Original Article

Contamination of Fresh Vegetables with Protozoan Parasites, in Duhok City, Kurdistan Region of Iraq

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Abstract

Background: Vegetables are essential for the human body and they constitute the main daily consumed diet. However, vegetable consumption is one of the main routes of transmission of intestinal parasites in humans. **Objective:** This study aimed to investigate parasites that caused vegetable contamination in Duhok city, Kurdistan region of Iraq. **Materials and Methods:** In the current study, from June 2021 through August 2021, a total of 166 samples of fresh vegetables were collected from several markets in different places of Duhok city. Samples were examined microscopically for parasitic investigation. **Results:** It was shown that 10.2% of vegetables were contaminated with parasites, but with no significant margin between contaminated and non-contaminated vegetables (*P* value = 0.81). The parasitic contamination was detected in lettuce (15%), parsley (14.3%), and radish (14.3%), with no parasitic contamination in both carrot and cucumber. Three types of parasites were detected in vegetable samples; they were in the order of 5.4% for *Entamoeba spp*., 4.2% *Giardia lamblia*, and 1.2% *Balantidium coli*. **Conclusion:** In conclusion, the present study identified fresh vegetable contamination with protozoan parasites in moderate rate, which can play an important role in the transmission of pathogenic intestinal parasites.

Keywords: Contamination, fresh vegetables, parasites

Introduction

Daily fresh eaten vegetables are an important part of the diet in a large percentage of people in the world. Many food-borne parasites may affect humans by consumption of contaminated fruits and vegetables. Man becomes infected with contaminated vegetables and fruits which are eaten raw or without peeling.[1] Unwashed or improper washing of vegetables is the main risk factor and plays an important role in the transmission of parasites. The prevalence and transmission of intestinal parasites were reported by many researchers in their studies especially in developing countries.[2] To preserve the flavor of vegetables, many people in many countries consume raw vegetables, which can cause parasitic transmission.[3,4] Contaminated vegetables and fruits are the potential source of infection in man by many pathogens, during collection, preparation, or transport process.[5-7] The main sources of vegetable contamination are irrigated or cleaning water, soil or human and animal stool, and more still, the rinsing and sprinkling of fresh vegetables with contaminated water.[5,8-10] In developing countries, a large number of people become infected with pathogenic parasites which lead to a high mortality rate.[11] In these countries, more studies reported a high intestinal infection with parasites which is associated with inadequate personal hygiene, poor sanitation, and eating of raw vegetables.[7,8,12] Several reports from different countries such as Iran,[8,9,13] Pakistan,[7] India,[4] Nigeria,[5,14-16] Ethiopia,[10-12] and Egypt[3,17] indicated that contaminated vegetables can be the main source of protozoan parasites transmission, including *Giardia lamblia*, *Entamoeba histolytica*, *Balantidium coli*, *Entamoeba coli* and transmission of helminths eggs and larvae such as *Enterobius vermicularis*, *Trichuris trichiura*, *Ascaris lumbricoides*, *Hymenolepis diminuta*, *Strongyloides stercoralis*, *Fasciola hepatica*, *Toxocara spp*., *Taenia spp*,. and *Hymenolepis nana*. Al-Binali *et al.* 2006,[18] indicated the presence of pathogenic parasites in watercress, radish,

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lettuce, leek, and green onion, also in Libya, Tripoli city was reported high parasitic contamination of raw salad vegetables.[19] In many countries, a large number of researches have noticed the parasitic contamination of vegetables.[20,21] Up to our knowledge, in our region, there are few studies regarding parasitic contamination of vegetables and fruits. Therefore, this study can provide a good report about local vegetable contamination, so the aim of this study is the investigation of parasitic contamination of fresh vegetables in Duhok city's local markets.

Materials and Methods

Study area and sample collection

The present study was conducted in Duhok city, Kurdistan Region of Iraq, from June 2021 to August 2021. Random Samples of fresh vegetables were collected from several markets in different parts of the city. A total of 166 fresh vegetables were collected from the markets. Collected fresh vegetables included coriander, carrot, dill, cucumber, lettuce, pepper, tomato, parsley, and radish. They were placed in sterile plastic labeled bags, and referred to the vegetable collection date, type of sample, and transported to the laboratory till examination.

Parasitological procedures

Fresh vegetable samples were soaked in water and washed with 10% normal saline solution for the detection of pathogenic parasite stages such as cysts, ova, and larvae. The washing saline was transferred to conical tubes for centrifugation at 2000 rpm for 15 min.[22] After centrifugation, the supernatants were discarded, and the sediments were examined under the light microscope (40 × and 100 × magnification) with a normal saline method and iodine preparations for detection of parasite stages.

Statistical analysis

In this study, statistical analysis of data was done by using SPSS 20.0. The Chi-square test was used to show the significant difference between the contaminated and noncontaminated vegetable type (significant P value <0.05).

