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# Prevalence of Parasitic Contamination in Salad Vegetables Collected from Supermarkets and Street Vendors in Amman and Baqa'a – Jordan

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Abstract

One of the main ways in transmitting parasites to humans is through consuming contaminated raw vegetables. The aim of this study was to evaluate the prevalence of parasitological contamination (helminthes eggs, *Giardia* and *Entamoeba histolytica* cysts) of salad vegetables sold at supermarkets and street vendors in Amman and Baqa'a – Jordan. A total of 133 samples of salad vegetables were collected and examined for the prevalence of parasites. It was found that 29% of the samples were contaminated with different parasites. Of the 30 lettuce, 33 tomato, 42 parsley and 28 cucumber samples examined the prevalence of *Ascaris* spp. eggs was 43%, 15%, 21% and 4%; *Toxocara* spp. eggs was 30%, 0%, 0% and 4%; *Giardia* spp. cysts was 23%, 6%, 0% and 0%; *Taenia*/*Echinococcus* eggs was 20%, 0%, 5% and 0%; *Fasciola hepatica* eggs was 13%, 3%, 2% and 0%; and *E. histolytica* cysts was 10%, 6%, 0% and 0%, respectively. There was no significant difference in the prevalence of parasite in salad vegetables either between supermarkets and street vendors, or between Amman and Baqa'a, *Ascaris* spp. was found to be the highest prevalent parasite in salad vegetables from supermarkets and street vendors and from Amman and Baqa'a. Our results pointed out that, the parasitic contamination of salad vegetables found in our study might be caused by irrigating crops with faecal contaminated water. We concluded that salad vegetables sold in Amman and Baqa'a may cause a health risk to consumers.

Key words: Amman, Baqa'a refugee camp, contamination, parasite, salad vegetable

## Introduction

Foodborne disease causes diarrhoea, diarrhoea was reported by the world health organization to be one of the five most common disease causes of death in the world (1.6 million deaths per year) (Baldursson and Karanis, 2011). Foodborne disease could be caused by viruses, bacteria and parasites, while transmission can occur by contaminated food such as contaminated vegetables. Vegetables can become contaminated during growth, harvesting, processing and distribution (Slifko *et al*., 2000; Dawson, 2005). The sources of vegetable parasite contamination during growth are sewage sludge, untreated waste water, contaminated slurry, farm livestock, and indigenous wildlife (Slifko *et al*., 2000; Lanata, 2003; Dawson, 2005).

Parasites (protozoa or helminthes) could be transmitted to humans by ingesting one of the parasite environmental transmission stages (protozoa: cysts and oocytes, helminthes: eggs, and larval) (Slifko *et al*., 2000; WHO, 2003). Consuming improperly washed vegetables such as salad vegetables represent one of the major forms in transmitting parasites into humans, in which raw vegetables play a role as a vehicle in the parasite transportation. The prevalence of parasites in vegetables was reported in many developed and developing countries (da Silva *et al*., 1995; Robertson and Gjerde, 2000; 2001; Al-Binali *et al*., 2006; Daryani *et al*., 2008; Uga *et al*., 2009; Abougrain *et al*., 2010; Al-Megrm, 2010; Iournals, 2014).

Jordan is a small Middle Eastern country with limited natural resources. Jordan water resources is one of the lowest in the world, the renewable fresh water resources is approximately 135 $m^3$ per capita for all uses and 90% of the country receive annual precipitation less than 200 mm (Raddad, 2005; Al-Jaloudy, 2006). Jordan population was estimated at 6.3 million in 2012 as reported by the Jordanian department of statistics (DSJ, 2014). Vegetables are one of the major components of the daily diet in Jordan, from which vegetable salad (cucumber, tomato, lettuce and parsley) being one of the daily dishes. The main parasites detected in

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vegetables in the neighbouring countries were *Ascaris* spp., *Taenia* spp., *Fasciola* spp., *Toxocara* spp., *Echinococcus* spp., *Giardia* spp. and *Entamoeba histolytica* (Sharif, 2002; Al-Shawa and Mwafy, 2007; Hadi, 2011; Hassan *et al.*, 2012; Adanir and Tasci, 2013; Ali and Ameen, 2013). To our knowledge, no published study to date has evaluated the parasitological contamination of salad vegetables sold at Jordanian markets. Therefore, the aim of this study was to evaluate the prevalence of parasitological contamination (helminthes eggs, *Giardia* and *E. histolytica* cysts) of salad vegetables at supermarkets and street vendors in Amman and Baqa'a – Jordan.

