Intestinal Parasites Infection in Vegetables: A Mini Review

Afzan Mat Yusof

Vocational School of Health Services, University of Karabük, Yenimahalle, Prof. Metin Sözen Cd., 78600 Safranbolu/Karabük, Turkey

Corresponding author: 1*

ABSTRACT—Intestinal parasites infections are the major disease that infecting human through food contamination. Consumption of raw vegetables become an important pathway for the parasitic infection towards the human host. Hence, the aim of this mini review is to reveal the past and present on the parasitic infections in vegetables which has been underestimated. In general, the implementation of Good Agricultural Practices (GAPs) by practicing good documentation and practices in agriculture, providing good facilities and amenities such as clean storage house and clean water supply will reduce the contamination of parasitic infections. Besides, we suggested that the importance to create new regulation to control the uses of fertilizer originated from untreated human and animal waste should be eliminated in order to reduce the contamination of parasitic infections in vegetables.

KEYWORDS: intestinal parasites infections, food contamination, vegetables, human, mini review

1. INTRODUCTION
Vegetables are important food components as a part of a human healthy diet. It provides nutrients, fibres, mineral, and vitamin to the human body system. Vegetables can be obtained easily at a reasonable price in comparison to poultry and meat. Certain vegetables are consumed raw in order to conserve the nutrient contents. Traditionally, most of the people consume raw vegetables as their food without knowing the contamination that might be transmitted especially from parasitic infections. It has been estimated that 60% of the world population are infected with intestinal parasites either pathogenic or non-pathogenic. These parasites can be transmitted through direct contact, indirect contact, food and water sources to human host. In developed and developing countries, consumption of raw vegetables is one of the important routes for the internal parasitic infections (Slifko et al., 2000). Hence, the mini review aimed to highlight the occurrence, the prevalence and the sources of contamination of intestinal parasites in raw vegetables.

2. Methodology
This mini review was done by reviewing several relevant articles on the prevalence of intestinal parasitic contaminants in vegetables. The research articles for this mini review was carried out by using the Scopus database. The keywords used were “parasite contamination” AND “vegetables”.

3. Results and Discussion

3.1 Prevalence of Parasitic Contaminants in Raw Vegetables
Raw vegetables can harbor various types of parasitic contaminants such as ova, larvae, cysts, and oocyst from vast species of parasites. A study was conducted in Burdur, Turkey, to determine the prevalence of intestinal helminths in raw vegetables able to detect the presence of helminth eggs on raw vegetables, including lettuce, parsley, green onions, cucumbers, carrots, cress, peppermint, spinach, leek, dill, and
rocket. 7 out of 111 raw vegetable samples were positive for helminths eggs on raw vegetables such as lettuce, parsley, carrots, cress, peppermint, spinach, and rocket salad. No helminth eggs were detected in leek, cucumbers, dill, and green onions (Adanir et al., 2012). According to the authors, helminths eggs detected was Ascaris lumbricoides because swine rarely consumed in the study area. Based on the result, there was no significant association between the sort of vegetables survey and parasite species. In this study, the author also claimed that polluted water and night soil was used for cultivation of vegetables contributing to the detection of the parasitic contaminant in the vegetable samples. A study was conducted in Saudi Arabia found that high intensity of Entamoeba histolytica, Giardia lamblia and Entamoeba coli were detected in the study samples (Abdalla et al., 2013). Authors stated that high level of parasitic contamination was found in watercress and green onion. The study also includes socio-demographic data such as gender, age group, and race but the authors only manage to detect a high incidence rate of intestinal parasite disease in the community. Based on statistical analysis, there was no significant difference between the incidence rate and socio-demographic characteristic. They also found that high risk of intestinal infection disease in the community in the study area because of the raw consumption of vegetables. In Khorramabad, Iran, 52.7% of samples out of a total 550 fresh vegetable samples were positive for intestinal parasites (Ezatpour et al., 2013). In the study, they able to detect protozoan cyst, oocysts, helminth eggs as well as larva from fresh vegetable samples. According to the author, the highest contaminated vegetable sample was leek and the least contaminated samples were green onion in spring and garden cress during winter. They able to detect the presence of five pathogenic and four non-pathogenic parasites from the vegetable samples. According to the author, presences of Entamoeba coli indicated that there was fecal contamination in the vegetables. Sewage and contaminated water were used for irrigation purpose for the vegetables. They also found that the rate of parasitic contamination significantly higher in spring than winter because of higher temperature more suitable for the parasite.

