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Parasitic Contamination of Raw Vegetables in Iran: A Systematic Review and Meta-Analysis

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Green leafy vegetables make up a large portion of the vitamins and minerals for human body. This study aims to estimate the prevalence of contamination of vegetables to different parasite stages in Iran by conducting a systematic review and meta-analysis. Multiple keywords such as vegetables, parasitic contamination, intestinal parasites and Iran used to search in SID, Magiran, Pubmed, Iranmedex, Irandoc and ISI databases. A total of 43 articles found, of which, eight articles did not have enough information and full text of 14 articles was not available. Finally, 21 studies entered in meta-analysis process. Variance of each study obtained using binomial distribution. Heterogeneity between studies checked using Cochran's Q Test. Random Effects Model was used to pool the prevalence of parasitic contamination and intestinal parasites in the studies. Among 4359 samples the overall prevalence was estimated results of 37% for parasitic contamination of vegetables in Iran. Vegetables: Scallion, Leek, Basil, Radish, Tarragon, Parsley, Lettuce, Coriander, Spearmint and Garden crest have been studied and parasites: Eggs of *Toxocara* sp. (75%), *Dicrocoelium dendriticum* (39%), *Hymenolepis nana* (39%), *Hymenolepis diminuta* (15%), *Fasciola* sp. (44%), *Taenia* spp. (26%), *Trichocephal* (50%), *Trichostrongylus* (25%), *Ascaris* (28%) and cyst of *Entamoeba coli* (47%), *Entamoeba histolytica* (25%), *chilomastix mesnili* (22%) and *Giardia lamblia* (43%) isolated from vegetables. Highest intensity of contamination (46%) was related to scallion. It may be concluded, despite the relative improvement of sanitary, economic, social and agricultural conditions, the parasites are common in vegetables that are frequently eaten. It is necessary to improve the public health and training methods for washing vegetables.

Key words: Vegetables, parasitic contamination, medical parasitology, Iran

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INTRODUCTION

Green vegetables are very useful plants in providing minerals, vitamins and fiber and are essential for human body and can prevent various infectious diseases. On the other hand, many pathogenic parasites spend a part of their life cycle on soil, vegetables and plants, so vegetables consumption can lead to people infection and spreading intestinal parasitic diseases (Avcioglu *et al*., 2011; Adamu *et al*., 2012; Said, 2012). In recent years, there has been an increase in the number of reported cases of food borne diseases linked to consuming fresh vegetables. The consumption of fresh or undercooked vegetables plays a main epidemiological role in the transmission of parasitic food-borne diseases. Parasitic disease, often are major health problems and are barriers to economic and social development in developing countries and fighting them have always been an important part of national planning in the world. Several studies showed that the vegetables can be agent for transmission of protozoan cysts and oocyst (*Entamoeba*, *cryptosporidium*, *Isospora*, *Toxoplasma*, *Cyclospora*) and helminthes eggs and larvae (*Toxocara*, *Ascaris*, *Hymenolepis*, *Trichocephal*) in different parts of the world. Therefore the parasitic diseases are still a major health problem in the world (Dawson, 2005; Klapec and Borecka, 2012). Based on reports, more than 40 million people are infected with parasitic infections worldwide and 10% of the world's population are at risk of infection to parasitic diseases (Marietta, 1992). The World Health Organization (WHO) announced that about 110 thousand people have died due to the amoebiasis from 1975-1981 (Zia Ali and Massoud, 1996). According to WHO statistics, 700 million people (26% of the world population) have been infected with *Ascaris lumbricoides* in 1975 (Zia Ali and Massoud, 1996). Pathogenic and non-pathogenic parasitic contamination of vegetables has been reported from 1.94-68.3% from different studies in different province of Iran (Gharavi *et al*., 2002). Outside Iran, also, the different percentages of vegetables parasitic contamination have been reported. For example, 56.25% of the consumed vegetables reported contaminated with protozoan cysts, eggs and larvae of nematode and egg of cestode worms in JOS, Nigeria (Damen *et al*., 2007). Combating diseases transmissible by water, food and vegetables, require familiarity with biotechnology and ecology of microorganisms and public awareness that how worms and parasites are transmitted to humans. To consider the health and economic aspects and losses due to the presence of parasites and worms in food and vegetables, the best method of prevention is recommended by researchers. However, in Iran, there is no exact collected information about parasitic contamination of vegetables, therefore, in order to identify the exact parasitic contamination of vegetables it was felt necessary that this investigation should be done.

