https://doi.org/10.47430/ujmr.2491.017

Received: 06 March 2024 **Accepted:** 10 June 2024

Occurrence and Diversity of Intestinal Parasites on Raw Vegetables Sold in Samaru, Zaria

[1]Yahaya, O., [2*]Bishop, H.G., [3]Abubakar, H., [4]Jacob, S., and [5]Apata, C.O.

[1]Department of Microbiology, Faculty of Life Sciences, Ahmadu Bello University, Zaria, Nigeria;
[2]Department of Microbiology, Faculty of Life Sciences, Ahmadu Bello University, Zaria, Nigeria;
[3]Department of Microbiology, Faculty of Life Sciences, Ahmadu Bello University, Zaria, Nigeria:
[4]Phelps International Limited, Rumoumasi, Port Harcourt, Nigeria;
[5]Thomas Adewumi University, Oko, Kwara State, Nigeria
[*]Correspondence: gabrielhenrybishop@gmail.com; +2347064608775

Abstract

Vegetables are part of everyday diet. There has been more emphasis on their palatability and nutritional values, but they potentially contribute to transmitting intestinal parasites, among other pathogens, to man. This study examined 10 samples of five commonly consumed vegetables from Samaru in Zaria, Nigeria. Twenty-five (25g) fresh vegetable samples were washed in 225 mL of sterile normal saline and gently shaken for 60 seconds. The wash water was allowed to stay for 3 hr in the dark. The supernatant was carefully discarded until only about 15mL was left. The sediment was further concentrated by centrifuging at 3000 revolutions per minute for 5 minutes and examined for intestinal parasites on wet mounts using the compound light microscope. The overall occurrence of intestinal parasites on the vegetables was 22.0%. Ascaris lumbricoides was the most occurring parasite (18.0%), followed by equal 2.0% of hookworms, Trichuris trichiura and Fasciola species. Vegetable samples obtained from Mangorori Market had the highest contamination with Ascaris lumbricoides than other markets, but overall parasitic contamination was highest on vegetables obtained from ABU Community Market. Cabbage was the most contaminated (50.0%), followed by 20% each of lettuce and carrots. Samples displayed on mats during the sale had the highest contamination with Ascaris lumbricoides (23.5%), followed by those displayed on the ground (22.2%). There was higher intestinal parasitic contamination of vegetables sold in dirty surroundings (23.3%) than in relatively clean surroundings (10.0%). Sufficient orientation on the role of fresh raw vegetables in transmitting intestinal parasites should be aimed at farmers, sellers, distributors and final consumers to curb potential health risks.

Key Words: Vegetables, Contamination, Intestinal parasites, Transmission, Zaria, Ascaris lumbricoides

INTRODUCTION

Vegetables will undoubtedly continue to be an indispensable component of the human diet (Yahaya and Bishop, 2022). Consumption of fresh raw vegetables gives the body essential supplements (Mohammed *et al.*, 2016; Bekele and Shumbej, 2019) like iron and vitamins, which include vitamin C, vitamin B12, niacin, and riboflavin (Gemechu *et al.*, 2023). Even though vegetables are essential for a good diet, they are readily prone to contamination and serve as vehicles for the transmission of intestinal parasites, mainly due to unhealthy methods of cultivation, storage, or distribution (Bekele *et al.*, 2017; Bishop and Yohanna, 2018). Faecal contamination of water sources used in crop irrigation, food processing, and preparation of meals leads to infection, where contamination of fresh fruits and vegetables causes the greatest health concern (Orlandi *et al.*, 2002). *Ascaris lumbricoides* (roundworms), *Trichiuris trichiura* (whipworm), *Ancylostoma duodenale*, and *Nacator americanus* (hookworms) are the most common intestinal helminths responsible for significant morbidity and mortality in endemic countries (Haque, 2007).

Contaminated or larva-infested farm soil, use of unsafe water for irrigation, application of untreated human wastes, dusty wind, and other human activities increase the predisposition of vegetables to various parasitic and microbial contaminations (Nkouayep *et al.*, 2017; Amoah *et al.*, 2018). Therefore, fresh raw vegetables can constitute a potential health risk to man if they are not hygienically obtained, poorly washed, or eaten raw in salad (Eraky *et al.*, 2014; Tefera *et al.*, 2014; Bishop and Yohanna, 2018; Nyirenda *et al.*, 2021). Infections with helminthic parasites have immediate and long-term consequences. They can impair growth and cognition, especially in children. Localized intestinal damage may result in malabsorption, blood loss, iron and/or protein deficiencies, anaemia, intussusception, rectal prolapse, teeth grinding, and sleep disturbances (Bishop and Yohanna, 2018). To combat some neglected tropical diseases, it had been severally advocated that vegetables should be cultivated, stored and distributed under hygienic methods. Before consuming any vegetable from the farm or market, it should be adequately washed with safe water and/or cooked (Yahaya and Bishop, 2022; Yahaya *et al.*, 2023).

