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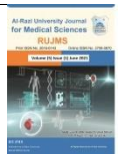

Detection of Intestinal Parasites of some Fresh Vegetables and their Consumers in Sana'a City, Yemen

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Abstract:

Background: Consumption of raw vegetables acts as a potential source for the transmission of several parasitic diseases. **Aims:** the present study was intended to detect the intestinal parasitic contamination in some common raw vegetables and their consumer in Sana'a, capital of the Yemen. **Methods:** One hundred and fifty samples of three types of common vegetable marketing in Sana'a. The vegetable samples were washed separately by using normal saline, tap water, water with salt, or water with vinegar 5% and the sedimentation was examined directly by microscopic. Also, fifty stool specimens were collected from vegetable consumers and microscopically examined for parasites detection. **Results:** The overall prevalence of parasitic contamination was 65.3%. The higher rate of parasite contamination was 76% observed in lettuce, 64% in mint, and 56% in watercress. The most frequent parasite contaminant was *Giardia lamblia* (65.3%), followed by *Entamoeba histolytica* (34.67%), *Enterobius vermicularis* (47.33%), *Ascaris lumbricoide* (36.67%), *Hymenolepis nana* (35.33%), *Ancylostoma duodenale* (24.67%), and *Schistosoma mansoni* (24.67%). Also, the observation of higher contamination was found in vegetables washed by normal saline, and lower was found in vegetables washed by water mixed with vinegar. This result revealed that 80% of vegetable consumers were infected by parasites. The males had a higher rate of parasites infection when compared to females. **Conclusion:** This finding reported the high rates of intestinal parasites contaminated vegetables to represent as the potential source of spreading intestinal parasites to humans. Therefore, it is necessary for health authorities to educate consumers about the standard washing methods of vegetables prior to consumption.

Keywords: Consumer, Fresh Vegetables, Intestinal Parasites, Sana'a City, Yemen

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Introduction

Nowadays, vegetables become a major component of the human diet in every family. Fresh vegetables are vital sources of energy and provide essential nutrients to humans such as vitamins and minerals. They are significantly rich sources of water, carotene, vitamin C, mineral elements (iron), vitamins (vitamin B12), niacin, and riboflavin[1,2 3,4].

The regular consumption of fresh vegetables is associated with reducing the risk of stroke and cardiovascular diseases as well as preventing the development of certain types of cancers [5,6].

Consumption of fresh vegetables represented a significant route in the transmission of numerous infectious diseases because the surface of vegetables allows the appropriate environment for the pathogen to attach and survive [7,8].

Vegetables could be contaminated during irrigation with contaminated water in the field or harvesting, transport, distribution, marketing, or during consumption [9,10].

The intestinal parasites such as *Entamoeba histolytica*, *Giardia lamblia*, *Entamoeba coli*, *Balantidium coli*, *Isospora belli*, *Cryptosporidium* sp., *Strongyloides stercoralis*, *Trichuris trichiura*, *Enterobius vermicularis*, *Fasciola hepatica*, *Ascaris lumbricoides*, *Toxocara* sp., *Hymenolepis nana*, *Hymenolepis diminuta,* and *Taenia* sp. are detected in fresh vegetables [11,12].

A number of reports documented that the prevalence rate of the intestinal parasitic infection among fresh vegetables was recorded at 29.6% in Egypt by Eraky *et al*.[13], 13.5% in Khartoum, Sudan [14], and 25.1% in Arba Minch, Ethiopia [11].

Yemen is one of the most developing countries which lack the an advanced wastewater treatment plant. So, the end water produced from these types of treatment systems is still contaminated with pathogenic microorganisms such as bacteria, viruses, and intestinal parasites as well as hazards substances resulting from industrial factories[15,16].

However, some farmers use inadequately treated wastewater to irrigate fruit and vegetable crops and maybe consider one of the most responsible that lead to an increase in the prevalence of intestinal parasitic infection in Yemen. Also, most of the studies conducted in different regions of Yemen focused on the prevalence of intestinal parasitic infection among the population and neglected the perform investigation in vegetables and fruits [17,18,19].

The data about the prevalence of vegetables contaminated in Yemen are limited. Therefore, this study aimed to detect the intestinal parasites of marketing vegetables and their consumers in Sana'a City, Yemen.

Materials and Methods

Study area and period

A cross-sectional study was conducted in Sana'a City from March to May 2021. Fresh vegetable samples were collected randomly from a local market. The source of sampled vegetables was from farms situated the Sana'a city that was irrigated with unclean water that collected from rainwater into dams.