## Experimental

### Materials and Methods

**The study area.** Samples were collected from different areas in Amman and Baqa'a. Amman is the capital city of Jordan, with a population of almost 2.5 million inhabitants (39% of Jordan population) (DSJ, 2014). Amman is situated in the mountain heights plateau of Jordan with an elevation ranging from 400 to 1000 m above sea level (Al Rawashdeh and Saleh, 2006), Amman has a mediterranean climate; moderate and dry in summer (average temperature 25°C) cold and wet in winter (average temperature 9°C) (JOMETEO, 2015) with an annual rainfall of almost 500 mm (Dahamsheh and Aksoy, 2007).

Baqa'a is the largest Palestinian refugee camp in Jordan with more than 100.000 registered refugees. Baqa'a is situated almost 20 km north of Amman (UNRWA, 2015) with a similar climate to Amman. Baqa'a refugee camp has a higher poverty and a poorer environmental hygiene compared to Amman (UNRWA, 2015).

**Sampling.** A total of 133 samples of salad vegetables were collected from supermarkets and street vendors in Amman and Baqa'a as shown in Table I. Salad vegetables were collected randomly between March 2014 and August 2014.

Table I
Number of samples collected from each area

| Total | Number of samples collected from Amman | | Number of samples collected from Baqa'a | | Total |
|---|---|---|---|---|---|
| | Supermarket | Street vendors | Supermarket | Street vendors | |
| Lettuce | 8 | 8 | 7 | 7 | 30 |
| Tomato | 7 | 8 | 10 | 8 | 33 |
| Parsley | 10 | 9 | 11 | 12 | 42 |
| Cucumber | 7 | 7 | 7 | 7 | 28 |

**Determination of intestinal parasites.** Each sample was weighed (250 g) and placed into sterile plastic bags, samples were then washed with one litter of sterile normal saline solution (0.85% NaCl) by shacking for 20 minutes. The washing saline was then left to sediment overnight. The supernatant was discarded and the remaining washing saline (50 ml) was centrifuged at 2000 RCF for 15 minutes. Supernatant was then discarded and the remaining pellet with 5 ml of the saline was collected (Erdoğrul and Şener, 2005). Three simple and three iodine stained smears were then prepared from each sample, smears were used to detect helminthes eggs, *Giardia* and *E. histolytica* cysts using light microscope (Downes and Ito, 2001).

**Statistical analysis.** Fisher's exact test was used to assess the differences between proportions, significance was defined as $P < 0.05$. The analyses were made using GraphPad Prism 5 software (San Diego, CA).

## Results

A total of 133 samples of salad vegetables (30 lettuces, 33 tomatoes, 42 parsley and 28 cucumbers; Table I) were examined for the presence of parasites (helminthes eggs, *Giardia* and *E. histolytica* cysts). It was found that 29% (39 out of 133) of the salad vegetable samples were contaminated with different parasites (helminthes eggs, *Giardia* and *E. histolytica* cysts). The highest percentage of contamination was detected in lettuce samples (63%), while tomato and parsley samples showed lower contamination percentage (27% and 24%, respectively). The least percentage of contamination was detected in cucumber (13%). Lettuce samples were contaminated significantly more often than tomato, parsley and cucumber with parasites ($P = 0.006$, Odds ratio = 4.6; $P = 0.001$, Odds ratio = 5.5 and $P < 0.0001$, Odds ratio = 46.6, respectively), further details are shown in Table II.

Twenty seven percent (18 out of 67) of salad vegetable samples sold at supermarkets and 32% (21 out of 66) of salad vegetable samples sold at street vendors were contaminated with different parasites (Table II), no significant difference was found between the prevalence of parasites in salad vegetables sold at supermarkets and street vendors ($P > 0.05$, Table II). *Ascaris* spp. was found to be the highest prevalent parasite in salad vegetables sold at supermarkets and street vendors (18% and 24%, respectively; Table III).

