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Original paper

Prevalence of intestinal parasites in raw vegetables consumed in Soran city, Kurdistan Region, Iraq

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ABSTRACT. Intestinal parasitic infections are one of the most important health problems. Although fresh vegetables are considered as a vital element of a healthy diet, they are a potential source of human intestinal parasitic infections during production, collection, transportation, preparation and consumption. The present study was carried out to determine and detecting the parasitological contaminations of fresh vegetables sold at different open-aired markets in Soran city, Iraq. A total of 225 raw vegetable samples were examined by sedimentation technique after washing the samples with normal saline. Of the 225 samples, 109 (48.4%) were microscopically positive for intestinal parasites. Particularly, a high rate of contamination was recorded in cress (*Lepidium sativum*) with 71.1%. However, the least contaminated sample was lettuce (*Lactuca sativa*) with 26.6%. The most encountered parasite was *Taenia* spp. egg (24%), whereas hookworms (4%) were the least detected ones and 34.6% of the samples harbored poly-parasitic contamination. Since, the results emphasize the fresh vegetables are potential sources of transmission for intestinal parasites in central markets of Soran city, strict hygienic measures should always be adopted to avoid parasitic contamination. Untreated sewage and the manure used by greengrocer as fertilizer can be implicated in vegetable contamination.

Keywords: intestinal parasites, vegetables, contamination

Introduction

Fresh vegetables are indispensable to human diet due to several health benefits. A vegetarian diet is a great source of vitamins, fibers, and minerals which usually reduces the risk of stroke, cardiovascular diseases, and potentially protects human body against certain types of cancers [1]. Despite their benefits, foods and specifically vegetables are a potential source of infective agents such as bacteria, viruses, and parasites during production, processing, and consumption [2]. It has been claimed that around 300 million severe helminthic infections are diagnosed only in developing countries leading to approximately 200,000 deaths [3]. In addition to humans, gastrointestinal infections cause several problems in the livestock industry and incur considerable economic losses [4].

Belonging to phylum nematode, geohelminths (also known as soil-transmitted helminths) are intestinal parasitic worms of humans and animals which affect more than 2 billion people worldwide [5]. The majority of geohelminths live in the digestive system (gastrointestinal tract) of humans but the eggs laid by adult worms are excreted outside the body via the stool. There are some differences in the infection and migration pathways of geohelminths inside their host, but generally the eggs contaminate the soil, vegetables, water and then are transmitted to humans [6]. In many parts of the world, especially in undeveloped countries, sewage sludge and wastewater are frequently utilized to irrigate agricultural land which results in the transmission of pathogenic organisms particularly intestinal microorganisms from the soil to crops, grazing animals, and humans [7,8]

Several studies have shown that the vegetables, especially those are eaten raw and without peeling, can act as a tool for the transmission of protozoa cysts, oocysts (*Giardia*, *Entamoeba*, *Toxoplasma* and *Isospora*), helminth eggs and larvae (*Hymenolepis*, *Taenia*, *Fasciola*, *Trichuris*, *Trichostrongylus*, *Strongyloides* and hookworms) to new hosts [7,9,10]. The individuals involved in the production and processing steps of vegetables for sale including pickers, handlers, packers, can potentially be contaminated with the intestinal parasites [11]. In developing countries, due to lack of high-tech system for diagnosis of foodborne pathogens, and proper supervision, usually outbreaks caused by contaminated vegetables cannot be detected and the incidence of foodborne pathogens is underestimated. Moreover, a high prevalence of intestinal parasites has been reported in communities which consume raw vegetables suggesting that the consumption of raw vegetable is an important route of the transmission [12]. Eating raw vegetables, especially native vegetables and salads is a common custom among Kurdish societies. Accordingly, the risk of intestinal parasitic infections would be increased when they are insufficiently washed. To our knowledge, limited studies have investigated the contamination of fresh vegetables eaten in Kurdistan and referring to existing scientific literature, no previous survey has evaluated the rate of parasitic contamination in vegetables from Soran. Therefore, this study was undertaken to assess the prevalence of intestinal parasites in vegetables consumed in Soran city.