The rate of parasite contamination is much higher in unwashed vegetables than in pre-washed ones. Study in Shahrekod, Iran shows that unwashed vegetables such as cucumber, tomato, lettuce, cabbage, pepper, carrot, mushroom and onion contained parasites such as Ascaris lumbricoides, Cryptosporidium spp., Enterobius vermicularis, Taenid spp., Strongyloides spp., Toxocara spp. and Entamoeba coli (Fallah et al., 2016). In addition, parasites such as A. lumbricoides, Cryptosporidium spp. and E. vermicularis were detected in pre-washed vegetable samples. According to the authors, the rate of contamination in unwashed vegetables obtained during the summer was significantly higher than those obtained during the other seasons. The rate of parasitic contaminants was higher due to the use of animal fertilizers, night soil and sewage water in vegetable cultivation. Entamoeba histolytica, Entamoeba dispar, Entamoeba coli, Giardia lamblia, A. lumbricoides, Strongyloides stercoralis, Trichuris trichiura and hookworm were detected in a study on parasitic contamination in fresh vegetables in Khartoum state, Sudan. 35 samples were positive for intestinal parasite out of 260 samples. The most prevalent parasites were Entamoeba histolytica and Entamoeba dispar while Ascaris lumbricoides and Trichuris trichiura were the least detected parasites (Mohamed et al., 2016). In Southern Ethiopia, 347 vegetable samples consist of cabbage, carrot, green pepper, salad and tomato were collected from local markets. Out of 347 vegetable samples, 87(25.1%) samples were contaminated with at least one type of parasites. Different species and stages of parasites were detected from vegetable samples including cysts of Entamoeba histolytica/dispar, cysts of Giardia lamblia, oocysts of Cryptosporidium, ova of Ascaris lumbricoides and hookworms, cysts of Balantidium coli, oocysts of Cyclospora species and larvae of Strongyloides like parasite. Among all vegetables collected, tomato (35.0%) was the most often contaminated vegetable while green pepper (10.6%) was the least contaminated with parasites. The types of vegetables and source of vegetables were significantly related with occurrence of parasitic contamination in vegetables (Alemu et al., 2019). Another study done on 17 leafy vegetable samples consisted of crisp lettuce
Lactuca sativa), arugula (Eruca sativa), chicory (Cichorium intybus and Cichorium endivia), chives (Allium fistulosum), purple lettuce, spinach (Spinacia oleracea) and chard (Beta vulgaris subsp. Vulgaris) were examined for parasitic contamination (Ferreira et al., 2018). Throughout molecular identification, Giardia intestinalis, Cryptosporidium spp. and Toxoplasma gondii was found in vegetable samples obtained from local markets in Brazil. Green leaf lettuce (L. sativa) cultivated by three cultivation methods; conventional system, organic system and hydroponic from São Paulo, Brazil were contaminated with at least one type of parasites (Santos et al., 2017). Green leaf lettuces grown in the hydroponic system were mostly contaminated with parasites than the organic system and conventional system. The authors discovered that inappropriate sanitary conditions of the irrigation water used in farming are the main factor of contamination of lettuce in this production system. A total of 133 samples of salad vegetables (30 lettuces, 33 tomatoes, 42 parsley and 28 cucumbers) were collected from supermarkets and street vendors in Amman and Baqa’a in Jordan (Ismail, 2016). It was found that 29% (39 out of 133) of the salad vegetable samples were contaminated with the presence of parasites (helminthes eggs, Giardia and E. histolytica cysts). The highest percentage of contamination was detected in lettuce samples (63%) followed by tomato (27%), parsley (24%) and the least percentage of contamination was detected in cucumber (13%). Ascaris spp. was found to be the most predominant parasite in salad vegetables sold at supermarkets and street vendors. Poor condition of agricultural areas with irrigation water contaminated with faeces was a major factor of parasitic contamination among vegetables.

