Original Article

The enteroparasitic contamination of commercial vegetables in Gaza Governorates*.*

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Abstract

Background: The objective of this study was to evaluate the parasitological contamination of vegetables to be consumed raw and commercialized in Gaza Governorates.

Methodology: We studied 216 samples of vegetables including parsley, dill, rocket, cucumber, red cabbage and purslane collected from markets in Gaza Governorates and Rafah Governorates, between June and August 2006. The study was carried out in the Department of Biology, Faculty of Science, Al-Azhar University of Gaza. The vegetables were washed in tap water; the washing solution was then centrifuged and the sediments were examined for parasites.

Results: The prevalence of the parasites was 22.5% in rocket, 17.5% in each of parsley and purslane, 16.3% in dill, 13.7% in red cabbage, and 12.5% in cucumber. The statistical analysis indicated that *Entamoeba histolytica, Giardia intestinalis* and *Ascaris lumbricoides* were the most common isolated parasites.

Conclusions: It may be concluded that parasites are common in vegetables that are frequently eaten raw and the use of tap water does little to remove them. These findings could open a new avenue of research in vegetables.

Key Words: enteroparasites, contamination, vegetables, Gaza Governorates.

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Introduction

Food-borne illnesses are caused by organisms or harmful chemicals in food consumed by either eating or drinking. Most of these illnesses are caused when certain bacteria, viruses, or parasites contaminate food [1]. Vegetables, particularly those eaten raw and without peeling, have been demonstrated to be a vehicle for transmission of a range of parasites. Various parasites that have been associated with vegetables include species of protozoan [2-4] and helminthes [5-7].

The degree of contamination caused by parasites in commonly used leafy vegetables has been studied in Saudi Arabia. This study revealed that the prevalence of parasites was 28% in green onion, 25% in radish, 17% in watercress, 17% in lettuce, and 13% in leek. Also the parasites were more common in the months of September to December [8].

Five species of parasitic eggs (Ascarid, Trichurid, *Trichostrongylus, Clonorchis* and hookworms) and 2 larvae (filariform and rhabditoid) were found in a parasitic survey on vegetables collected from markets and vegetable gardens in the Taegu area [9].

Epidemiological research carried out in different areas in Gaza Governorates has shown that the social and economical situation of the individuals is an important factor in the prevalence of intestinal parasites. In addition, poor sanitary and environmental conditions are known to be relevant in the propagation of these infectious agents [10-12].

No studies to our knowledge have examined the enteroparasitic contamination of commercial vegetables in Gaza Governorates. Therefore, this is the first study to investigate the enteroparasitic contamination of commercial vegetables in Gaza Governorates and provides a clear picture on the prevalence of intestinal parasitic infections in common vegetables that are frequently eaten raw. These findings could open a new avenue of research in vegetables and could also lead to better practices in growing and handling vegetables to protect against intestinal parasitic infections.

Materials and Methods

The study area

The Gaza Governorates constitute a narrow coastal strip of land along the Mediterranean Sea in the Middle East. It takes its name from Gaza, its main city, and has about 1.4 million residents, all Palestinians. The population density of Gaza Governorates is estimated at about 2,146 persons per square kilometer. It is a densely populated region inhabited primarily by Palestinian refugees; the majority live in large, overcrowded refugee camps. The Gaza Governorates are 50 kilometers long and 5-12 kilometers wide with a total area of 362 square kilometers. It is a subtropical region of five provinces (Governorates): North Gaza, Gaza City, Mid Zone, Khan-Younis and Rafah (Figure 1).

Figure 1. Map of Gaza Strip, adapted from United Nations Relief and Works Agency (UNRWA) headquarters website (http://www.unrwa.org), Gaza. (February, 2005).

There are five towns in Gaza Governorates, eight refugee camps, and fourteen villages [13]. Geographically, the Gaza Governorates form the westernmost portion of the Palestinian territories in Southwest Asia, having land borders with Egypt on the southwest, the green line on the north, and the Negev Desert on the east. On the west, it is bounded by the Mediterranean Sea (Figure 1). Gaza Governorates are under the jurisdiction of the Palestinian Authority, which also controls the Gaza's border with Egypt [14].

Sampling of vegetables

Vegetables that are frequently eaten raw (Table 1) include dill, rocket, cucumber and red cabbage. These were chosen for the study as the majority of the population consume them on a daily basis, are of equal of importance to the people in Gaza, and are planted in Gaza lands. Vegetables were collected from the Feras market, a popular central market in Gaza Governorate. Farmers bring their vegetables to it from agricultural lands. We also collected parsley and purslane from the Rafah Governorate, which is located at the south of Gaza.

Thirty-six samples of each vegetable were analyzed (36×6=216). These samples were collected between June and August, 2006.

