Hidden Risks: Fresh vegetable contamination with parasitic helminth

Running title: Hidden parasitic risks in fresh vegetables

Arshad Mohammad Abdullah
Department of Basic Science, College of Pharmacy, University of Duhok, Iraq
ORCID: 0000-0002-1409-4250

Corresponding author: Arshad Mohammad Abdullah
E-mail: arshadzanko@gmail.com
Tel: +9647504572331
Address: University of Duhok, College of Pharmacy, Duhok City, Iraq

Abstract

Background: Vegetables and fruits as nutrition have an important place in human life, and are used daily as food. Eating contaminated vegetables and fruits sometimes cause problems and can transmit many intestinal parasites. This study aims to determine the presence and percentage of helminths in daily vegetables in Duhok city, Iraq.

Methods: Sample collection for this study was from June 2021 to August 2021, in different parts of the city which included about one hundred twenty-six samples of Lettuce, Coriander, Pepper, Dill, Radish, and Parsley, and all of these samples were examined microscopically for the detection of parasites.

Results: In this study were detected 15.9% of contaminated vegetables with parasitic helminths were detected, without a significant difference in both contaminated and non-contaminated collected samples (P-value: 0.628). In these collected samples, three species of helminths were reported with different percentage, which include 7.9% of *Ascaris lumbricoides*, 6.3% of *Enterobius vermicularis*, and 2.4% of *Hymenolepis nana*. The Parsley was recorded highest contaminated vegetable with 23.8%, Lettuce with 20%, and the Pepper with lowest contamination with 4.8%.

Conclusion: This research has shown the contaminated vegetables with moderate percentages of helminths, which can play important role in human infection by eating of these contaminated vegetables.

Keywords: Vegetables, Helminths, Parasites, Contamination.

Introduction

In our daily diet, vegetables and fruits play a crucial role, and primarily serve as a main source of essential nutrients, elements, and vitamins (1). The use of various types of liquid waste and sewage in vegetable cultivation can potentially result in contamination of vegetables with eggs and larvae of human intestinal parasites, posing a significant public health concern. The consumption of raw or unwashed vegetables may therefore lead to human infection (2, 3). Although fresh fruits and vegetables are widely regarded as nutritious and beneficial to health, they can also serve as vehicles for foodborne illnesses when contaminated with pathogenic microorganisms, including protozoan parasites and parasitic helminths (4, 5). Despite the well-recognized health benefits of consuming fresh produce, increasing attention has been given to the global risk associated with contamination by human pathogenic parasites. Epidemiological studies have shown that in regions where helminth infections are prevalent and untreated wastewater is used for irrigation, and where vegetables are frequently consumed raw, there is an increased risk of parasitic infection resulting from the ingestion of contaminated produce (6). Inadequate hygiene during the transportation, handling, preparation, and processing of fruits and vegetables by vendors and consumers further contributes to contamination. Susceptibility to foodborne illnesses is influenced by multiple factors, including dietary habits. The growing reliance on meals from restaurants, fast-food outlets, canteens, and street food vendors—where food hygiene standards may not always be strictly followed-has increased the risk of exposure (6). Human pathogenic parasites, particularly protozoa and helminths, represent a major global health burden. Interactions between enteric parasites, the human host, and intestinal microbiota can significantly influence infection outcomes (7). Worldwide, approximately 1.7 billion cases of diarrheal diseases with considerable socioeconomic consequences for healthcare systems have been reported. (8, 9). Intestinal protozoa and parasitic helminths are among the primary causes of diarrheal diseases, with contaminated fruits and vegetables playing an important role in their transmission through ingestion (10-12). Clinical manifestations of intestinal parasitic infections include mild to severe diarrhea, abdominal pain, nausea, vomiting, iron deficiency, cyst formation, anemia, flatulence, anorexia, fatigue, fever, and weight loss (12-14). The consumption of raw or lightly cooked vegetables, often practiced to preserve flavor and nutritional value, may further increase the risk of parasitic transmission (15). Infection with enteric parasites remains a major global public health issue, particularly in developing countries where inadequate sanitation and poor personal hygiene are common. Environmental factors such as geography, climate, temperature, and soil type also play a crucial role in the prevalence of parasitic infections (16). Numerous studies have identified contaminated fruits and vegetables, unsafe drinking water, poor housing conditions, and inadequate sanitation as key contributors to human parasitic infections (17-19). Consequently, the ingestion of contaminated produce significantly increases the risk of parasitic infection (2). Therefore, the present study aimed to assess the level of contamination with parasitic helminths in fresh vegetables commonly consumed and sold in Duhok city.