Ethical statement

The study protocol was approved by Queen Arwa University to start samples collection.

Sample collection

Vegetable samples

Three types of green vegetables that include Watercress, Lettuce, and Mint were selected in the current study. A total of 150 samples (50 samples of each type) were collected randomly from a local market. Samples were collected weekly (teen samples for each type of examined vegetables). About 600 grams of each type of edible part of vegetables were collected into sterile nylon bags and transported immediately to the Parasitology Laboratory at Medical Science of Queen Arwa University.

Stool specimens of consumed vegetables

About 50 stool specimens were collected from males and females who living near the bought the vegetables from the selected market and constantly consuming the targeted vegetables.

Sample processing and examination

Vegetables

Each type of fresh vegetable sample was divided into four parts and transferred separately into a sterile plastic container. The first and second parts were immersed, respectively, by NaCl 0.9% and tap water. Also, the third and fourth parts were

immersed, respectively, by water with salt and water with vinegar (concentration 40%). All parts were shaken well and left approximately 15 minutes for sedimentation. Then, the vegetables were removed and the remaining water was transferred separately into tubes and centrifuged at 2000×rpm for 15 min. After that, the supernatant was carefully removed and the sediment was examined under a light microscope using 10× and 40× objectives [20].

Stools processing

By using the sedimentation technique, a small amount of stool specimen was transferred into a container containing 10 mL of normal saline and mixed well. Put a funnel on the tube and put the gauze on the funnel. Spill the mixture over the gauze. Let the tube stand for 30-60 minutes. The supernatant was discarded and the sediment was examined under a light microscope of 10× and 40× objectives [20].

Results

Out of 150 vegetable specimens, about 98 (65.3%) were identified to be contaminated with intestinal parasites. The highest rate of parasite contamination was 38 (76%) observed in lettuce, 32 (64%) in mint, and 28 (56%) in watercress (Figure 1).

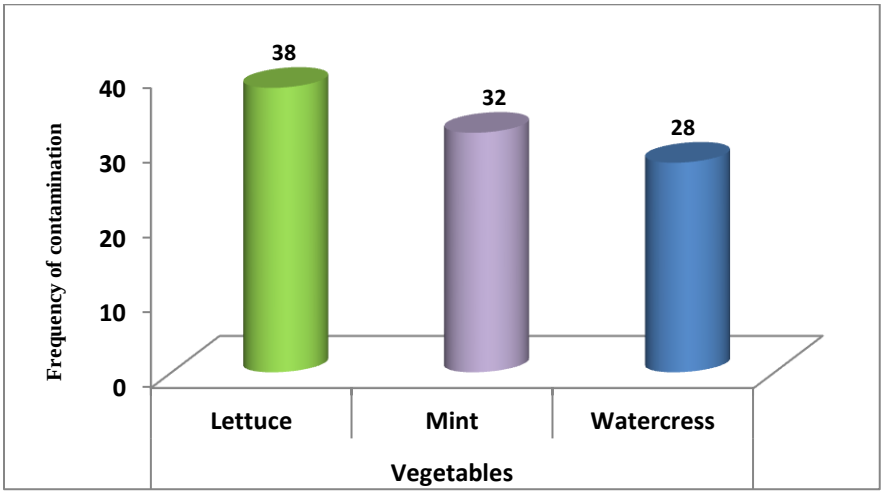

Figure 1: Frequency of contaminated vegetables by parasites

The present result revealed that the overall prevalence of intestinal contamination was 65.3% recorded for examined vegetables. The *G. lamblia* and *E. histolytica* protozoa were detected in 98(65.3%) and 52(34.67%) vegetable samples. A high rate of *G. lamblia* was found in Lettuce while a high rate of *E. histolytica* was found in Watercress (Table 1).

Prevalence of helminthes parasites

Table 2 shows the helminthes parasitic prevalent among examined vegetables. It was found that the *E. vermicularis* was the most frequent at 47.33%, followed by *A. lumbricoide* (36.67%), *H. nana* (35.33%), *A. duodenale,* and *S. mansoni* (24.67% for each).