Materials and Methods

Study area

Five types of common fresh vegetables were collected from markets in the center and suburbs of Soran, a district in Erbil province in the Kurdistan region of Iraq. It is about 110 km northeast of Erbil, bordering with Iran and Turkey (44°32’16.1052’’E). The capital of the district is Soran city (elevation: 680 m), which is also called Diana (population: 125,000) and has a Mediterranean climate with hot, dry summers, and cool to cold, damp, humid winters.

Sample collection

A total of 225 fresh vegetable samples, including leek (*Allium porrum*), garden cress (*Lepidium sativum*), garden radish (*Raphanus sativus*), celery (*Apium graveolens*), and lettuce (*Lactuca sativa*) were randomly collected. Forty-five samples of each type of vegetables were analyzed (45×5=225). Approximately 200–250 grams of each vegetable was placed in a separate nylon bag and labeled with a specific number and date of collection, then transported immediately to the Laboratory of Biology at Faculty of Sciences, Soran University, for parasitic examination.

Detection of parasites

Each sample was washed with one liter of physiological saline solution. After filtration through sterile gauze, the solution was left overnight. The top layer of the washing solution was discarded and about 15 ml of the remaining solution centrifuged at 3000 RPM for 5 minutes. After centrifugation, the supernatant layer was carefully decanted and the sediment was collected and examined directly by an optical microscope at 100× and 400× magnifications. For each tube, three slides (one direct and two iodine smears) were prepared to increase the chance of parasite detection [13].

Statistical analysis

Data analysis was done using SPSS software (version 22). The analysis of variance ANOVA and Chi-square test were used to compare the rate of parasitic contamination among different types of vegetables and calculate the association between the species of parasite and type of vegetable. A P-value of less than 0.05 was considered statistically significant.

Results

Of the 225 samples, different helminth eggs and protozoan cysts were detected in the 109 (48.4%) samples. Significant differences were noticed among the various types of vegetables ($P<0.05$). As indicated in Table 1, cress and lettuce had the highest and lowest contamination rates 71.1% and 26.6%, respectively. As can be seen from Table 2, the vegetables were infected with different species of nematodes (37.2%), cestodes (32%) and protozoa (21.2%). Furthermore, eggs of *Taenia* and *Ascaris*, as well as *Giardia* cyst were found in all types of the vegetables. The highest contamination (24%) belonged to *Taenia* spp., followed by *Ascaris* spp. (12%), and hookworm was the least infective agent (4%). As illustrated in Table 3, poly-parasitic contamination (co-occurrence) was observed in 74 (32.8%) samples. To be specific, 54 (24%) samples

Table 1. Contamination rate of intestinal parasites in vegetables according to their types in Soran city

Vegetables	No. examined	No. contaminated	Contamination (%)
Cress	45	32	71.11
Celery	45	27	60
Leek	45	23	51.11
Garden radish	45	15	33.30
Lettuce	45	12	26.60
Total	225	109	48.44

Table 2. Prevalence of intestinal parasites in fresh vegetables in Soran city

		Type of vegetables					Total (%)
		Cress	Celery	Leek	Garden radish	Lettuce	
Cestoda	*Taenia* spp.	18	12	15	6	3	54 (24%)
	Hymenolepis spp.	6	6	3	3	–	18 (8%)
Protozoa	*Entamoeba* spp.	6	3	12	3	–	24 (10.6%)
	Giardia lamblia	9	3	6	3	3	24 (10.6%)
Nematoda	*Ascaris* spp.	12	6	3	3	3	27 (12%)
	Larvae of nematodes	6	3	6	–	3	18 (8%)
	Trichuris trichiura	6	3	3	3	–	15 (6.6%)
	Hookworm	3	3	–	–	3	9 (4%)
	Toxocara spp.	3	6	–	3	3	15 (6.6%)

were contaminated with two species of parasites, while 18 (8%) samples had three species of parasites and quadruple parasitic contamination were observed only in two samples (0.8%). *Taenia* eggs were observed in the majority of poly-parasitic contaminations and cress had the highest multiple contamination rate (24 of 32 positive samples).