Methods

This study were done in Duhok city, Iraq, from period of June to August in 2021, and in this research all vegetables samples were collected in many markets in different part of city randomly. Total number of collected samples of vegetables was 126 samples, and the types of vegetables samples were parsley, lettuce, radish and pepper. All types of vegetables were stored in sterile plastic bags, and were labeled with the name of the vegetable, date of collection and location of collection, and were transported to laboratory for microscopic examination. Laboratory

procedures: For detection of parasitic helminthes, larvae, cysts and ova in collected vegetables, 200 g. of each vegetable sample were washed in normal saline (500 mL), then 15 mL of washing solution were collected and were centrifuged at 3,000 rpm for 5 minutes (20), and the solution supernatant were removed and used for detection of parasites under light microscope in normal saline and iodine preparation method. Statistical analysis of research: all collected vegetable data in this study were tested by using SPSS 20.0, and the Chi-square test was used to obtain of statistical significant between contaminated and non-contaminated collected vegetables samples (p-value<0.05).

Results

In current study a total of 126 collected samples of vegetables were tested for detection of parasites, which only 15.9% (20 samples) were recorded as contaminated vegetables with parasitic helminthes. The recorded percentage indicated that there are no statistical significant differences between contaminated and non-contaminated samples of vegetables (Table 1). Regarding to our results, the higher percentage of parasitic contamination were detected in parsley (23%) and lettuce (20%), and lowest detection of parasites in pepper (4.8%).

Table 1. Fresh vegetables contamination with Helminths

Vegetable type	Examined samples	Contaminated samples	Contamination (%)
Coriander	21	3	14.3
Dill	22	3	13.6
Lettuce	20	4	20.0
Pepper	21	1	4.8
Parsley	21	5	23.8
Radish	21	4	19.0
Total	126	20	15.9

In this study three types of parasitic worms were identified in collected samples, which were *Enterobius vermicularis, Ascaris lumbricoides* and *Hymenolepis nana* (Table 2). The highest contamination of vegetables were recorded in *Ascaris lumbricoides* with 7.9%, followed by *Enterobius vermicularis* with 6.3%, and the lowest one was *Hymenolepis nana* with 2.4%. Regarding to detection of *Ascaris lumbricoides* worm in vegetables, the parsley was detected in highest percentage of contamination (19%), radish with 14.3%, and this type of worm not detected in Coriander and Pepper (Table 2).

Table 2. Parasitic helminths distribution among fresh vegetable types

Parasite Types	Fresh vegetable type							P-value
	Coriander	Dill	Lettuce	Pepper	Parsley	Radish	Total	
	N= 21	N=22	N=20	N=21	N= 21	N=21	N=126	
	Contamination (%)							
Ascaris lumbricoides	0	1 (4.5)	2 (10)	0	4 (19)	3 (14.3)	10 (7.9)	0.628
Enterobius vermicularis	1 (4.8)	0	3 (15)	1 (4.8)	2 (9.5)	1 (4.8)	8 (6.3)	
Hymenolepis nana	0	0	1(5)	0	1 (4.8)	1 (4.8)	3 (2.4)	

In this study, the detection of *Enterobius vermicularis* in contaminated vegetables was shown at the highest rate in lettuce with 15% and parsley with 9.5%, and no contamination in dill with this parasitic helminth. And in contamination of vegetables with *Hymenolepis nana*, the highest

percentage of this type of worm was detected in lettuce (5%), followed by other vegetables, including parsley and radish, in 4.8%, and without contamination of dill and pepper with these helminths.