Results

In this study, out of 166 collected samples of fresh vegetables, only 17 (10.2%) samples were shown contaminated with parasites, and there were no significant differences between contaminated and noncontaminated vegetables (P value = 0.81) [Table 1].

A high percentage of parasitic contamination was detected among lettuce, parsley, and radish, with 15% of contamination was shown in lettuce and 14.3% of contamination in both parsley and radish. However, there was no parasitic contamination in both carrot and cucumber [Figure 1].

Three types of parasites were detected in fresh vegetable samples [Table 2], all detected parasites were intestinal protozoa (*Entamoeba spp*., *Giardia lamblia*, and *B. coli*) and in contrast, there was no detection of the helminthic parasite in this study. From total examined fresh vegetables, *Entamoeba spp*. was detected in 5.4%, followed by *Giardia lamblia* (4.2%) and *B. coli* (1.2%). The highest contamination with *Entamoeba spp*. was shown in tomato (10%), followed by 9.5% in all of coriander, parsley, and radish. Regarding *Giardia lamblia*, the highest contamination with this parasite was recorded in lettuce (10%), followed by dill (9.1%). Finally, the highest contamination with *B. coli* was shown in lettuce (5%), followed by parsley (4.8%).

Discussion

Vegetables with their vitamin content are an important part of the daily diet, so food safety should be the main concern to everyone. However, parasites are the main risk of food contamination.[23] In this study, three protozoan parasites were detected from examined vegetable samples with the microscopic normal saline method. About 10% of examined vegetables were contaminated with protozoan parasites, which disagreed with Mohamed

Table 1: Parasitic contamination of different types of freshly eaten vegetables in Duhok city

Vegetable type	No. of examined samples	No. of contaminated samples	% Contaminated
Coriander	21	2	9.5
Carrot	10	0	0.0
Dill	22	3	13.6
Cucumber	10	0	0.0
Lettuce	20	3	15.0
Pepper	21	1	4.8
Tomato	20	2	10.0
Parsley	21	3	14.3
Radish	21	3	14.3
Total	166	17	10.2

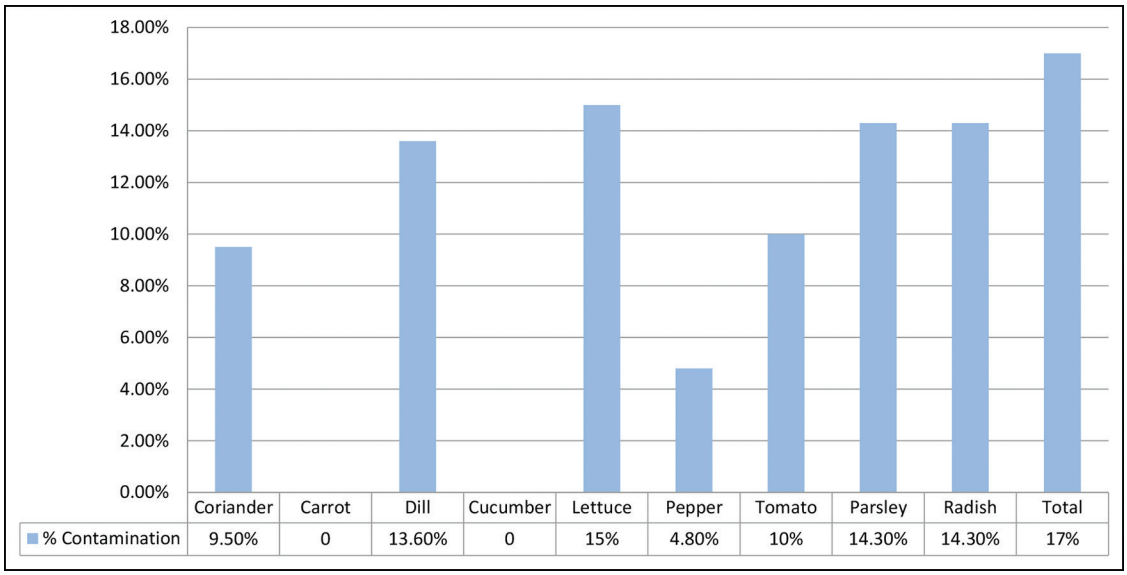

Figure 1: Parasitic contamination of different types of vegetables in Duhok city

Table 2: Distribution of parasites species among freshly eaten vegetables types in Duhok city