MATERIALS AND METHODS

In this study, meta-analysis methods have been used in order to conduct the research. The statistical population of this study was all researches, thesis and published scientific research articles, concerning the parasitic contamination of raw vegetables in Iran which had been conducted during a twenty year period (1990-2010).

Multiple keywords related to the topic, such as vegetables, parasitic infections, intestinal parasites and Iran used in databases such as SID, Magiran, Pubmed, Iranmedex, Irandoc, ISI web of sciences and Google scholar for search. A total of 43 articles were found, of which, eight articles did not have enough information and full text of 14 articles was not available. Finally 21 studies entered a meta-analysis.

All of the 21 studies mentioned in this research had good sample sizes and were favorable in terms of the reliability and stability of their measuring instruments and sampling methods. Data were extracted from articles and archived in excel software for analysis. Variance of each study obtained using binomial distribution. Heterogeneity of studies surveyed using Cochran's Q Test. Statistical analysis was performed with Stata software Version 11.2 and random effects models was used for analysis.

RESULTS

Parasitic contamination of vegetables in different cities of Iran is shown in Table 1. The overall prevalence of 37% [(confidence interval 95% (CI 95%): 28-43] was obtained among 21 articles and 4359 investigated vegetables samples. Ten kinds of vegetables including scallion, Leek, Basil, Radish, Tarragon, Parsley, Lettuce, Coriander, Spearmint and Garden crest have been studied and 13 species of parasites including eggs of *Toxocara* spp. 75% (95% CI), *Dicrocoelium dendriticum* (39% (95% CI), *Hymenolepis nana* (39% (95% CI), *Hymenolepis diminuta* (15% (95% CI), *Fasciola* spp. (44% (95% CI), *Taenia* spp. (26% (95% CI), *Trichocephal* (50% (95% CI), *Trichostrongylus* (25% (95% CI), *Ascaris lumbricoides* (28% (95% CI) and cyst of *Entamoeba coli* (47% (95% CI), *Entamoeba histolytica* (25% (95% CI), *Chilomastix mesnili* (22% (95% CI) and *Giardia lamblia* (43% (95% CI), have been isolated from

Table 1: Articles used to estimate the parasitic contamination of vegetables in Iran

City	Sample size	Prevalence (%)	95% CI	References
Tehran	270	41	0.41 (0.35, 0.47)	Homauni and Khalji (2004)
Tehran	263	65	0.65 (0.59, 0.71)	Gharavi *et al.* (2002)
Esfahan	480	14	0.14 (0.11, 0.17)	Izadi *et al.* (2006)
Pakdasht	403	2	0.02 (0.01, 0.04)	Beliani and Saeedi-Asl (2009)
Ghazvin	150	36	0.36 (0.28, 0.43)	Shahnazi and Jafari-Sabet (2010)
Kerman	135	30	0.30 (0.22, 0.37)	Malakutian *et al.* (2009)
Kerman	315	12	0.12 (0.08, 0.16)	Moulazadeh *et al.* (2007)
Jiroft	160	21	0.21 (0.15, 0.27)	Zohour and Molazadeh (2001)
Ardebil	141	77	0.77 (0.64, 0.79)	Daryani and Ettehad (2005)
Sabzevar	345	54	0.54 (0.48, 0.59)	Bahadory *et al.* (2008)
Shahrud	92	38	0.38 (0.28, 0.48)	Nazemi *et al.* (2011)
Tabriz	100	58	0.58 (0.48, 0.68)	Garedaghi *et al.* (2011)
Zabol	64	76	0.76 (0.66, 0.87)	Soleimanpoor *et al.* (2011)
Ahvaz	40	37	0.37 (0.22, 0.52)	Rahdar *et al.* (2011)
Ahvaz	411	24	0.24 (0.19, 0.28)	Akhlaghi (2001)
Bushehr	136	13	0.13 (0.07, 0.18)	Sahebani *et al.* (2001)
Arak	150	66	0.66 (0.58, 0.74)	Davami (2000)
Shiraz	101	38	0.38 (0.29, 0.47)	Vosughi *et al.* (1998)
Yazd	234	39	0.39 (0.33, 0.47)	Etminanrad and Mazhab (2003)
Yasuj	102	30	0.30 (0.21, 0.39)	Sarkari (1996)
Hamedan	267	27	0.27 (0.22, 0.32)	Seyedtabaii and Sajadi (1993)
Iran	4359	37	0.37 (0.28-0.47)	Overall