MATERIALS AND METHODS

Study Area

This study was conducted in Samaru, Zaria, in Sabon Gari Local Government Area of Kaduna State, Nigeria. Three major markets were selected for the study: Samaru Main Market, Mangori Market, and ABU Community Market.

Collection of Samples

The study items comprised five vegetable types, comprising 10 each of lettuce, carrot, cucumber, cabbage and pumpkin leaf. The 50 vegetable samples were aseptically obtained into separate sterile polythene bags from randomly selected sellers within the three major markets in Samaru. The samples were subjected to parasitological examination at the Department of Microbiology, Faculty of Life Sciences, Ahmadu Bello University, Zaria, Nigeria.

Parasitological examination

The procedure by Yahaya and Bishop (2022) was applied in processing the vegetable samples. Twenty-five (25g) of each fresh vegetable sample was weighed into 225mL of sterile normal saline in a plastic beaker and washed gently between three fingers (the thumb, index finger, and middle finger using sterile hand gloves). The mixture was gently shaken for 60 seconds before discarding the vegetable. The wash water was allowed to stay for 3 hr in the dark. The supernatant was carefully discarded until only about 15mL was left. The remaining mixture was gently agitated by gently tapping the beaker on the table and swirling, followed by immediate transfer into a screw-capped plastic centrifuge tube. Another 15mL of sterile normal saline was added to rinse the beaker and transferred immediately after gentle agitation into another tube. Both tubes (containing the same sample) were concentrated further by centrifuging at 3000 revolutions per minute (rpm) for 5 minutes. Each supernatant was discarded, and the residues pooled together before the microscopy. By means of a Pasteur pipette, aliquots of the sediment were transferred onto a clean, grease-free glass slide, and a cover slip was applied. Where the sediment was much, multiple wet mounts were made until the entire sediment was examined. The wet mount was examined for parasites under ×10 and ×40 objectives of the light microscope using a coloured atlas of parasitology as a guide.

Statistical analysis

The data and laboratory findings were subjected to statistical analyses by Chi-Square and Odd Ratio (OR) using IBM SPSS version 23 at 95% confidence interval. The final results were presented in a chart and tables.

RESULTS

Out of fifty (50) fresh raw vegetable samples obtained from different markets within Samaru in Zaria, which comprised 10 each of cabbage, carrot, cucumber, lettuce, and pumpkin leaves, the overall occurrence of parasitic contamination on the vegetables was 22.0% as shown in Figure 1.

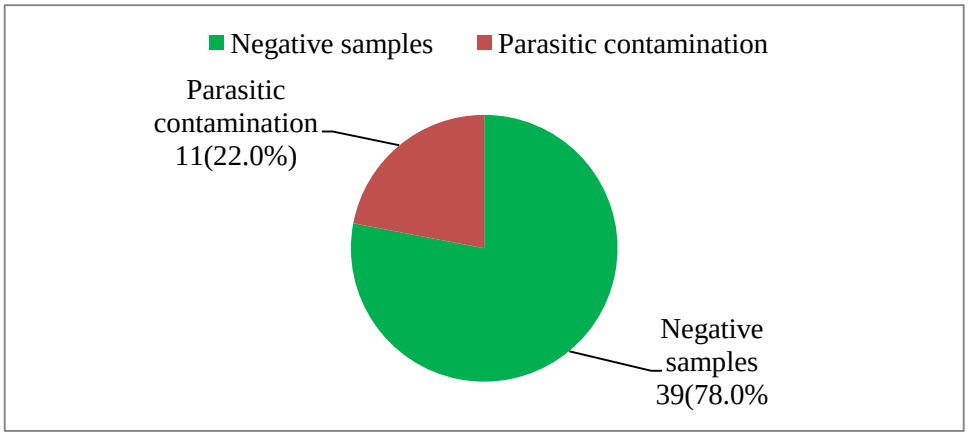

Figure 1: Overall Intestinal Parasitic Contamination of Fresh Vegetables Sold in Samaru, Zaria

Diverse intestinal parasites were found on the raw vegetables obtained from Samaru, Zaria. The most occurring parasite was *Ascaris lumbricoides* 9(18.0%), followed by equal occurrences of *Trichuris trichiura* (2.0%), hookworms (2.0%), and *Fasciola* species (Table 1).

