vegetables sold in Zaria based of sampling locations

Location	Number of Samples Examined	*A. lumbricoides* (%)	*E. vermicularis* (%)	Hookworm (%)	*S. haematobium* (%)	*Strongyloides stercoralis* (%)	*T. trichiura* (%)	Negative samples (%)
Farm	118	12(10.2)	3(2.5)	13(11.0)	1(0.8)	12(10.2)	3(2.5)	74(62.7)
Sabon-Gari Market	114	5(4.4)	0(0.0)	5(4.4)	1(0.9)	13(11.4)	2(1.8)	88(77.2)
Samaru Market	114	7(6.1)	0(0.0)	3(2.6)	1(0.9)	8(7.0)	1(0.9)	94(82.5)
Statistics		χ^2=21.703, df=3 P=0.041						

DISCUSSION

Vegetables are indispensable in human diet (Bishop and Yohanna, 2018). They are on high demand all year round, which has necessitated the adoption of irrigation system. Over the years, more attention has been drawn towards constant supply of vegetables with little attention on their safety. The use of untreated human wastes to improve crop yield is a common practice in the study area as many of the farmers assented to the practice. This practice predisposes the vegetables to parasitic contamination. This study recovered a total prevalence of 26.0% of parasites on fresh vegetables from some major markets and farms in Zaria. This is similar to the findings of Bishop and Yohanna (2018) who reported a prevalence of 25.0% in Samaru-Zaria.

Vegetable samples from the farms were more contaminated than those sold in the markets. Samples from the markets were pre-washed by the sellers before sale to the final consumers. However, a common container of water was used to wash all the vegetables sold by each seller. This practice is not efficient in reducing contamination, because an uncontaminated vegetable washed in such water can pick up pathogens. In Samaru Market, most

vegetables were displayed on tables for sale, while those in Sabon-Gari Market were mostly placed on mats and bare ground. The use of tables to display the vegetables as seen in Samaru Market had helped in eliminating direct contact of the vegetables with the soil which is a repository for soil-transmitted helminthes, and explained for the lower level of parasitic contamination. However, higher prevalence of geohelminths on vegetables had been reported on vegetables by Simon-Oke *et al.* (2014).

The level of environmental hygiene, adoption of safe farming practices like the use of treated manure and safe water for irrigation will ensure safety of vegetables for human consumption. It should be advocated that before any vegetable is consumed, there should be adequate washing of the vegetable in running tap water. Leafy vegetables (like cabbage, lettuce and spinach) significantly harboured more parasites because of the large surface area for attachment/adherence by parasites.
Strongyloides stercoralis was the most prevalent parasitic larvae on vegetables collected from the two selected markets, indicating a possible direct contamination of the vegetables with soil from the markets during the period they were kept on the wet ground for sale. A 21.9% prevalence of *Strongyloides* as the most common parasite on fruits and vegetables had been reported by Terefa *et al.* (2014). However, *Ascaris lumbricoides* was the most prevalent on vegetables collected directly from the farms, a direct indication of faecal contamination. *Ascaris lumbricoides* is the most commonly recovered parasite contaminating fruits and vegetables around the world (Uneke, 2007; Gupta *et al.*, 2009; Shafa-ul –Haq *et al.*, 2014). The ova of *Ascaris lumbricoides*, *Trichuris trichiura* and hookworms are known to be resistant to harsh environmental conditions, making them persist for long in the soil (Bishop and Yohanna, 2018).

The presence of *Schistosoma haematobium* egg showed that the water for irrigation was contaminated with human urine and/or infested with snails as its intermediate host. Water pollution affects people in the community in many ways (Simon-Oke *et al.*, 2020). Vegetables remain prone to contamination from various sources like untreated human and animal wastes, dried faecal matter carried by wind, contaminated wash water, unsafe water body for irrigation, during transportation and even by handlers (Tefera *et al.*, 2014; Simon-Oke *et al.*, 2014; Bishop and Yohanna, 2018;Nyirenda *et al.*, 2021).

Conclusion

Overall prevalence of parasites on fresh vegetables from selected major markets and farms in Zaria was found to be 26.0% in this study. The parasites recovered included *Strongyloides stercoralis* larvae (9.5%), *Ascaris lumbricoides* (6.9%), hookworms (6.1%), *Trichuris trichiura* (1.7%), *Enterobius vermicularis* (0.9%) and *Schistosoma haematobium* (0.9%).

Vegetable samples collected from the selected farms were most contaminated with parasites (38.1%), followed those from Sabon-Gari Market (32.9%), and Samaru Market (17.5%).
Of the seven vegetable types examined, cabbage (42.0%), lettuce (32.0%) and Spinach (32.0%) were the most contaminated with various parasites. These vegetables have large surface areas for attachment and adherence by the parasites.

Ascaris lumbricoides was the most prevalent parasite on vegetables collected directly from the farms. It means therefore that the use of untreated human and animal wastes is still in practice. Though samples from the market had lower level of parasitic contamination, the vegetables still remain unsafe for human consumption.
It is important that vegetables must be cultivated under safe farming practices and adequately handled until they reach final consumers. The final consumers must also ensure proper washing of vegetable purchased from the sellers, and/or cook them before eating.

Author's Contributions

Yahaya, O. Concept and study design, sampling, laboratory experiment.
Bishop, H.G. Study design, laboratory experiment, statistical analysis, manuscript development.

Conflict of Interest

The authors declare that there is no any financial interest or any other conflict of interest in this study.

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