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Research Article

A study of the parasitic contamination of commonly consumed vegetables in Wasit Province, Iraq

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Abstract
Fresh, raw vegetables are a source of parasitic infections. This study aimed to investigate the vegetables that are most susceptible to parasitic infections, and the parasites are the most prevalent. A total of 300 samples of six raw vegetables were washed using physiological saline solution (0.9%) to remove parasites. The vegetables were leek, basil, radish, cucumbers, celery, and carrots. The overall contamination rate was 82.33% rate and this rate was 100, 96, 86, 76, 75, 40% for basil, leek, carrot, celery, radish, and cucumber, respectively. The twenty parasites were identified in the examined vegetables that radish had all parasites. Leek, celery, and basil showed a high infection rate in most types of parasites, while cucumber and carrot showed little infection. The most detected parasites were *Strongyloides stercoralis* (100), and the least one *Hymenolepis nana*, *Balantidium coli*, and *Diphyllopotherium latum* with infection rates of 8, 7, and 2, respectively.

Keywords: Parasitic contamination, Vegetable, Worm, Protozoan.

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Introduction

Intestinal parasitic infection is widespread worldwide, causing health problems, and economic and physical risks. The lack of attention to personal hygiene and poor health, and environmental systems in developing countries cause the high prevalence rate of parasitic infections (Tomass & Kidane 2012; Wegayehu et al. 2013; Alade et al. 2013; Punsawad et al. 2019). Vegetables and fruits are the main components of a healthy diet (Okyay et al. 2004). They are also important because of having high amounts of fiber, minerals, carbohydrates, and vitamins. The World Health Organization recommends eating vegetables and fruits at least 400g per day (Weyayehu et al. 2013). However, consumption of unhygienic and unwashed fruits and vegetables can be a potential source of infectious parasites (Izadi et al. 2006).

Parasitic infections are a global public health problem. It occurs in the lack of perfect personal hygiene and sterilization practices. In addition, environmental factors such as temperature, soil type, climate, and rainfall contribute to the spread of parasitic infections (Duedu et al. 2014). Parasites such as protozoa are common in humans e.g. *Ascaris lumbricoides, Cryptosporidium* spp*., Entamoeba histolytica/ dispar, E. vermicularis, Giardia intestinalis,* hookworm*, Hymenolepis* spp*.,* and *Trichuris trichiura* (Hong et al. 2014; Duedu et al. 2014; Robertson et al. 2016; Bekele et al. 2017). Vegetables and fruits infections happen due to polluted waters used to irrigate them (Tram et al. 2014; Mohamed et al. 2016; Bekele et al. 2017).

About 1.7 billion cases of diarrhea are recorded globally every year, imposing an economic and social problem to healthcare services (Julian et al.

2016; Ryan et al. 2017). Infection of intestinal protozoan is caused by severe chronic diarrhea (Fletcher et al. 2012) accompanied by flatulence and abdominal cramps, vomiting, fatigue, loss of appetite, low temperature, and weight lack (Ryan et al. 2018: Glangaspero et al. 2019). This study was conducted to determine the more susceptible vegetables to the most prevalent parasites in Wasit Province of Iraq.

Material and Methods

This cross-sectional study was performed on raw native vegetables consumed in the waist Province of Iraq from August to November 2020. Three hundred fresh vegetable samples in 6 types were randomly collected from 3 districts, i.e. east, west, and central of Wasit Province. The vegetables were leek, basil, radish, cucumbers, celery, and carrots. The samples were transferred to the examination laboratory after being placed in clean plastic bags**.**

In the laboratory, the samples weighing 150-200g were washed with 1000ml of physiological saline (0.9% NaCl), then shaken for 15min until parasites were separated from the vegetables. Later, the washing water was collected and left during the night to give chance sedimentation of the parasites. The supernatant was removed, the precipitate (10ml) was taken and centrifuged at 2000×g for 15min. After centrifugation, the supernatant was carefully taken out. A drop of the precipitate was taken and placed on a clean glass slide and examined under a microscope with magnification of 100 and 400× for detection of eggs, larva, or protozoan cysts (Garcia 1993). Protozoan cysts were identified using Lugol's iodine staining (Rahmati et al. 2017). Three slides were prepared from each sample to give a greater chance of detecting parasites.