Table 1: Diversity of Intestinal Parasites on Fresh Vegetables Sold in Samaru, Zaria

Intestinal Parasite (n = 50)	Occurrence (%)
Ascaris lumbricoides	9(18.0)
Hookworms	1(2.0)
Trichuris trichiura	1(2.0)
Fasciola species	1(2.0)

There was no statistically significant difference ((P>0.05) in the occurrence of intestinal parasites on the fresh vegetables across the different sampling areas in Samaru, Zaria. However, samples obtained from Mangorori Market had the highest occurrence of *Ascaris lumbricoides* (22.2%), followed by those from ABU Community Market 5(20.8%), and the least was (11.8%) from Samaru Main Market. On the other hand, when overall parasitic contamination was considered, fresh vegetable samples obtained from ABU Community Market had the highest contamination with different parasites (29.2%), while those from Samaru Main Market had the least (11.8%), as shown in Table 2.

Table 2: Distribution of Intestinal Parasites based on Sampling Locations of Vegetables in Samaru

Sampling location (Market)	Number Examined	**Ascaris lumbricoides* Number positive (%)	ˣOverall Parasitic contamination Number positive (%)
ABU Community	24	5(20.8)	7(29.2)
Mangorori	9	2(22.2)	2(22.2)
Samaru Main	17	2(11.8)	2(11.8)

*x^2 = 0.687, df = 2, P = 0.709; ˣx^2 = 1.756, df = 2, P = 0.416

Cabbage samples had the highest contamination with *Ascaris lumbricoides* (40.0%), followed by carrot and lettuce with 20.0% each, but there was no occurrence of *Ascaris lumbricoides* on the cucumber samples. Overall, parasitic contamination was highest in cabbage (50.0%), but cucumber and pumpkin leaf samples had the least parasitic contamination of 10.0% each. Differences in the occurrence of *Ascaris lumbricoides* and overall parasitic contamination on the vegetable types were not statistically significant (Table 3).

Table 3: Distribution of intestinal Parasites based on Type of Vegetables Sold in Samaru, Zaria

Vegetable type	Number Examined	**Ascaris lumbricoides* Number positive (%)	ˣOverall Parasitic contamination Number positive (%)
Cabbage	10	4(40.0)	5(50.0)
Carrot	10	2(20.0)	2(20.0)
Cucumber	10	0(0.00	1(10.0)
Lettuce	10	2(20.0)	2(20.0)
Pumpkin leaf	10	1(10.0)	1(10.0)
	*x^2 = 5.962, df = 4, P = 0.202;		ˣx^2 = 6.294, df = 4, P = 0.174

Vegetable samples displayed on mats during sale had the highest contamination with *Ascaris lumbricoides* (23.5%), followed closely by those displayed on the ground (22.2%), while the least parasitic contamination was on samples displayed on tables (12.5%). Overall, parasitic contamination was also highest on vegetable samples displayed on mats (35.3%), and the least was on vegetables displayed on tables (12.5%). Vegetable samples sold in dirty environments had a higher occurrence of *Ascaris lumbricoides* (23.3%) than those sold in clean environments. Similarly, overall parasitic contamination was higher on vegetables sold in dirty environments (30.0%) than on those sold in clean environments (10.0%). However, there was no statistically significant relationship (P>0.05) in the occurrence of intestinal parasites based on display methods or surrounding hygiene in this study (Table 4).

Table 4: Effects of Display Methods and Surrounding Hygiene on Parasitic Contamination of Vegetables Sold in Samaru, Zaria

Factor	Number Examined	**Ascaris lumbricoides* Number positive (%)	ˣOverall Parasitic contamination Number positive (%)
[a]**Display method**			
Ground	9	2(22.2)	2(22.2)
Mat	17	4(23.5)	6(35.3)
Table	24	3(12.5)	3(12.5)
[b]**Surrounding**			
Dirty	30	7(23.3)	9(30.0)
Clean	20	2(10.0)	2(10.0)
	[a]*x^2 = 0.953, df = 2, P = 0.621;		[a]ˣx^2 = 3.013, df = 2, P = 0.222
	[b]*x^2 = 1.445, df = 1, P = 0.229, OR = 0.365;		[b]ˣx^2 = 2.797, df = 1, P = 0.0.94, OR = 0.259