Discussion

In the present study, five types of vegetables that are commonly consumed in Soran were examined and, 9 types of parasites were detected. According to several reports, high incidences of intestinal parasitic infections have occurred in societies that consume raw vegetables, especially in circumstances that unrefined sewage or human and animal fertilizers are used for cultivation of vegetables [14]. This study showed a considerably high level of contamination with intestinal parasites (48.4%). Some studies in other parts of the world show the lower rate of contamination such as 31.7% in Egypt [15], 32.6% in Iran (Ardabil) [16], 16.4% in Saudi Arabia [17]. However, other researchers have recorded higher levels of contamination compared to our study, for example, 71% in Iran (Shahrekord) [18], 58% in Libya [19] and 75.9% in Kenya [20]. The observed discrepancies can be attributed to variations in geographical location, the size and type of sampling, parasitic infection rate of hosts in each area, techniques employed for sampling and even the agricultural methods in different regions. Different laboratory procedures may also play a role in retrieving different parasites since some procedures can either float or sediment the parasites.

Cress had the highest contamination rate (71.11%), followed by celery (60%), leek (51.11%),

Table 3. Poly-parasitic contamination in examined vegetables in Soran city

	Type of vegetables					
	Lettuce	Garden radish	Leek	Celery	Cress	Total (%)
Double	6	9	11	16	12	54 (24%)
Triple	0	0	6	1	11	18 (8%)
Quadruple	0	0	1	0	1	2 (0.8%)
Total (%)	6 (2.6%)	9 (4%)	18 (8%)	17 (7.5%)	24 (10.7%)	74 (32.8%)

garden radish (33.3%), and lettuce (26.6%). The high level of contamination in these samples is probably due to the utilization of high amounts of animal manures. It should be mentioned that in the majority of the examined samples, animal manure adhered to vegetables was observed. Our result showed that *Giardia lamblia* cysts were detected in 10.6% of the total samples which is higher than that of reported from Egypt, (6.7%) and lower than that of reported from Saudi Arabia (31.6%) [13].

In this study, the eggs of *Ascaris* spp. were detected in 12% of the samples. In Iran, the contamination of vegetables with this parasite has been reported to be 2% [16]. *Toxocara* spp. eggs were also detected in 6.6% of the samples. Considering that domestic (dogs and cats) and wild animals are the source of *Toxocara* spp. eggs, the presence of eggs indicate that these animals were traveling on land under the cultivation of vegetables in this area. In this study, free-living larvae were detected in 8% of vegetable samples. In this regard, a lower level of free-living larvae (7%) was reported in native vegetables from Tabriz, Iran [21], but its prevalence was 40% in Khorramabad, Iran [13]. It was noticed that the contamination rates with *Taenia* spp., *Entamoeba* spp. and *Ascaris* spp. were significantly different between the investigated samples ($p<0.05$). Although published information on possible infections of animals and humans with these parasites is extremely insufficient in Soran city, the high rate of vegetable contamination, can probably be related to the high infection rate of hosts, especially livestock in this area.

Our experiments clearly showed that fresh vegetables can act as a potential source of infection with intestinal parasites in Soran, Kurdistan. Therefore, strict hygienic measures should urgently be adopted to reduce fruit- and vegetable-borne parasitic infections. More importantly, untreated sewage as fertilizer for cultivation of vegetables should be avoided. Furthermore, preventing animals from entering into the vegetable farms, washing, cleaning and disinfecting the vegetables especially before raw consumption, education, sanitation and treatment of infected peoples in Soran can significantly decline the rate of contamination. Finally, further examination of livestock, soil, water and other types of vegetables especially local, garden or farm vegetables using sensitive and accurate methods in order to find the main source of contamination and rupturing the parasitic infection cycles are strongly recommended.

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