Discussion

By consuming contaminated vegetables containing pathogenic parasites, humans can become infected with these parasites. Therefore, the transmission of pathogenic parasites is easy through the ingestion of unwashed or raw contaminated vegetables with these species of parasites. In this study, our understanding of parasites and the transmission of parasitic helminths through contaminated vegetables has increased (16). As shown in this study, the contamination rate of fresh vegetables was detected at 15.9%, which is similar to the findings of contaminated fresh vegetables in Duhok City, Iraq (21). The highest infection rates with pathogenic parasites were reported in individuals who ate unwashed and raw vegetables, especially those who used vegetables grown in fields fertilized with animal and human waste (16, 22). Moreover, raw consumption of vegetables to preserve vitamins and heat-sensitive elements can sometimes increase the transmission of pathogenic parasites and lead to infection (16). In the current study, the detection rate of *Ascaris lumbricoides* was high, similar to the findings of Eraky et al. (23). However, our results are higher than those of a study in Egypt by Mohamed et al. (24) and lower than those of Asfaw et al. in Ethiopia (25). Regarding *Enterobius vermicularis*, this worm was less frequently detected in vegetables compared to findings from Egypt (23), but our results were higher than those of Asfaw et al. in Ethiopia (25). Concerning *Hymenolepis nana*, our study showed a lower detection rate in vegetables compared to the findings of Bekele and Shumbej (2019) (2). The higher percentage of contamination with parasitic helminths was reported in parsley and lettuce, which aligns with the findings of Al Nahhas and Abou Alchamat (2020) (26). This supports the idea that the short stems of lettuce and parsley increase contact with contaminated soils containing parasite eggs, which is a major factor in contamination (6, 27). In contrast, contamination of peppers with parasitic helminths was lower than other vegetable samples, consistent with the study by Alemu et al. (28). Various factors can influence vegetable contamination, including the type of vegetable, irrigation methods, source of vegetables, quantity of produce, and microscopic examination techniques. All these factors are associated with the transmission and prevalence of pathogenic parasites and an increase in infection rates (24). As for worm species, *Ascaris lumbricoides* was reported at high rates in parsley (19%) and radish (14.3%), but was not detected in peppers and coriander. These results differ from those of Bekele and Shumbej (2019) (2), where this species was most common in lettuce. The detection of *Enterobius vermicularis* was higher in lettuce (15%) in our study, differing from Eraky et al. (23), who found this worm most frequently in parsley. In our research, lettuce was also contaminated with *Hymenolepis nana* at a higher rate, consistent with Bekele and Shumbej (2019) (2). Irrigation water used in cultivation is a crucial factor affecting the contamination of vegetables with parasitic cysts and eggs of pathogenic helminths (15). These findings highlight the contamination rates of vegetables with pathogenic parasitic helminths that can transmit parasites and infect people. Therefore, it is very important to adopt new techniques and methods for detecting parasites and other pathogens in various types of vegetables consumed by people, to reduce the hidden risks of infection through vegetable consumption.

Conclusion

The results of our research show that unwashed and raw fresh vegetables act as carriers of pathogenic helminths and can infect individuals. Therefore, these types are important sources of

parasitic helminths. Current study findings showed the important human health issues, including many parasitic infections by pathogenic helminths such as ascariasis, enterobiasis, and hymenolepiasis. Potentially, the consumption of these contaminated unwashed vegetables can cause to transmission of parasites, and can infect the individuals.

Acknowledgements

I would like to express our great appreciation to everyone who provided their extremely insight and support, which helped to ensure the successful completion of this research.

Funding sources

This study did not receive any external funding.

Ethics considerations

This research does not contain any studies with human participants or animals performed and the research was subjected to review and approval by the Scientific/Ethics Committee of the College of Pharmacy, University of Duhok.

Conflicts of interest

There are no conflicts of interest associated with this work.

Author contributions

The study's conception, design, Fieldwork contributions, data analysis, the initial draft of the paper, and discussions about the results were carried out by AMA.