In Malaysia, a study on lettuce samples were collected from the local market in Penang (Chapman, 1980). There was a high number counts of presumptive and fecal coliform in all lettuce samples. Of the 11 samples, five were detected with Salmonella and Shigella. The count of fecal coliform varied between 10^4 - 10^6 per gram. Lettuce is usually eaten raw and this has become potential to cause bacterial infections resulting in various forms of gastroenteritis. Other research on parasite contamination in vegetable and herbs was done in Kota Bharu, Kelantan by Zeehaida et al., (2011). The authors have reported Strongyloides stercoralis rhabdatiform larvae were detected in water samples used to wash pegaga, kesum and water spinach. As locals love to eat raw vegetables and herbs, community members may be exposed to transmission of larvae in their foods that are risk for intestinal parasitic infection. Meanwhile, another study done by Yusof et al., (2017) reported the occurrence of helminth and protozoan parasites in vegetables known as “pegaga” from the Kuantan wet market, Pahang. It is the most contaminated leafy vegetables in this study and Strongyloides is the most frequently isolated parasite. By implementing Good Agricultural Practices (GAP), the occurrence of parasitic contamination in vegetables can be minimised. The implementation of intervention methods should be empowered including improving sanitation in areas where vegetables are produced and processed and increasing the hygiene of vegetable vendors and the cleanliness of markets to control parasite transmission. In South Thailand, a study of parasite contamination in vegetables was conducted. Out of 265 fresh vegetable samples, celery was the most contaminated sample (63.3%) followed by peppermint (60.0%), gotu kola (57.1%), coriander (44.8%), leek (43.3%), cilantro (36.7%), Chinese cabbage (23.3%), lettuce (20%), Thai basil (20%) and Chinese morning glory (6.7%) (Punsawad et al., 2019). Among the parasites detected in vegetable samples were hookworms, Strongyloides stercoralis, Trichuris trichiura, Ascaris lumbricoides and Blastocystis spp. Celery was the most contaminated vegetable samples with hookworm, Strongyloides larvae and eggs of Ascaris lumbricoides could be due to celery is made up of several stalks attached to the base with leaves on the top of the stalks. The U-shaped stalk structure in the slit pattern allows parasites to attach more easily to the surface of celery and make them more difficult to remove. Typically, celery samples obtained from the markets are often sold with roots and stalks that can increase the chances of soil contamination from roots to stalks. On the other hand, the Chinese morning glory is reported to be less contaminated with parasites because the smooth surface of the
stalks reduces the probability of parasite attachment.

3.2 Sources of Parasitic Contamination in Vegetables
The main source of parasitic contamination in vegetables comes from the source of water for irrigation. During dry season farmer normally faced scarcity of water for irrigation. This caused the farmer to use any available water including wastewater and sewage-contaminated water for vegetable irrigation (Ismail, 2016). Warm-season such as spring provides high and suitable temperature for parasites development. High humidity environment also provides a favorable condition for free-living parasite helminths to grow and reproduce (Ezatpour et al., 2013). Vegetable samples from hydroponic systems had a high level of contamination by intestinal parasites due to submerging parts of plant underwater that allows parasite attachment to the vegetables (Santos et al., 2017). Besides, polluted soil, contaminated water during cultivation, poor hygienic practices during transport and sale of vegetable may increase parasitic contamination in vegetables. Besides, broad uneven surface of leaf provides a suitable surface for attachment of parasite eggs and larvae to the vegetables. Another source of intestinal parasites infection is from night soil (Fallah et al, 2016). It was originated from human waste and used by the farmer as low-cost fertilizer for growing vegetables. In addition, post washing handling technique and unsanitary practice also contribute to transmitting parasitic contaminants from the environment into the human trough raw vegetable consumption (Fallah et al., 2016). Parasite contamination in food especially vegetables is also caused by domestic animals such as dogs and cats that have defecated onto cultivation area and caused contamination of the cultivated vegetables (Punsawad et al., 2019). In addition, vegetable samples sold by farmers were more contaminated with parasites compared to vegetables supplied by large scale vendors. Large scale vendors are more systematic in distributing vegetable started from received vegetables they from farm land, packed carefully, transported, store it properly and distribute to small scale vendors to sell. On the other hand, small scale vendors who receive vegetables directly from farmers transport it either via back of animals or human labor; vegetables are readily exposed to contamination in this case (Alemu et al., 2019).