Parasite types	Freshly vegetables type of									
	Coriander	Carrot	Dill	Cucumber	Lettuce	Pepper	Tomato	Parsley	Radish	Total
	N = 21	N = 10	N = 22	N = 10	N = 20	N = 21	N = 20	N = 21	N = 21	N = 166
	Number contaminated (%)									
Entamoeba spp.	2 (9.5)	0 (0.0)	0 (0.0)	0 (0.0)	1 (5.0)	0 (0.0)	2 (10.0)	2 (9.5)	2 (9.5)	9 (5.4)
Giardia lamblia	0 (0.0)	0 (0.0)	2 (9.1)	0 (0.0)	2 (10.0)	1 (4.8)	0 (0.0)	1 (4.8)	1 (4.8)	7 (4.2)
Balantidium coli	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (5.0)	0 (0.0)	0 (0.0)	1 (4.8)	0 (0.0)	2 (1.2)

et al. 2016[24] in Khartoum, Sudan, and Hassan *et al.* 2012.[25] in Alexandria, Egypt. In the current study, the highest contamination was shown in lettuce, (15.0%) which is lower than that of Mohamed *et al.* 2016,[24] in Khartoum (Sudan) and more than Hassan *et al.* 2012,[25] in Alexandria (Egypt). In this study, parsley and radish contamination were recorded in 14.3%, which disagree with results of Al-Mozan and Dakhil, 2019,[26] in Thi-Qar Province-Iraq (79.2%), and Shahnazi *et al.* 2009[20] in Qazvin-Iran (parsley 60% and radish 80%), which they recorded higher contamination. Contamination with parasites in collected samples of dill was shown in 13.6%, which is higher than the results of Hassan *et al.* 2012,[25] and lower than Al-Shawa and Mwafy, 2007.[27] On the other hand in the current study, the examined samples of tomato (10.0%), coriander (9.5%), and pepper (4.8%) were shown lower contamination with parasites as compared with findings of Mohamed *et al.* 2016.[24] In this study, no record of any parasitic contamination in both carrot and cucumber, but Shakir *et al.* 2019,[28] in their study were shown the higher parasitic contamination of carrot and cucumber, in Iraq (Samarra city). The observed differences and discrepancies may be the result of geographic and environmental variations; also the type and size of collected samples can be the main reason for these differences.[24] Different agricultural techniques in different places and various laboratory techniques such as microscopic and molecular methods in diagnosis may play important role in this variation.[24] About protozoan parasite types, which are shown in this study, the highest contaminations were recorded with *Entamoeba ssp*. (5.4%), which is lower than the findings of Mirzaei *et al.* 2021[29] in Soran city, Kurdistan Region of Iraq, and Benti and Gemechu (2014)[30] in Ethiopia. Contamination with *Entamoeba spp*. was recorded in tomato (10%) and 9.5% in both coriander and parsley, which is higher than the findings of Mohamed *et al.* 2016[24] and Hassan *et al.* 2012,[25] respectively, and also contamination of radish with *Entamoeba spp.* (9.5%) was shown higher than Mirzaei *et al.* 2021[29] and lower than Hassan *et al.* 2012.[25] Vegetable contamination with *Giardia lamblia* was shown in 4.2%, which is lower than Mirzaei *et al.* 2021,[29] Mohamed *et al.* 2016,[24] and Hassan *et al.* 2012[25] results. Contamination with *Giardia lamblia* was recorded in high percentage in dill (9.1%) and 4.8% in pepper, radish, and parsley, which is the disagreement with the findings of Hassan *et al.* 2012,.[25] Contamination of vegetables with *B. coli* (1.2%), recorded in lowest percentage as compared with *E. spp*. and *G. lamblia*, but lettuce and parsley contamination were recorded in 5% and 4.8%, respectively, and these results

are in contrast with findings of Al-Mozan and Dakhil, 2019[26] (22.7%) in Thi-Qar province-Iraq and Ogbolu *et al.* 2009[31] findings (0.8%). Vegetable contamination is mainly related to vegetable irrigation water and the sources of water for fields irrigation, which was reported by the Center for Environment and Development in the Arab Region and Europe.[32] Unsanitary working during transportation of vegetables, washing of vegetables with contaminated water, and vegetable contamination with the stool of stray dogs, foxes, and wild jackals are major sources of the parasitic contamination.[15] The current study clearly indicated that vegetables by the transmission of intestinal parasites can cause infection of humans in Duhok city, Kurdistan Region of Iraq.

Conclusions

Current study findings may play an important role in the food safety process and may be able to clearly indicate the vegetable risk factors for public health by intestinal parasites transmission. In addition, more studies are needed to show and indicate vegetable contamination with intestinal protozoan parasites and helminth parasites in our region, and to show the contamination level of soil and irrigation water in vegetable cultivation, and application of advanced methods in vegetable disinfection.

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Conflicts of interest

There are no conflicts of interest.

Author contribution

Author has made substantial, direct and intellectual contribution to the work and approved it for publication.

Data availability

All datasets generated or analyzed during this study are included in the manuscript.

Ethics statement

This article does not contain any studies with human participants or animals performed by any of the authors.

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