DISCUSSION

Vegetables are part of everyday meals, which are indispensable for maintaining good human health. This study recovered an overall occurrence of 22.0% of parasitic contamination of vegetables in Samaru, Zaria. Previous studies on parasitic contamination of vegetables within Nigeria had reported 25.0% in Zaria (Bishop and Yohanna, 2018), 14.3% in Bauchi (Istifanus and Panda, 2018), 26.0% in Zaria (Yahaya and Bishop, 2022); while 24.8% was reported in Idah, Kogi State (Yahaya *et al.*, 2023). From Lusaka in Zambia, a prevalence of 35.8% was reported by Nyirenda *et al.* (2021), while 57.8% was reported from Jimma Town in Southwest Ethiopia (Tefera *et al.*, 2014). Parasitic contamination of vegetables in Nigeria is lower when compared to reports from other African countries. However, vegetables are constantly being contaminated and serve as a potential vehicle for transmitting infectious diseases to man. Majorly, unhealthy farming practices like applying untreated/raw sewage and night soil on farms to improve crop yield are still much in practice. Demand for vegetables is not seasonal; irrigation farming is routinely employed to compensate for the high yearly demand. The second major problem is the habit of using raw water from ponds, rivers, and lakes for irrigation, which is heavily contaminated with different pathogens.

In this study, ova of *Ascaris lumbricoides* were the most identified on the vegetable samples. *Ascaris lumbricoides* has been commonly reported as the most occurring parasite on vegetables in Nigeria (Istifanus and Panda, 2018; Yahaya *et al.*, 2023). Ova of *Ascaris lumbricoides* resist desiccation and other harsh environmental conditions, making them persistent on vegetables and water (Bishop and Yohanna, 2018).

Ascaris lumbricoides occurred more in the other markets than on vegetable samples obtained from Mangorori Market. Mangorori market is poorly organized, and dusty, and the surrounding hygiene is poor, and most of the vegetables are displayed on the ground during sales. The nature of the market could have predisposed the vegetables to further post-harvest contaminations.

Hookworms, *Trichuris trichiura,* and *Fasciola* species had equal occurrences on vegetables in this study. This is evidence of polyparasitic contaminations of vegetables sold within Samaru. Consumption of such vegetables, either raw or in salad, could increase worm burden among people in the area. Therefore, instead of the intended nutritional benefits, contaminated vegetables sold in the area can seriously threaten human health.

There is a need to orient vegetable farmers on safe farming practices regarding applying organic manure and water quality for irrigation. Vegetable sellers must adhere to good hygiene during sale, distribution, and storage.

Cabbage had the highest contamination with parasites because it has a larger surface area for attachment by the parasites (Yahaya and Bishop, 2022). This was similarly the case with lettuce, while carrots could have been contaminated directly from the soil on which they were cultivated.

Displaying vegetables directly on the ground or mats can predispose them to easy contamination with parasites from the soil. Where a table is used to display vegetables during sale, it is elevated from the ground level. This prevents direct contact with the soil or floor and reduces post-harvest contamination during sale, especially if other hygiene measures are followed. Where the surroundings of the sale point/market were clean, there was less parasitic contamination of the vegetables than where the surroundings were dirty.

It is important to note that vegetable contamination arises from different sources that include air-borne, faecal debris, contaminated wash water, unsafe irrigation water, during the sale, transportation, storage, and occasional flooding of farmlands (Tefera *et al.*, 2014; Simon-Oke *et al.*, 2014; Bishop and Yohanna; 2018; Yahaya and Bishop, 2022). Therefore, caution must be taken by the final consumers to properly wash vegetables and cook them before eating (Yahaya *et al.*, 2023); otherwise, consuming raw vegetables can constitute a health risk (Gemechu *et al.*, 2023).

CONCLUSION

Raw vegetables play a significant role in transmitting intestinal parasites to man. This study recovered an overall 22.0% occurrence of parasitic contamination of vegetables sold in Samaru, Zaria. Four different parasitic ova were detected on the vegetable samples. The most occurring parasite was *Ascaris lumbricoides* (18.0%), followed by an equal 2.0% of hookworms, *Trichuris trichiura,* and *Fasciola* species. Ova of *Ascaris lumbricoides* occurred highest on vegetables obtained from the Mangorori market than in other markets. Cabbage samples were the most contaminated with parasites. Vegetable samples displayed on the mat or ground during sale or sold in dirty surroundings had more occurrences of intestinal parasites. There is a need to raise sufficient awareness of fresh raw vegetables' role in transmitting intestinal parasites among farmers, sellers, distributors, and final consumers in Nigeria.