The vegetables were processed immediately on arrival in our laboratory in the biology department of Al-Azhar University of Gaza. Each vegetable was divided into 2 parts, leaves and roots. The roots were excluded from the study. Approximately 100 gm of each vegetable were soaked in 150 ml of tap water in a 500 ml beaker. With the aid of a mechanical shaker, the beaker was shaken for 15 minutes. The washing solution was poured through sterile gauze into a sedimentation flask and left to settle for 30 minutes. After this time, the supernatant was decanted and the sediment was transferred into a centrifuge tube. The tube was filled with the washing solution and centrifuged at 1500 rpm for 5 minutes. The supernatant was decanted, and a few drops of the sediment were spread on 3 slides and examined for parasites.

Data analysis

Data were compiled in a spreadsheet (Microsoft Excel). Descriptive statistics and comparisons were made by one sample t-test using SPSS v.11.0 ® (Chicago, Illinois) statistical software. A probability level of less than 0.05 was considered as significant ($p<0.05$).

Results

Each slide for each type of vegetable was examined to confirm the findings. As shown in Table 1, the overall prevalence of parasites for the vegetables was 37.0%.

The examined vegetables collected from markets in Gaza were found to be contaminated with one or more intestinal parasites.

Rocket was more likely to be contaminated with intestinal parasites, followed by parsley. The least contaminated was cucumber. Table 2 shows the distribution of parasites detected in vegetables collected from markets.

Table 1. Vegetables involved in survey collected from markets and global results.

Common name	Scientific name	Origin
Parsley	*Petroselinum crispum*	Rafah
Dill	*Anethum graveolens* L.	Gaza
Rocket	*Eruca sativa*	Gaza
Cucumber	*Cucumis sativa* L.	Gaza
Red Cabbage	*Brassica oleracea*	Gaza
Purslane	*Portulaca oleracea* L.	Rafah

Result	N (%)
Positive (contaminated)	80 (37.0%)
Negative (non-contaminated)	136 (63.0%)
Total (36 × 6)	216 (100.0%)

The highest number of parasites was found in rocket [18 (22.5%)] and the lowest in cucumber [10 (12.5%)]. The prevalence of parasites in other vegetables was 14 (17.5%) in each of parsley and purslane, 13 (16.3%) in dill, and 11 (13.7%) in red cabbage. *Entamoeba histolytica* was the most common parasite detected [30 (37.5%)], followed by *Giardia intestinalis* [23 (28.7%)], *Ascaris lumbricoides* [16 (20.0%)], and then *Strongyloides stercoralis* [6 (7.5%)].

Table 2. Distribution of parasites detected in the examined vegetables collected from markets.

Parasites	Vegetables						
	Parsley	Dill	Rocket	Cucumber	Cabbage	Purslane	Total (%)
N	36	36	36	36	36	36	216
Entamoeba histolytica	6	4	4	5	3	8	30 (37.5)
Giardia intestinalis	0	9	1	3	7	3	23 (28.7)
Ascaris lumbricoides	5	0	5	2	1	3	16 (20.0)
Strongyloides stercoralis	0	0	6	0	0	0	6 (7.5)
Enterobius vermicularis	2	0	0	0	0	0	2 (2.5)
Trichuris trichiura	1	0	0	0	0	0	1 (1.3)
Hymenolepis nana	0	0	2	0	0	0	2 (2.5)
Number positive (%)	14 (17.5)	13 (16.3)	18 (22.5)	10 (12.5)	11 (13.7)	14 (17.5)	80 (100)

The least detected parasite was *Trichuris trichiura* [1 (1.3%)]. Other parasites detected in the examined vegetables are shown in Table 2.

The statistical analysis shown in Table 3 indicates that contamination from *Entamoeba histolytica* was significantly higher (p<0.001) than contamination from the other parasites, ranging from 3 to 8 cysts per 100 g vegetable (mean 5.0±0.7 [±SE] cysts per 100 g vegetable, variance 3.2).

Table 3. Significant relations for the intestinal parasitic infection in vegetables collected from markets.

Species	Mean±SE	SD	Range	Variance	P
Entamoeba histolytica	5.00±0.70	1.8	5.00	3.2	<0.001
Giardia intestinalis	3.80±1.40	3.5	9.00	13.5	<0.05
Ascaris lumbricoides	2.70±0.80	2.1	5.00	4.3	<0.05
Strongyloides stercoralis	1.00±1.00	2.4	6.00	6.0	ND
Enterobius vermicularis	0.30±0.30	0.8	2.00	0.67	ND
Trichuris trichiura	0.17±0.17	0.4	1.00	0.17	ND
Hymenolepis nana	0.30±0.30	0.8	2.00	0.67	ND

The number of sample was 36 in each examined vegetable. SE: Standard error; SD: Standard deviation; ND: not determined.