The prevalence of *Ascaris* spp. eggs found in the 30 lettuce, 33 tomato, 42 parsley and 28 cucumber samples examined was 43%, 15%, 21% and 4%, respectively. *Ascaris* spp. eggs was found to be significantly higher in total lettuce samples than in total tomato and cucumber samples ($P = 0.024$, Odds ratio = 4.2 and

Table II
Prevalence of parasites in salad vegetables according to area, retail and vegetable type

| | Parasite contamination% Amman | | Parasite contamination% Baqa'a | | Total Parasite contamination |
|---|---|---|---|---|---|
| | Supermarket % (No.)[a] | Street vendors % (No.) | Supermarket % (No.) | Street vendors % (No.) | |
| Lettuce | 62.5% (5 out of 8) | 75% (6 out of 8) | 42.9% (3 out of 7) | 71.4 (5 out of 7) | 63.3% (19 out of 30)[b] |
| Tomato | 14.3% (1 out of 7) | 25% (2 out of 8) | 40% (4 out of 10) | 25% (2 out of 8) | 27.3% (9 out of 33)[c] |
| Parsley | 10% (1 out of 10) | 44.4% (4 out of 9) | 27.3% (3 out of 11) | 16.7% (2 out of 12) | 23.8% (10 out of 42)[d] |
| Cucumber | 14.3% (1 out of 7) | 0% (0 out of 7) | 0% (0 out of 7) | 0% (0 out of 7) | 3.6% (1 out of 28) |
| Total salad vegetables | 25% (8 out of 32) | 37.5% (12 out of 32) | 28.6% (10 out of 35) | 26.5% (9 out of 34) | 29.3 (39 out of 133) |

Note: 26.9% (18 out of 67) of salad vegetable samples sold at supermarkets were contaminated with parasites and 31.8% (21 out of 66) of salad vegetable samples sold at street vendors were contaminated with different parasites (no significant difference between the two ways of retail, $P > 0.05$).
[a] No.: number of contaminated samples out of the total sample number.
[b] Lettuce samples were contaminated significantly more often than tomato, parsley and cucumber samples with parasites (P = 0.006, Odds ratio = 4.6; P = 0.001, Odd ratio = 5.5 and P < 0.0001, Odds ratio = 46.6, respectively).
[c] Tomato samples were contaminated significantly more often than cucumber samples with parasites (P = 0.016, Odds ratio = 10.1).
[d] Parsley samples were contaminated significantly more often than cucumber samples with parasites (P = 0.041, Odds ratio = 8.4).

Table III
Prevalence of different parasites detected in salad vegetables from supermarkets and street vendors

| Vegetables | Source | *Ascaris* spp. No. (%) | *Toxocara* spp. No. (%) | *Giardia* spp. No. (%) | *Taenia/ Echinococcus* No. (%) | *Fasciola* spp. No. (%) | *Entamoeba histolytica* No. (%) |
|---|---|---|---|---|---|---|---|
| Lettuce | Supermarkets n = 15 | 5 (33.3)[a] | 4 (26.7) | 2 (13.3) | 2 (13.3) | 1(6.7) | 0 (0) |
| | Street vendors n = 15 | 8 (53.3)[b] | 5 (33.3) | 5 (33.3) | 4 (26.7) | 3 (20) | 3 (20) |
| | Total n = 30 | 13 (43.3)[c] | 9 (30)[e] | 7 (23.3)[f] | 6 (20.0)[g] | 4 (13.3) | 3 (10) |
| Tomato | Supermarkets n = 17 | 3 (17.6) | 0 (0) | 1 (5.9) | 0 (0) | 0 (0) | 2 (11.8) |
| | Street vendors n = 16 | 2 (12.5) | 0 (0) | 1 (6.3) | 0 (0) | 1 (6.3) | 0 (0) |
| | Total n = 33 | 5 (15.2) | 0 (0) | 2 (6.1) | 0 (0) | 1 (3.0) | 2 (6.1) |
| Parsley | Supermarkets n = 21 | 3 (14.3) | 0 (0) | 0 (0) | 1 (4.8) | 0 (0) | 0 (0) |
| | Street vendors n = 21 | 6 (28.6) | 0 (0) | 0 (0) | 1 (4.8) | 1 (4.8) | 0 (0) |
| | Total n = 42 | 9 (21.4)[d] | 0 (0) | 0 (0) | 2 (4.8) | 1 (2.4) | 0 (0) |
| Cucumber | Supermarkets n = 14 | 1 (7.1) | 1 (7.1) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| | Street vendors n = 14 | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0 ) | 0 (0) |
| | Total n = 28 | 1 (3.6) | 1 (3.6) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| All vegetables | Supermarkets n = 67 | 12 (17.9) | 5 (7.5) | 3 (4.5) | 3 (4.5) | 1 (1.5) | 2 (3.0) |
| | Street vendors n = 66 | 16 (24.2) | 5 (7.6) | 6 (9.1) | 5 (7.6) | 5 (7.6) | 3 (4.5) |
| | Total n = 133 | 28 (21.1) | 10 (7.5) | 9 (6.8) | 8 (6.0) | 6 (4.5) | 5 (3.8) |