Data availability statement

All data were collected from vegetable markets in Duhok City, and all relevant data used in this study are provided in the article's tables

References

1. Olza J, Aranceta-Bartrina J, González-Gross M, Ortega RM, Serra-Majem L, Varela-Moreiras G, et al. Reported dietary intake and food sources of zinc, selenium, and vitamins A, E and C in the Spanish population: findings from the ANIBES study. Nutrients. 2017;9(7):697.
2. Bekele F, Shumbej T. Fruit and vegetable contamination with medically important helminths and protozoans in Tarcha town, Dawuro zone, South West Ethiopia. Research and reports in tropical medicine. 2019:19-23.
3. Duedu KO, Yarnie EA, Tetteh-Quarcoo PB, Attah SK, Donkor ES, Ayeh-Kumi PF. A comparative survey of the prevalence of human parasites found in fresh vegetables sold in supermarkets and open-aired markets in Accra, Ghana. BMC research notes. 2014;7(1):1-6.
4. Bouzid M, Kintz E, Hunter PR. Risk factors for Cryptosporidium infection in low and middle income countries: A systematic review and meta-analysis. PLoS neglected tropical diseases. 2018;12(6):e0006553.
5. Herman KM, Hall A, Gould L. Outbreaks attributed to fresh leafy vegetables, United States, 1973–2012. Epidemiology & Infection. 2015;143(14):3011-21.
6. Damen J, Banwat E, Egah D, Allanana J. Parasitic contamination of vegetables in Jos, Nigeria. Annals of African Medicine. 2007;6(3):115.

7. Grondin JA, Jamal A, Mowna S, Seto T, Khan WI. Interaction between intestinal parasites and the gut microbiota: implications for the intestinal immune response and host defence. Pathogens. 2024;13(8):608.
8. Ryan U, Paparini A, Oskam C. New technologies for detection of enteric parasites. Trends in parasitology. 2017;33(7):532-46.
9. Julian TR. Environmental transmission of diarrheal pathogens in low and middle income countries. Environmental Science: Processes & Impacts. 2016;18(8):944-55.
10. Fletcher SM, Stark D, Harkness J, Ellis J. Enteric protozoa in the developed world: a public health perspective. Clinical microbiology reviews. 2012;25(3):420-49.
11. Dawson D. Foodborne protozoan parasites. International journal of food microbiology. 2005;103(2):207-27.
12. Alemu G, Mama M, Misker D, Haftu D. Parasitic contamination of vegetables marketed in Arba Minch town, southern Ethiopia. BMC infectious diseases. 2019;19:1-7.
13. Giangaspero A, Gasser RB. Human cyclosporiasis. The Lancet Infectious Diseases. 2019;19(7):e226-e36.
14. Ryan U, Hijjawi N, Xiao L. Foodborne cryptosporidiosis. International journal for parasitology. 2018;48(1):1-12.
15. Said DES. Detection of parasites in commonly consumed raw vegetables. Alexandria Journal of Medicine. 2012;48(4):345-52.
16. Punsawad C, Phasuk N, Thongtup K, Nagavirochana S, Viriyavejakul P. Prevalence of parasitic contamination of raw vegetables in Nakhon Si Thammarat province, southern Thailand. BMC Public health. 2019;19:1-7.
17. Okyay P, Ertug S, Gultekin B, Onen O, Beser E. Intestinal parasites prevalence and related factors in school children, a western city sample-Turkey. BMC public health. 2004;4(1):1-6.
18. Wegayehu T, Tsalla T, Seifu B, Teklu T. Prevalence of intestinal parasitic infections among highland and lowland dwellers in Gamo area, South Ethiopia. BMC public health. 2013;13:1-7.
19. Li J, Wang Z, Karim MR, Zhang L. Detection of human intestinal protozoan parasites in vegetables and fruits: a review. Parasites & Vectors. 2020;13:1-19.
20. Tefera T, Biruksew A, Mekonnen Z, Eshetu T. Parasitic contamination of fruits and vegetables collected from selected local markets of Jimma Town, Southwest Ethiopia. International scholarly research notices. 2014;2014.