3.3 Suggestion on Vegetables Handling
The good hygienic practice must be applied to reduce the risk of getting an intestinal parasitic infection. The vegetables must be washed thoroughly by using plenty of chlorinated water. To reduce the parasitic load in the vegetables, the vegetables can be washed and clean using disinfectant. The common ingredient such as saltwater and acetic acid also known as vinegar also can be used as disinfectant. Certain law should be enforced by local environmental authorities in prohibiting the uses of night soil, sewage, untreated animal manure and wastewater for irrigation and fertilizer for the vegetables (Adanir et al., 2012). Local authorities are also responsible to ensure market places are always in good hygienic condition. Besides, the local authorities also need to give enough education and continuous inspection towards farmers and retailers to prevent contamination of vegetables sold at local markets (Alemu et al., 2019). Implementation of good agriculture practices also can reduce the contamination of parasites and also improving water treatment efficacy. The benefits for water treatment is the water used for irrigation will be cleaner and hygiene (Yusof et al., 2017). Self-awareness is required to reduce parasite contamination in vegetables by educating consumers on proper vegetable washing before consume. Preventive methods such as wearing gloves and washing hands after handling vegetables should also be practiced by sellers who are at risk of acquiring soil-transmitted helminths infections through skin penetration (Punsawad et al., 2019).

4. Conclusion
The risk of intestinal parasitic infection caused by consumption of raw vegetables can be reduced by applying good agriculture and vegetables processing technique. Vegetables can be consumed raw but the
cleaning process should be done properly to minimise the risk of getting intestinal parasite infection. These finding might give important information on the prevalence of parasitic contaminants in fresh vegetables, where the parasitic contaminants were originated and how it being transmitted into human. This information will create awareness for public observe their hygiene and encourage local authorities to create new regulation to control the uses of fertilizer originated from untreated human and animal waste.