[a] The highest prevalent pathogenic intestinal parasite found in supermarkets was *Ascaris* spp.
[b] The highest prevalent pathogenic intestinal parasite found in street vendors was *Ascaris* spp.
[c] The prevalence of *Ascaris* spp. eggs was significantly higher in total lettuce samples than in total tomato and cucumber samples ($P = 0.024$, Odds ratio = 4.2 and $P = 0.0005$, Odds ratio = 20.7, respectively).
[d] The prevalence of *Ascaris* spp. eggs was significantly higher in total parsley samples than in total cucumber samples ($P = 0.042$, Odds ratio = 7.4).
[e] The prevalence of *Toxocara* spp. eggs was significantly higher in total lettuce samples than in total tomato, parsley and cucumber samples ($P = 0.0006$, Odds ratio = 29.6; $P = 0.0002$, Odds ratio = 37.6 and $P = 0.013$, Odds ratio = 11.6, respectively).
[f] The prevalence of *Giardia* spp. cysts was significantly higher in total lettuce samples than in total parsley and cucumber samples ($P = 0.0014$, Odds ratio = 27.1 and $P = 0.011$, Odds ratio = 18.2, respectively).
[g] The prevalence of *Taenia/Echinococcus* eggs was significantly higher in total lettuce samples than in total tomato and cucumber samples ($P = 0.009$, Odds ratio = 17.8 and $P = 0.024$, Odds ratio = 15.1, respectively).

$P = 0.0005$, Odds ratio = 20.7, respectively), it was also found to be significantly higher in parsley samples than in total cucumber samples ($P = 0.042$, Odds ratio = 7.4). Table III shows further details of the prevalence of parasites (helminthes eggs, *Giardia* and *E. histolytica* cysts) that have been detected in salad vegetable samples collected from supermarkets and street vendors.

Thirty one percent (20 out of 64) of salad vegetables samples sold in Amman and 28% (19 out of 69) of salad vegetables samples sold in Baqa'a were contaminated

Table IV
Prevalence of different parasites detected in salad vegetables from Amman and Baqa'a

| | Vegetables sold in Amman, No. (%), n = 64 | Vegetables sold in Baqa'a, No. (%), n = 69 |
|---|---|---|
| Non-infected | 44 (68.8) | 50 (72.5) |
| Infected | 20 (31.2) | 19 (27.5) |
| *Ascaris* spp. | 14( 21.8)[a] | 13 (18.8)[b] |
| *Toxocara* spp. | 5 (7.8) | 5 (7.2) |
| *Giardia* spp. | 5 (7.8) | 4 (5.8) |
| *Taenia/Echinococcus* | 5 ( 7.8) | 2 (2.9) |
| *Fasciola* spp. | 2 (3.1) | 4 (5.8) |
| *Entamoeba histolytica* | 3 (4.7) | 2 (2.9) |

[a] The highest prevalent pathogenic intestinal parasite found in vegetables sold in Amman was *Ascaris* spp.
[b] The highest prevalent pathogenic intestinal parasite found in vegetables sold in Baqa'a was *Ascaris* spp.

with different parasites (Table IV). No significant difference was found between the prevalence of parasites in salad vegetables sold at Amman and Baqa'a ($P > 0.05$). *Ascaris* spp. was found to be the highest prevalent parasite in salad vegetables at Amman and Baqa'a areas (22% and 19%, respectively; Table III). Table IV shows further details of the prevalence of parasites that have been detected in salad vegetable samples collected from Amman and Baqa'a.