The chi-square test was used to compare the parasitic contamination between the different types of vegetables and between the different areas where the samples were collected. A *P*-value of less than 0.05 was considered statistically significant.

Results and Discussion

Out of 300 samples of the six types of vegetables, 247 were contaminated by parasites (82.33%). The rate of contamination indicated basil as 100% i.e. the highest rate of contamination (60 out of 60 samples) while cucumbers (40%) had the least rate of contamination (12 out of 30 samples) (Table 1). A total of 20 parasite species were identified in vegetables that all 20 parasite species had contaminated radish followed by leek, celery, and basil had high infection having the most type of parasites, while cucumbers and carrots showed little infections. Free-living larvae and eggs were the common and least common parasites in our study, respectively. The most detected parasites were *Strongyloides stercoralis* (100), *A. lumbricoides* (85), and *Iodamoeba butschlii* (76), followed by *Hymenolepis nana*, *Balantidium coli*, and *Diphyllopotherium latum* as 8, 7, and 2, respectively (Table 2; Fig. 2).

The isolation of parasites from vegetables showed that they are a potential source of transmitting diseases to humans (Omowaye & Audu 2012). The prevalence of parasitic infection in this study was 82.33% in agreement with a study in Thi-Qar Province, Iraq (88.3%) (Hanaa & Khlid 2019), and a close rate to a record in Northern Iran (69.33%) (Bahman et al. 2017), and a study in Yemen showed a high rate of infection (100%) (Abdul-Wahab et al. 2016). In addition, the current study did not agree with findings in Egypt where the rate of infection was 39% (Samia et al. 2017), and UAE as 15.1% (Ali et al. 2020). These differences are due to the different hygiene practices and sanitation methods, as well as the different environmental conditions between the study areas.

In this work, basil, leek, and carrot were the most contaminated items as 100, 96, and 86%, respectively, and cucumbers the least as 40%, which is identical to what was recorded in Iraq (Hanan & Khalid 2019). These results were in agreement with the findings of Ali et al. (2020) and Okpala et al. (2016) who reported little parasite contamination in cucumbers in the Emirates and Nigeria. These

Table 1. Contamination rate of vegetable samples.

Vegetables	No. examined	No.contaminated (%)
Leek	60	58(96%)
Celery	60	46(76%)
Basil	60	60(100%)
Radish	60	45(75%)
Carrots	30	26(86%)
Cucumbers	30	12(40%)

Fig.1. Images of research samples include a: Cucumber, b: Carrot, c: Radish, d. Leek, e. basil, f. celery.

differences in the contamination rate between the vegetables may be due to the fact that basil, leek, and carrots have rough surfaces making the parasites attached to them easily. The sleek surface of cucumber might lessen the rate of parasitic attachment. Moreover, the strong parasites adhesion to these vegetables overcomes washing effects.

In the current study, the most prevalent parasite was *S. stercoralis* followed by *A. lumbricoides* and *I. butschlii*, and the least spread one was *D. latum.* In a study conducted in Bahir city and Nigeria, *Strongyloide* sp. was the most frequent parasite (Okpala et al. 2016; Getaneh et al. 2020). These results were not in agreement with (Hanan & Khalid 2019) in Iraq. The reason for the difference may be due to the type of samples used in the study and the methods to prepare them in the laboratory e.g. in a study in Ghana, the vegetables were washed with saline solution twice to remove the parasites (Kudah et al. 2018), however in our study, samples were washed once. In a study in Brazil, the vegtables (salad, lettuce and green onion) were collected among February and July (Luz et al. 2017); but in the present study, samples were collected in August to November. The most common parasites discovered in this study are *Strongyloides* spp. larvae. This may be due to the ability of this parasite to live in a free state, which makes it more abundant in the environment and thus easily contaminates vegetables. In addition, infected animals that are a host for this parasite like dogs could also pollute the environment (Dankwa et al. 2018).

Conclusion

The results indicate a high rate of contamination in raw vegetables with worms and different stages of protozoa. The wastewater discharged into the Tigris River, the source of irrigation has a major role in

Table 2. Distribution of parasites among the study samples.