Table 1: Frequency of protozoa contamination in vegetables

Vegetables	Examined samples	Type of parasites	
		G. lamblia No. (%)	*E. histolytica* No. (%)
Mint	50	32 (64)	18 (36)
Watercress	50	28 (56)	22 (44)
Lettuce	50	38 (76)	12(24)
Total	**150**	**98 (65.3)**	**52(34.67)**

Table 2: Prevalence of helminthes parasites in vegetables

Vegetables	Examined samples	*H. nana*	*A. lumbricoide*	*A. duodenale*	*E. vermicularis*	*S. mansoni*
		No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Mint	**50**	18 (36)	18 (36)	17 (34)	24 (48)	11 (22)
Watercress	**50**	14 (28)	11 (22)	10 (20)	18 (36)	9 (18)
Lettuce	**50**	21 (42)	26 (52)	20 (40)	29 (58)	17 (34)
Total	**150**	**53(35.33)**	**55(36.67)**	**37(24.67)**	**71(47.33)**	**37(24.67)**

Washing methods and parasites distribution

Table 3 reveals the intestinal parasitic prevalent in vegetables according to used washing methods. The most frequent intestinal parasitic contamination was observed when washing the vegetables with normal saline. In contrast, when used the water mixed with vinegar 5% for vegetable washing, the parasites decreased.

Table 3: Intestinal parasitic prevalent according to used washing methods

Vegetables	Washing methods	*G. lamblia*	*E. histolytica*	*H. nana*	*A. lumbricoide*	*A. duodenale*	*E. vermicularis*	*S. mansoni*
		No. (%)	No. (%)	No. (%)	No.(%)	No.(%)	No.(%)	No.(%)
Mint	N.S	12(24)	7(14)	5 (10)	8(16)	6 (12)	10(20)	4 (8)
	Tap water	10(20)	6(12)	6 (12)	6 (12)	4 (8)	8(16)	4 (8)
	Water and salt	6(12)	3(6)	4 (8)	3 (6)	4 (8)	4 (8)	2 (4)
	Water and vinegar	4(8)	2(4)	3 (6)	1 (2)	3 (6)	2 (4)	1 (2)
Watercress	N.S	11(22)	10(20)	5 (10)	5(10)	6 (12)	8(16)	3 (6)
	Tap water	8(16)	7(14)	4 (8)	3 (6)	1 (2)	5(10)	3 (6)
	Water and salt	5(10)	3(6)	3 (6)	2 (4)	2 (4)	3 (6)	2 (4)
	Water and vinegar	4(8)	2(4)	2 (4)	1 (2)	1 (2)	2 (4)	1 (2)
Lettuce	N.S	12(24)	5 (10)	10(20)	10(20)	8(16)	10(20)	6 (12)
	Tap water	10(20)	3 (6)	5 (10)	8(16)	5 (10)	8(16)	6 (12)
	Water and salt	9(18)	3 (6)	5 (10)	5 (10)	5 (10)	8(16)	3 (6)
	Water and vinegar	7(14)	1 (2)	1 (2)	3 (6)	2 (4)	4 (8)	2 (4)

Parasites result among consumer

Table 4 shows that the overall rate of intestinal infection was 19(76%) and 21(84%), respectively, recorded among females and males who consume the vegetables. In females, the higher rate of intestinal parasitic infection was recorded among the age group of 31-40 and 20-30 years in females and males, respectively.

Table 4: Prevalence of intestinal parasites among vegetable consumers

Gender	Age group	Examined samples	*G. lamblia*	*E. histolytica*	Infected
			No. (%)	No. (%)	No. (%)
Female	20 – 30	14	6 (42.86)	3 (21.43)	**9**
	31-40	11	6 (54.55)	4 (36.37)	**10**
Total		**25**	**12 (48)**	**7 (28)**	**19 (76)**
Male	20 – 30	12	7 (58.33)	3 (25)	**10**
	31-40	13	6 (46.13)	5 (38.46)	**11**
Total		**25**	**13 (52)**	**8 (32)**	**21 (84)**
Total of specimen		**50**	**25(50)**	**15(30)**	**40(80)**

Discussion

The forced habit of eating uncooked vegetables plays a serious epidemiological role in spreading parasitic food-borne diseases. Detection of intestinal parasites from fresh vended vegetables is an indication of the quality of the overall process of farming, irrigation and post-harvest handling, and may be helpful in indicating the incidence of intestinal parasites among a local community [2,21,22].

In the current study, it was found 65.3% of examined vegetables had a parasites contamination. This study is higher than a study carried out in Egypt by Eraky *et al*.[13] observed that about 29.6% of examined fresh vegetables were contaminated with intestinal parasites. Also, Mohamed *et al*.[14] showed the prevalence of intestinal parasites was 13.5% recorded among tested fresh vegetable marketing in Khartoum, Sudan. In a similar report in Arba Minch, Ethiopia by Alemu *et al*.[11] showed 25.1% of fresh vegetables had an intestinal parasitic contamination.