## Discussion

Fresh vegetable could become contaminated by parasites while growing in the field through irrigation, soil or types of fertilizers used. Other sources of contamination include harvesting, distribution or the retail market (Beuchat, 2002).

When comparing the prevalence of parasites attached to salad vegetables in the neighbouring developing countries and the developed countries (Table V), it is clear that the prevalence is higher in neighbouring developing countries ranging from 16% to 58% (Al-Binali *et al.*, 2006; Al-Shawa and Mwafy, 2007; Daryani *et al.*, 2008; Abougrain *et al.*, 2010; Al-Megrm, 2010; Fallah *et al.*, 2012; Hassan *et al.*, 2012; Ali and Ameen, 2013) when compared to the prevalence in more developed countries like Turkey (Adanir and Tasci, 2013) and Norway (Robertson and Gjerde, 2001) (6% for both countries). In our study, it was found that 29% of the 133 salad vegetables samples examined were contaminated with different parasites (helminthes eggs, *Giardia* and *E. histolytica* cysts). The similarity between the prevalence of parasites attached to salad vegetables found in our study and the neighbouring developing countries could reflect a common way of contamination. The previous studies (Al-Binali *et al.*, 2006; Al-Shawa and Mwafy, 2007; Daryani *et al.*, 2008; Abougrain *et al.*, 2010; Al-Megrm, 2010; Hassan *et al.*, 2012; Ali and Ameen, 2013) shared the finding that the main source of parasite contamination found in vegetables was from irrigating vegetables with faecal contaminated water.

High prevalence of transmitted helminthes and protozoa could be caused by poverty, poor environmental hygiene and poor sanitation (Montresor *et al.*, 1998; Jamaiah and Rohela, 2005). In our study we compared the prevalence of parasites in salad vegetables sold in Amman and in Baqa'a refugee camp (31% and 28%, respectively). Unexpectedly, no significant difference was found in the prevalence of parasites in salad vegetables between these two areas. The study also compared the prevalence of parasites attached to salad vegetables

Table V
Prevalence of parasites in salad vegetables at different neighbouring developing countries and developed countries

| City | Prevalence of parasite in examined salad vegetables % (No.)[a] | Reference |
|---|---|---|
| Tripoli – Libya | 57.9% (73 out of 126) | (Abougrain *et al.*, 2010) |
| Ardabil – Iran | 56.7% (80 out of 141) | (Daryani *et al.*, 2008) |
| Sulaimani – Iraq | 49.8% (119 out of 239) | (Ali and Ameen, 2013) |
| Gaza Governorates | 37.0% (80 out of 216) | (Al-Shawa and Mwafy, 2007) |
| Shahrekord – Iran | 32.6% (99 out of 304) | (Fallah *et al.*, 2012) |
| Abha – Saudi Arabia | 27.2% | (Al-Binali *et al.*, 2006) |
| Alexandria – Egypt | 19.4% (19 out of 98) | (Hassan *et al.*, 2012) |
| Riyadh – Saudi Arabia | 16.2%(76 out of 470) | (Al-Megrm, 2010) |
| Burdur – Turkey | 6.3% (7 out of 111) | (Adanir and Tasci, 2013) |
| Norway | 6.1% (29 out of 475) | (Robertson and Gjerde, 2001) |

[a] No.: number of contaminated samples out of the total sample number.

sold at supermarkets and street vendors (27% and 32%, respectively), yet again no significant difference in the prevalence of parasites in salad vegetables was found between these two modes of retail. These findings exclude poor environmental hygiene and poor sanitation of the marketing area or retail method as the main cause of salad vegetable contamination, and points to the vegetable field growing area as the main source of contamination.

In Tripoli – Libya *Ascaris* spp. eggs were reported to be the most predominant parasite attached to salad vegetables, the study reported that 68% of salad vegetables examined were contaminated with *Ascaris* spp. eggs (Abougrain *et al*., 2010). *Ascaris* spp. was also one of the most prevalent detected parasite attached to vegetables in the neighbouring developing countries ranging from 12% to 26% (Al-Shawa and Mwafy, 2007; Al-Megrm, 2010; Fallah *et al*., 2012; Ali and Ameen, 2013). In Jordan, a study by Al-Lahham *et al*. (1990) found that the highest intestinal parasite detected in the stool samples collected from 283 food handlers was *Ascaris lumbricoides* with a detection rate of 5%. In our study the prevalence of *Ascaris* spp. eggs attached to vegetables was 21% and were found to be the highest detected parasite in salad vegetables examined, our findings agrees with the previous studies. This study did not differentiate between *A. lumbricoides* and *Ascaris suum* eggs as these two species eggs have a highly similar morphological appearance (Blaszkowska *et al*., 2011).

