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Hidden risks: Fresh vegetable contamination with parasitic helminths

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Abstract

Background: Vegetables and fruits are an important part of human nutrition and are consumed daily. Consumption of contaminated vegetables and fruits can sometimes cause health problems and facilitate the transmission of many intestinal parasites. This study aimed to determine the presence and percentage of helminths in commonly consumed vegetables in Duhok city, Iraq.

Methods: Sample collection for this study was conducted from June 2021 to August 2021 in different parts of the city. A total of one hundred twenty-six samples of lettuce, coriander, pepper, dill, radish, and parsley were collected, and all samples were examined microscopically for the detection of parasites.

Results: In this study, 15.9% of vegetables were found to be contaminated with parasitic helminths, with no significant difference between contaminated and non-contaminated samples (P-value: 0.628). Three species of helminths were identified in the collected samples at different percentages, including 7.9% *Ascaris lumbricoides*, 6.3% *Enterobius vermicularis*, and 2.4% *Hymenolepis nana*. Parsley was recorded as the most contaminated vegetable (23.8%), followed by lettuce (20%), while pepper showed the lowest contamination rate (4.8%).

Conclusion: This study demonstrated that vegetables were contaminated with helminths at moderate levels, which may play an important role in human infection through the consumption of contaminated vegetables.

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Introduction

In the daily diet, vegetables and fruits play a crucial role and primarily serve as major sources of essential nutrients, minerals, 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. Consumption of raw or inadequately washed 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 risks associated with contamination by human pathogenic parasites.

Epidemiological studies have shown that in regions where helminth infections are prevalent, untreated wastewater is used for irrigation, and 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 the 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 range from mild to severe diarrhea and include 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 was conducted in Duhok city, Iraq, from June to August 2021. Vegetable samples were collected randomly from many markets in different parts of the city. A total of 126 vegetable samples were collected, including parsley, lettuce, radish, and pepper. All vegetable samples were placed in sterile plastic bags, labeled with the name of the vegetable, date of collection, and location of collection, and transported to the laboratory for microscopic examination.

Laboratory procedures

For the detection of parasitic helminths, larvae, cysts, and ova in the collected vegetables, 200 g of each vegetable sample was washed in 500 mL of normal saline. Then, 15 mL of the washing solution was collected and centrifuged at 3,000 rpm for 5 minutes (20). The supernatant was removed, and the sediment was examined for the detection of parasites under a light microscope using normal saline and iodine preparation methods.

Statistical analysis

All collected vegetable data in this study were analyzed using SPSS version 20.0. The chi-square test was used to determine statistically significant differences between contaminated and non-contaminated vegetable samples, with a P-value < 0.05 considered statistically significant.

Results

In the current study, a total of 126 vegetable samples were examined for the detection of parasites, of which 15.9% (20 samples) were recorded as contaminated with parasitic helminths. The recorded percentage indicated that there was no statistically significant difference between contaminated and non-contaminated vegetable samples (Table 1). According to our results, the highest percentage of parasitic contamination was detected in parsley (23%) and lettuce (20%), while the lowest level of parasitic contamination was observed in pepper (4.8%).

Table 1. Fresh vegetable 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 helminths were identified in the collected samples: *Enterobius vermicularis*, *Ascaris lumbricoides*, and *Hymenolepis nana* (Table 2). The highest level of contamination was recorded for *Ascaris lumbricoides* (7.9%), followed by *Enterobius vermicularis* (6.3%), while *Hymenolepis nana* showed the lowest contamination rate (2.4%). Regarding the detection of *Ascaris lumbricoides* in vegetables, parsley showed the highest percentage of contamination (19%), followed by radish (14.3%). This helminth was not detected in coriander or pepper (Table 2).

In this study, detection of *Enterobius vermicularis* in contaminated vegetables was highest in lettuce (15%) and parsley (9.5%), while no contamination with this parasitic helminth was observed in dill. Regarding contamination of vegetables with *Hymenolepis nana*, the highest percentage was detected in lettuce (5%), followed by parsley and radish (4.8% each), with no contamination detected in dill and pepper.

Table 2. Parasitic helminth 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)	

Discussion

By consuming contaminated vegetables containing pathogenic parasites, humans can become infected with these organisms. Therefore, transmission of pathogenic parasites can easily occur through the ingestion of unwashed or raw vegetables contaminated with these parasite species. 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 15.9%, which is similar to findings reported for contaminated fresh vegetables in Duhok city, Iraq (21). The highest infection rates with pathogenic parasites have been reported among individuals who consume unwashed and raw vegetables, especially those using vegetables grown in fields fertilized with animal and human waste (16,22). Moreover, the 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 were higher than those reported in a study from Egypt by Mohamed et al. (24) and lower than those reported by Asfaw et al. in Ethiopia (25). Regarding *Enterobius vermicularis*, this helminth was detected less frequently in vegetables compared to findings from Egypt (23), but our results were higher than those reported by 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 highest percentage of contamination with parasitic helminths was reported in parsley and lettuce, which is consistent 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 soil containing parasite eggs, which is a major factor contributing to contamination (6,27). In contrast, contamination of peppers with parasitic helminths was lower than that of 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 increased infection rates (24).

Regarding 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 findings differ from those of Bekele and Shumbej (2019) (2), in which this species was most commonly detected in lettuce. Detection of *Enterobius vermicularis* was highest in lettuce (15%) in our study, differing from the findings of Eraky et al. (23), who reported this worm most frequently in parsley. In our research, lettuce was also contaminated with *Hymenolepis nana* at a higher rate, which is consistent with the findings of Bekele and Shumbej (2019) (2). Irrigation water used during cultivation is a crucial factor affecting vegetable contamination with parasitic cysts and eggs of pathogenic helminths (15). These findings highlight the contamination rates of vegetables with pathogenic parasitic helminths that can be transmitted to humans. Therefore, it is very important to adopt improved techniques and methods for detecting parasites and other pathogens in various types of vegetables consumed by people, in order to reduce the hidden risks of infection through vegetable consumption.

Conclusion

The results of this research show that unwashed and raw fresh vegetables can act as carriers of pathogenic helminths and may infect individuals. Therefore, these vegetables represent important sources of parasitic helminth transmission. The findings of the current study highlight important human health issues, including parasitic infections caused by pathogenic helminths such as ascariasis, enterobiasis, and hymenolepiasis. Consumption of contaminated and unwashed vegetables can potentially lead to parasite transmission and infection in humans.

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Ethical statement

This research did not involve any studies with human participants or animals. The study was reviewed and approved 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 conception and design, fieldwork, data analysis, preparation of the initial draft of the manuscript, and discussion of 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 tables included in the article.

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