Undoubtedly, this variation in findings might be attributed to geographical location, number and type of samples investigated, detection methods, source of water used for irrigation, harvesting, handling, distribution of such vegetables and even the type of water used to wash vegetables can play a role in contributing in the transmission of parasitic diseases

The present result showed that the parasite contamination was 76%, 64%, and 56%, respectively, reported in lettuce, mint, and watercress this result is in accordance with studies conducted by investigators. Eraky *et al*.[13] revealed that the highest contaminated vegetable was reported in lettuce (45.5%) followed by watercress (41.3%), parsley (34.3%), green onion (16.5%), and leek (10.7%). Similarly, Mohamed *et al*.[14], Remarkably, a high level of contamination in fresh vegetable samples was recorded in lettuce (36.4%). Also, in Iran Isazadeh *et al.*[23] found that the most contaminated one by intestinal parasites was lettuce (58.3%). In contrast, Chau *et al*.[24] reported that the watercress was the vegetable most infected by parasites, followed by basil and lettuce marketing in Hue, Vietnam.

This difference in prevalence rates may be due to the changes in the shape and surface of vegetables. Lettuce and watercress vegetables have uneven surfaces that possibly facilitate stacking of parasitic cysts, oocysts, and eggs more readily, either at the farm or when washed with contaminated water [9,25].

This result revealed that the most predominate of parasite contaminant was *G. lamblia* (65.3%), followed by *E. histolytica* (34.67%), *E. vermicularis* (47.33%), *A. lumbricoide* (36.67%), *H. nana* (35.33%), *Ancylostoma duodenale* (24.67%), and *S. mansoni* (24.67%). In a similar study by Eraky *et al*.[13] found that the *G. lamblia* was the most predominant parasite (8.8%) followed by *Entamoeba* sp. (6.8%), *E. vermicularis* (4.9%), *H. nana* (2.8%), *H. diminuta* (2.1%), and *Ascaris lumbricoides* (0.6%). Also, Alemu *et al*.[11] documented that the *E. histolytica/dispar* (29, 8.4%) was the commonest parasitic contaminant detected followed by *G. lamblia* (24, 6.9%) and *Cryptosporidium* sp. (5.8%).

In contrast, Tefera *et al.*[26] showed that the *Strongyloides* like a parasite (21.9%) was the most frequent parasitic contaminant followed by *Toxocara* sp. (14.7%), *Cryptosporidium* sp. (12.8%), *H. nana* (8.3%), *G. lamblia* (7.5%), *A. lumbricoides* (6.7%), *E. histolytica*/*dispar* (5.3%), *Cyclospora* sp. (5.0%), and *H. diminuta* (1.4%).

The presence of intestinal parasites in these samples indicates that these types of vegetables are cultivated in contaminated areas and irrigated with water contaminated with the sewage water. Sana'a lacks to complete sewage-water system which leads to overflow of this water with raining water that is eventually collected in dams used for irrigating the vegetables and fruits.

In the present work, it was observed that the washing methods was reduced the rate of parasites contaminating vegetables. Washing vegetables by water with vinegar had a significant reduction in the rate of parasitic contamination. Along with the findings of the current study, the previous study reported that washing vegetables with tap water reduces the rate of parasitic contamination but does not eliminate contaminated parasites [27,28].

This investigation observed that the overall rate of intestinal parasitic infection among vegetables consumers was 80%. Also, it was found that the male was more infected by intestinal parasites than the female. This study is the first one and no previous study was performed to make a comparison with it.

The high prevalence of the parasites among vegetable consumers indicates there is a strong relationship between the use of vegetables and the parasites prevalent. Also, males are always responsible for buying the requirements of the food in Yemen and they sometimes used to eat unwashed vegetables during marketing, while the females aren't. This explains that males were more

exposure to parasites infection than females in Yemen [29,30].

Recently, the increase of diseases prevalent among Yemeni peoples resulted from the lack of awareness of the mode of infectious diseases transmission. The educational health programs were absent last year due to the wear since 2015 and so far that has led to the destruction health system, decreased individual income, and increase prices of life requirements. These factors contribute by direct or indirect on disease prevalence transmitting rapidly in different regions in Yemen[31-35].

Conclusion

This finding reported the high rates of intestinal parasites contaminated vegetables to represent as the potential source of spreading intestinal parasites to humans. Monitoring of contamination remains the utmost effective approach for reducing intestinal parasites infection via vegetables. So, farmers should use clean water for vegetables irrigation and harvesting in a safe way. Also, health authorities must educate consumers about the standard washing methods of vegetables prior to consumption.

Conflict of interest

No conflict of interest is associated with this work.

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