Lettuce and parsley leafs have a more rough surface texture and surface area when compared to tomato and cucumber surfaces making it a more easier area for attaching parasites, lettuce and parsley vegetable are also in more direct contact with soil and irrigating water than in tomato and cucumber vegetables. In the present study the prevalence of *Ascaris* spp. eggs was found to be significantly higher in lettuce samples (43%) than in tomato (15%) and cucumber (4%) samples. *Ascaris* spp. eggs were also significantly higher in parsley samples (21%) than in cucumber samples (4%) and higher than in tomato (15%) samples. *Ascaris* spp. is usually found in sewage and untreated waste water and is used as an indicator organism for sewage and water treatment process (Gerba and Smith, 2005). These findings may indicate that the soil that crops grow on and water used in irrigating crops are faecal contaminated.

The prevalence of *Toxocara* spp. attached to vegetables in some neighbouring developing countries ranged from 3% to 18% (Hadi, 2011; Fallah *et al*., 2012; Adanir and Tasci, 2013). In Jordan a study by Abo-Shehada (1989) found that 16% of soil samples collected from school playgrounds and public places were contaminated with *Toxacara* eggs. A serological survey conducted in north of Jordan by Abo-Shehada *et al.* (1992) showed a seroprevalence of *Toxocara canis* in 11% of tested individuals. In the present study *Toxocara* spp. eggs were detected in 10% of salad vegetables which agrees with the previous findings. According to our finding, consuming unwashed salad vegetables may cause *Toxocariasis*. This study did not differentiate between *Toxacara cati* and *T. canis* eggs as these two species eggs have a highly similar morphological appearance (Blaszkowska *et al*., 2011).

A study conducted in Jordan by El-Shehabi *et al.* (1999) detected *T. canis* in the intestines of 1.2% of dogs infected with intestinal helminths. In our study, the prevalence of *Toxocara* spp. eggs attached to lettuce was found to be 30% and significantly higher than the prevalence found in tomato (0%), parsley (0%) and cucumber (4%) samples. As *Toxocara* spp. eggs are excreted by dogs and cats faeces (Deplazes *et al*., 2011), our finding indicate that lettuce is cultivated in an opened lands that are inhibited with more roaming dogs and cats when compared to parsley, tomato and cucumber cultivation lands.

*Giardia* cysts are found on surface water such as lakes and rivers, and their concentration is positively associated with the water pollution by means of residential or agricultural faecal contamination (Rosen *et al*., 2000; Karanis *et al*., 2006). The prevalence of *Giardia* spp. cysts attached to vegetables in some neighbouring developing countries ranged from 7% to 10% (Abougrain *et al*., 2010; Hassan *et al*., 2012; Ali and Ameen, 2013). In our study we detected the eggs of *Giardia* spp. in 9% of salad vegetables which agrees with the previous studies, our finding suggest that using faecal contaminated water for irrigation could be the main source of contamination of salad vegetables with *Giardia* spp.

*Giardia lamblia* causes giardiasis in humans, it is reported that ingesting as low as 10 *Giardia* cysts by humans may cause disease (Arnone and Walling, 2007). A study by Shakkoury and Wandy (2005) reported that the prevalance of *G. lamblia* in stool samples collected from individuals visiting primary health care centres in Amman – Jordan was 30%. In our study, the prevalence of *Giardia* spp. cysts attached to lettuce was found to be 23% and significantly higher than the prevalence in parsley and cucumber samples (*Giardia* spp. was not detected in the parsley and cucumber samples). Our results indicate that the high prevalence of *Giardia* spp. in lettuce may pose a risk to consumer's health if unwashed prior to consumption.