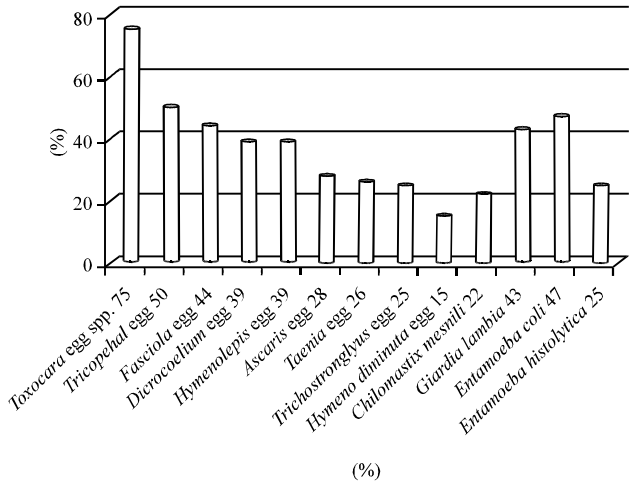

Fig. 1: Distribution of parasites detected in the examined vegetables in Iran

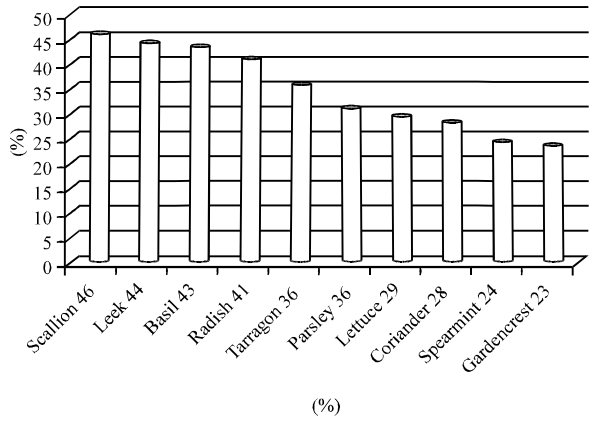

Fig. 2: Intensity of parasitic contamination in different vegetables in Iran

investigated vegetables in Iran by researchers (Fig. 1). The highest and lowest rate of vegetables contamination of 76 and 2% has been reported in Zabol and Pakdasht cities, respectively.

Toxocara sp. egg with 75% of prevalence was the most common parasite. Among vegetables, intensity of contamination is obtained from scallion with 46%. Among isolated parasites, *Chilomastix mesnili* and *Entamoeba coli* are non pathogen and all others (11 species) are pathogen for humans. The prevalence of parasites with 95% CI is given in Fig. 1. Contamination intensity of vegetables is given in Fig. 2. This analysis showed that there was no significant association between year and contamination intensity of vegetables ($p>0.05$) (Fig. 3).

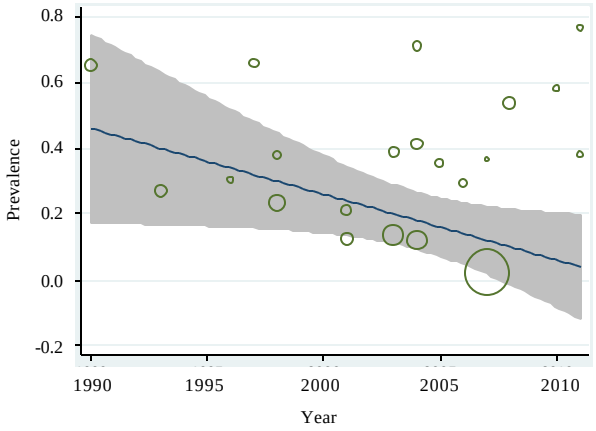

Fig. 3: Trend of prevalence parasites on vegetables with 95% CI from 1990-2010 in Iran using meta-regression

DISCUSSION

Fortunately, valuable information was found in this present study. The present study has shown that investigation of 10 vegetables used routinely for human consumption in Iran resulted in several parasitic stages carried by these plants. These parasites are considered as pathogenic agents for human and the consumption or manipulation of such contaminated agricultural crops is considered unsafe and might lead a risk for farmers and the whole population.

Based on this present study, parasitic contamination of vegetables is very high in Iran and consumption of raw or undercooked vegetables facilitates transmission of large numbers of zoonotic infections, so, it is a serious threat to health of Iranian people. Isolated pathogenic parasites can produce a wide range of symptoms and even death. Source of vegetables contamination is not clear, but it is clear that many of these parasites are common between humans and animals and have a human or animal origin. But, the parasites that their final hosts are humans just have a human origin. So, survey of parasitic infections in human and animal feces could be a reflection of vegetables contamination.