5. Acknowledgement
The author would like to express their gratitude and appreciation to University of Karabuk.

6. References


<table>
<thead>
<tr>
<th>Area of study</th>
<th>Type of parasites found</th>
<th>Vegetables</th>
<th>Year, Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kota Bharu, Kelantan, Malaysia</td>
<td>Strongyloides stercoralis rhabdatiform larvae</td>
<td>Pegaga (Centella asiatica), kesum (Vietnamese mint) and water spinach</td>
<td>(Zeehaida et al., 2011)</td>
</tr>
<tr>
<td>Burdur, Turkey</td>
<td>Taenia spp., Toxocara spp., Ascaris lumbricoides, Enterobius vermicularis</td>
<td>Lettuce, parsley, carrots, cress, peppermin, spinach and rocket</td>
<td>(Adanir et al., 2012)</td>
</tr>
<tr>
<td>El. Khorma Province, Saudi Arabia.</td>
<td>Entamoeba histolytica, Giardia lamblia, Taenia saginata, Entamoeba coli, Enterobius vermicularis, Schistosoma mansoni, Ascaris lumbricoides and hookworm</td>
<td>Watercress, green onion, cabbage, lettuce and mint</td>
<td>(Abdalla et al., 2013)</td>
</tr>
<tr>
<td>Khorrambad, Iran</td>
<td>Giardia lamblia, Ascaris lumbricoides eggs, Enterobius vermicularis eggs, Strongyloides stercoralis eggs, Fasciola hepatica eggs, Entamoeba coli cyst, Iodamoeba butschlii cyst and Endolimax nana cyst</td>
<td>Leek, green onion, radish, garden cress and mint</td>
<td>(Ezatpour et al., 2013)</td>
</tr>
<tr>
<td>Amman and Baqa’a</td>
<td>Ascaris spp. eggs, Toxocara spp. eggs, Giardia spp. cyst, Taenia/Echinococcus eggs, Fasciola hepatica eggs and E. histolytica cyst</td>
<td>Lettuce, tomato, parsley and cucumber</td>
<td>(Ismail, 2015)</td>
</tr>
<tr>
<td>Shahrekord, Iran</td>
<td>Ascaris lumbricoides, Cryptosporidium spp., Enterobius vermicularis, Taentid spp., Strongyloides spp., Toxocara spp. and Entamoeba coli</td>
<td>Cucumber, tomato, lettuce, cabbage, pepper, carrot, mushroom and onion</td>
<td>(Fallah et al., 2015)</td>
</tr>
<tr>
<td>Location</td>
<td>Organisms Found</td>
<td>Host Plants</td>
<td>Source</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>----------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Khartoum State, Sudan</td>
<td>Entamoeba histolytica/dispar, Entamoeba coli, Fasciola spp., Giardia lamblia, Strongyloides stercoralis, hookworm, Trichuris trichiura, Ascaris lumbricoides</td>
<td>Lettuce and watercress</td>
<td>(Mohamed et al., 2016)</td>
</tr>
<tr>
<td>Pahang, Malaysia.</td>
<td>Entamoeba spp. cysts, Blastocystis spp. cysts, Strongyloides larvae, Diphyllobothrium egg, unidentified fluke</td>
<td>Centella asiatica (pennywort or pegaga), Persicaria odorata (Vietnamese coriander or daun kesum)</td>
<td>(Yusof et al., 2017)</td>
</tr>
<tr>
<td>Sao Paulo, Brazil</td>
<td>Entamoeba spp. cyst, Trichostrongylid spp. eggs and larvae, Strongyloides spp. eggs</td>
<td>Green leaf lettuce (Lactuca sativa)</td>
<td>(Santos et al., 2017)</td>
</tr>
<tr>
<td>Brazil</td>
<td>Toxoplasma gondii, Cryptosporidium spp. and Giardia intestinalis</td>
<td>Crisp lettuce (Lactuca sativa), arugula (Eruca sativa), chichory (Cichorium intybus and Cichorium endivia), chives (Allium fistulosum), purple lettuce, spinach (Spinachia oleracea) and chard (Beta vulgaris subs. Vulgaris)</td>
<td>(Ferreira et al., 2018)</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>Ova of Ascaris lumbricoides, hookworms, cysts of Giardia lamblia, Entamoeba histolytica/dispar, Balantidium coli, oocyst of Cryptosporidium</td>
<td>Tomato (Lycopersicon esculentum), cabbage (Brassica oleracea), green pepper (Capsicum annuum), carrot (Daucus carota) and salad (Lactuca sativa)</td>
<td>(Alemu et al., 2019)</td>
</tr>
<tr>
<td>Nakhon Si Thammarat province, Southern Thailand</td>
<td>Hookworms, Strongyloides stercoralis, Trichuris trichiura, Ascaris lumbricoides and Toxocara spp.</td>
<td>Celery (Apium graveolens), Peppermint (Mentha x piperita), lettuce (Lactuca sativa), coriander (Coriandrum sativum), leek (Allium porrum), gotu kola (Centella asiatica), Chinese cabbage (Brassica rapa subsp. pekinensis), culantro (Eryngium foetidum), Thai basil (Ocimum basilicum) and Chinese morning glory (Ipomoea aquatica)</td>
<td>(Punsawad et al., 2019)</td>
</tr>
</tbody>
</table>

This work is licensed under a Creative Commons Attribution Non-Commercial 4.0 International License.