The prevalence of *Taenia* spp. attached to vegetables in some neighbouring countries was 11% in Sulaimani – Iraq (Ali and Ameen, 2013) and 3% in Burdur – Turkey (Adanir and Tasci, 2013). In our study we did not differentiate between the eggs of *Taenia* spp. and the eggs of *Echinococcus* spp. as they are undistinguishable from each other. The prevalence of *Taenia*/*Echinococcus* attached to vegetables in the present study was 6%.

The prevalence of *Taenia* spp. attached to leafy vegetables in Riyadh – Saudi Arabia was 20% (Al-Megrm, 2010), and the prevalence of *Taenia*/*Echinococcus* attached to lettuce in Tripoli – Libya was 33% (Abougrain *et al*., 2010). In Jordan, a study by Al-Lahham *et al.* (1990) detected *Taenia saginata* in 0.4% of the stool samples collected from 283 food handlers. In our study, the prevalence of *Taenia*/*Echinococcus* attached to lettuce was found to be 20% and significantly higher than the prevalence in tomato and cucumber samples (*Taenia*/*Echinococcus* were not detected in the tomato and cucumber samples). The high prevalence of *Taenia*/*Echinococcus* in lettuce may pose a risk to consumer's health if unwashed prior to consumption. In Jordan the annual incidence of hydatidosis (a human disease caused by *Echinococcus granulosus*) depending on the region was found to be 15–65 per 100.000 (Kamhawi and Hijawi, 1992).

A study by Ajlouni *et al.* in 1984 found that 14% of stray dogs in Jordan were infected with *E. granulosus* (Ajlouni *et al*., 1984) and a study by Maraqa *et al*. (2005) reported that 20% of Jordan local sheep were infected with *E. granulosus*. As *Echinococcus* spp. eggs are excreted by dogs and sheep faeces (Deplazes *et al*., 2011), our finding indicate that lettuce is cultivated in open lands that are inhabited with more roaming dogs or sheep when compared to tomato and cucumber cultivation lands.

The prevalence of *Fasciola* spp. attached to vegetables in some neighbouring developing countries was 21% in Sulaimani – Iraq (Ali and Ameen, 2013) and 15% in Riyadh – Saudi Arabia (Al-Megrm, 2010). A study by Maraqa *et al*. (2005) reported that 3.2% of the sheep imported to Jordan from Romania were infected with *Fasciola hepatica* and a study by Sharrif *et al*. (1998) found that the prevalance rate of *F. hepatica* in camels grown in Jordan was 4%. In our study we detected the eggs of *Fasciola* spp. in 5% of salad vegetables.

The prevalence of *E. histolytica* attached to vegetables in some neighbouring developing countries ranged from 7% to 38% (Al-Shawa and Mwafy, 2007; Hassan *et al*., 2012; Ali and Ameen, 2013). A study in Amman – Jordan by Al-Momani *et al*. (2006) detected *E. histolytica* in 20% of the positive parasite stool samples. Another study in Amman – Jordan by Chazal and Adi (2007) found that *E. histolytica* as the most prevalent parasite detected in stool samples, with an infection rate of 28%. In our study we detected the cysts of *E. histolytica* in 4% of salad vegetables and the highest prevalence was found in lettuce samples (10%). Our results indicate that, the high prevalence of *E. histolytica* in salad vegetables especially in lettuce may pose a risk to consumer's health, if unwashed prior to consumption. The presence of *E. histolytica* in salad vegetables indicates that salad vegetables are faecal contaminated.

Our results point out that, the most probable source of the parasite contamination found in salad vegetables sold at Amman and Baqa'a is from using faecal contaminated water in irrigating crops. It seems that the scarceness of fresh water in Jordan has pushed farmers to use faecal contaminated water in irrigating their crops. So, action is needed to direct farmers to use treated wastewater in irrigating trees or vegetable crops that is not intended to be eaten row, educating farmers on the risk of using faecal contaminated water for irrigation on the public health and perform a proper treatment of sewage water. In order to confirm the source of parasite contamination found in salad vegetable, further studies is needed to examine the salad vegetables cultivation area and to examine the water sources used in irrigation.

Our study showed that salad vegetables sold in Amman and Baqa'a are contaminated with parasites (helminthes eggs, *Giardia* and *E. histolytica* cysts) that may cause health risk to consumers. So, programs in the essentiality of washing raw vegetables prior to consumption and personal hygiene must be intensified.

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