Parasites	Leek	Celery	Basil	Radish	Cucumber	Carrot	Total
Giardia lamblia	10	10	30	9	4	2	65
Entamoeba histolytica	5	8	15	8	0	5	41
Ascaris lumbricoides	21	13	32	17	0	2	85
Ancylostoma duodenale	13	9	17	9	0	11	59
Strongloides stercoralis	19	13	35	19	3	11	100
Balantidium coli	2	5	0	0	0	0	7
Entamoeba coli	7	5	8	4	0	0	24
Coccidia	0	3	5	2	0	0	10
Toxocara sp.	9	2	21	6	0	2	40
Enterobius vermicularis	8	7	20	10	0	5	50
Hymenolepis nana	2	2	3	1	0	0	8
Taenia saginata	1	1	3	4	0	0	9
Diphyllobotherrium latum	0	0	0	2	0	0	2
Trichuris trichiura	3	3	2	2	0	0	10
Schistosoma sp.	1	3	6	2	0	0	12
Fasciola hepatica	3	2	12	2	0	0	19
Echinococcus sp.	4	3	5	1	0	0	13
Blasstocystis hominis	3	2	13	5	2	4	29
Iodamoeba butschlii	10	12	20	12	10	12	76
Hookworm egg	1	1	14	1	0	0	17

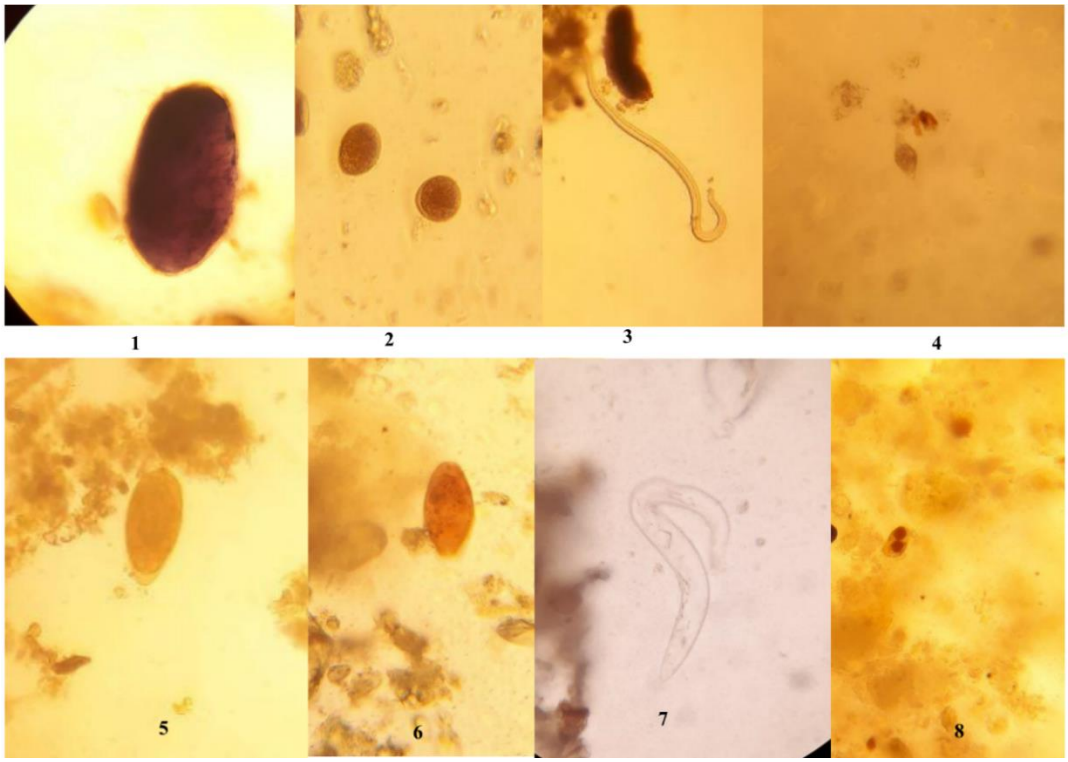

Fig.1. Representative images of parasites found in this survey, 1*: Ascarislumbricoides*, 2: *Toxocara*, 3: *Strongyloides*, 4: *Schistosoma*, 5: *Diphyllobotherium*, 6*: Trichuris*, 7: *Enterobius* and 8: *Coccidia*.

increasing the contamination of fresh vegetables with parasites. In addition, the use of animal fertilizers that are of human and animal origin in agricultural lands has a major role in spreading parasitic infection.

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