Conflict of interest

The authors of this article wish to declare that there is no conflict of interest regarding this research.

REFERENCES

Amoah, I.D., Adegoke, A.A. and Stenström, T.A. (2018). Soil-transmitted helminth infections associated with wastewater and sludge reuse: A review of current evidence. *Tropical Medicine and International Health,* 23(7):692-703. **[Crossref]**

Bekele F. and Shumbej T (2019). Fruit and vegetable contamination with medically Important helminths and protozoans in Tarcha town, Dawuro zone, Southeast Ethiopia. *Research and Reports in Tropical Medicine,* 10:19-23. **[Crossref]**

Bekele, F., Tefera, T., Biresaw, G. and Yohannes, T. (2017). Parasitic contamination of raw vegetables and fruits collected from selected local markets in Arba Minch town, Southern Ethiopia. *Infectious Diseases of Poverty*, 6(1):19. **[Crossref]**

Bishop, H.G. and Yohanna, A.Z. (2018). Contamination of vegetables with geohelminths: prevalence, intensity and roles of hygiene practices in Samaru-Zaria, Nigeria. *International Journal of Academic and Applied Research*, 2(7):8-13

Eraky, M.A., Rashed, S.M., Nasr, M.E., El-Hamshary, A.N.S. and El-Ghannam, A.S. (2014). Parasitic contamination of commonly consumed fresh leafy vegetables in Benha, Egypt. *Journal of Parasitology Research*, 2014(Article ID 613960). **[Crossref]**

Gemechu, T., Bona, J., Aliyo, A., Dedecha, W. and Shenafi, G. (2023). Assessment of Intestinal Parasites and Its Associated Factors among Fruits and Vegetables Collected from Local Markets of Bule Hora Town, Southeast Ethiopia. *Journal of Tropical Medicine*, 2023(1861919). **[Crossref]**

Haque, R. (2007). Human intestinal parasites. *Journal of Health, population and Nutrition*. 25(4):387-391.

Istifanus, W.A. and Panda, S.M. (2018). Parasitic agents in fresh fruits and vegetables sold in open markets in Bauchi, Nigeria. *Journal of Food Quality and Hazards Control*, 5(2018):84-88. **[Crossref]**

Mohamed, M.A., Siddig, E.E., Elaagip, A.H., Edris, AM.M. and Nasr, A.A. (2016). Parasitic contamination of fresh vegetables sold at Central markets in Khartoum state, Sudan. *Annals of Clinical Microbiology and Antimicrobials*, 15(17). **[Crossref]**

Nkouayep, V.R., Tchakounté, B.N., and Poné, J.W (2017). Profile of geohelminth eggs, cysts, and oocysts of protozoans contaminating the soils of ten primary schools in Dschang, West Cameroon. *Journal of Parasitology Research*. 2017(Article ID 1534675). **[Crossref]**

Nyirenda, S.S., Bukowa, K.M., Banda, W.R., Mbewe, J., Hamankolom, F., Banda, F., Kwenda, G., Munba, M. and Zulu, E. (2021). Parasitic contamination of common vegetables sold in Lusaka, Zambia. *Journal of Food Quality and Hazards Control*, 8(2021):112-118. **[Crossref]**

Orlandi, P.A., Chu, D.T., Bier, J.W. and Jackson, G.J. (2002). Parasites and the food supply. *Food Technology*, 56(4):72-81.

Simon-Oke, I.A., Afolabi, O.J. and Obasola, O.P. (2014). Parasitic contamination of fruits and vegetables sold in Akure metropolis, Ondo State, Nigeria. *Researcher*, 6: 30-35.

Tefera, T., Biruksew, A., Mekonnen, Z., Eshetu, T. (2014). Parasitic contamination of fruits and vegetables collected from selected local markets of Jimma Town, Southwest Ethiopia. *International Scholarly Research Notices*, 2014(ID 382715). **[Crossref]**

Yahaya, O. and Bishop, H.G. (2022). Parasitic contamination of fresh vegetables sold in some major markets and farms in Zaria. *Science World Journal*, 17(1):130-133.

Yahaya, O., Bishop, H.G., Umar I.O., Enoch, A.C. and Markus, D.A. (2023). Distribution dynamics of intestinal parasites on vegetables sold in Egah Market, Kogi State, Nigeria. *Science World Journal*, 18(1):71-74.