Contamination with *Giardia intestinalis* and *Ascaris lumbricoides*, the next two most commonly found parasites, was significantly lower (p<0.05) than infection with *Entamoeba histolytica,* ranging from 0 to 9 per 100 g vegetable for *Giardia intestinalis* (3.8±1.4 cysts per 100g vegetable, variance 13.5) and 0 to 5 eggs per 100 g vegetable for *Ascaris lumbricoides* (2.7±1.4 eggs per 100 g vegetable, variance 4.3).

Discussion

As awareness of the potential for food-borne outbreaks of parasitic infections increases, studies involving the recovery of parasites from vegetables are being increased worldwide. To our knowledge no previous studies have either examined or discussed the enteroparasitic contamination of commercial vegetables in Gaza Governorates. For this reason, the recovery of parasites from vegetables found to be the source of infection may be of considerable importance in epidemiologic considerations.

Parasitic food- and water-borne zoonoses contribute to these statistics by inflicting a heavy toll on human health and causing serious direct and indirect losses to the agricultural industry. The consumption of raw or undercooked meat, crustaceans, fish, and vegetables facilitates transmission of large numbers of zoonotic infections [15].

A relatively extensive search of vegetables collected from markets within Gaza found them to be contaminated with one or more intestinal parasites, with 37.0% overall prevalence, in accordance with other studies [6,16,17]. This finding could be considered a proxy to the intestinal parasitic diseases that are endemic in many countries, particularly in the developing world.

The Gaza Governorates are endemic areas for many intestinal parasitic diseases. Population size, density, and socio-economic conditions all contribute to the development and transmission of many intestinal parasites, as do environmental factors such as the warm climate, the relative humidity, the moisture, the sandy and clay nature of the soil, and the salty nature of the water..

Much research has been done on intestinal parasites in Gaza and prevalence has ranged from 53.3% in rural areas, 48% in refugee camps, and between 24.5% and 33.0% [18, 19] in urban areas.

The deterioration of the commercial and social infrastructure in Palestine has contributed to the increase of environmental health risks, especially for children, as a result of the lack of a pure water supply, the lack of human waste disposal, and the problems associated with the buildup of solid waste [20].

Contamination of vegetables may occur in a variety of ways, such as from contact with the soil, and from contact pre- and post-harvest. In most cases, contamination is associated with the water used for irrigation [3,21].

Biologically, the highest health risk is for acquisition of helminthes infections, when compared with other pathogens, because helminthes persist for longer periods in the environment, but also because host immunity to helminthes is usually low to non-existent. Data for the presence of *Entamoeba histolytica, Giardia intestinalis* and *Ascaris lumbricoide*s, in addition to other helminthes encountered in this study, are similar to those identified by other investigators [9,22,23].

Several factors may account for the high prevalence of intestinal parasites contamination recorded in most of the analyzed vegetables (although not directly reported). Among these is the use of polluted water for irrigation and the use of fresh poultry manure as fertilizer. Both the irrigation water and the manure are applied on top of the crops. Another contamination source is market-related handling, especially where provision for better sanitary standards (e.g., clean water for crop washing and refreshing) is lacking [24-26].

Nolla and Cantos surveyed the relationship between intestinal parasites in food handlers and epidemiological factors in the city of Florianopolis, Santa Catarina, Brazil, and found that habitual daily intake of fruits and vegetables was the factor most heavily associated with infection. Their study further suggests that intestinal parasites are frequent among food handlers in this city [27].

A study on the health impact of the utilization of raw domestic sewage for vegetable cultivation in the suburbs of Asmara, Eritrea, showed heavy contamination of vegetables from fecal coliforms and Giardia cysts, as well as from other pathogens, such as Shigella and Salmonella bacteria. Also the dietary intake of raw greens (e.g., lettuce, cabbage) grown on the raw sewage appears to cause giardiasis, amebiasis and bacterial diarrhoeas in the farming community as well as in the surrounding area. This study indicates as well that agricultural use of untreated wastewater was the major cause of the increase in giardiasis and other gastrointestinal diseases [28].

In conclusion, our study shows that parasites are common in vegetables that frequently are eaten raw, and the use of tap water does little to remove them. Rocket was more likely to be contaminated with intestinal parasites, followed by parsley. Dill, cucumber, red cabbage and purslane were also found to be contaminated. *Entamoeba histolytica, Giardia intestinalis* and *Ascaris lumbricoides* were the most common isolated parasites. Meanwhile, the least common parasite in the study was *Trichuris trichiura.*

These findings may have important implications for those concerned with global food safety and indicate the need for further investigation in this area.

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