Researchers have been performed several studies on bacterial, fungal and parasitic contamination of consumed vegetables in Iran and they obtained different results. But, interesting thing is that the vegetables without contamination have not been reported in all studies. Generally, with regard to health status, type of livestock and agricultural conditions of people, rate of parasitic contamination of vegetables is different throughout the world. For example, a study conducted in Saudi Arabia demonstrated that eggs of *Encylostoma* and *Ascaris* together with cysts of *Entamoeba coli* and *Blastosystis hominis* are the most common parasite stages found in the five leafy vegetable plants investigated (Robertson and Gjerde, 2001) while in Kenya intestinal parasites found on the vegetables included *Entamoeba histolytica*, *Giardia lamblia* and *Trichuris trichura* (Nyarango *et al*., 2008). Overall parasitic contamination of consumed vegetables (35) has been reported considerable in Turkey and Norway (Robertson and Gjerde, 2000). This rate has been reported in Nigeria 36% that is slightly lower than result of this study (37%) (Damen *et al*., 2007). Two percent of investigated vegetables were positive for *Giardia lamblia* in Norway (Robertson and Gjerde, 2001). Mong and Arias in a study on vegetables in Costa Rica showed that 5% of them were contaminated with giardia lamblia cysts (1996).

In this present study, *Toxocara* sp. egg (75%) is reported as a main parasitic contamination of consumed vegetables in Iran. Adult worm of *Toxocara* lives in the small intestine of dog and cat, the eggs enter human environment by feces of these animals, ingested by human by contaminated food or water and its larval stage causes visceral larva migran in body (Abdi *et al*., 2012). Several seroepidemiological studies about human toxocariasis have been conducted and various percent of infection reported in Iran (Rokni, 2008; Sadjjadi *et al*., 2000). Dog and cat is the final host of *Toxocara* spp. And they exist in human environment, so, special attention must be done to these animals to controlling the disease. Contamination of vegetables with *Ascaris* egg in other countries such as Libya, 68%, Saudi Arabia 16%, Turkey 14% and South Korea 56% have been reported (Abougrain *et al*., 2010; Al-Binali *et al*., 2006; Choi and Lee, 1972; Ulukanligil *et al*., 2001). While the *Ascaris* eggs contamination of vegetables in the present study is 28%. High temperature and washing vegetables by raining is cause of lower prevalence in area such as Saudi Arabia and Turkey, respectively. On the other hand, Iran country has a moderate climate and has a higher prevalence in comparison with contamination in Saudi Arabia and Turkey. Also the mean egg contamination rate of vegetables with taenidae family eggs obtained 26% in present study. *Echinococcus granulosus*, causative agent of hydatidosis, is member of taenidae family. It causes economic and health losses across the world.

Among protozoan parasites, the average contamination rate of vegetables with *Entamoeba histolytica*, human deadly parasite, found 25%. This parasite can cause colon perforation and can

led to peritonitis, the main cause of death in amoebiasis. Contamination of vegetables to *Entamoeba histolytica* in Saudi Arabia 3.1% reported which is too lower than the rate of the parasite in Iran (Al-Binali *et al*., 2006). In a meta-analysis study prevalence rate of *Entamoeba histolytica* infection 1.3% reported in human by Karambeigi in Iran (Karambaigi *et al*., 2012).

The results of the above studies are different from our findings in present study. The contributing factors of parasitic infections are irrigation, fertilization, socioeconomic factors and the difference in the amount of stray animals. Other factors such as sample size and methods of vegetables parasites survey can also be effective in different results. In the study of parasites on vegetables consumed in India 44.2% have been contaminated that are slightly higher than finding of this present study (Gupta *et al*., 2009). Among cities of Iran, the highest rate of contamination has been reported in Zabol by Soleimanpoor *et al*. (2011). The weather is very hot in this area so high level of contamination is justified. The lowest infection rates of 2% reported by Baliany in 2007 in Pakdasht city. In that study, low levels of water contamination, used for farm irrigation, was cause of low level of vegetables contamination. In this present study, although we expected that leafy vegetables had a highest intensity of contamination but Scallion with 46% prevalence had a highest contamination and watercress with 23% had a lowest parasitic contamination. The leaves of Scallion are twisted together and don't wash by raining so it is the main cause of maintenance of parasites there.

CONCLUSION

In conclusion, in regards to results of this study, despite the relative improvement of sanitary, economic, social, agricultural and vegetables consumption conditions, overall prevalence of parasites is still too high in Iran and the importance of vegetables in the transmission of intestinal parasites is stressed. So, educational measures, including public health and the training methods used for washing vegetables is essential. While educational programs for vegetable cultivation and collection can be useful to reduce parasitic contamination of vegetables, techniques as well as proper use of wastewater can reduce the amount of contamination in vegetables. Also, many parasites, such as *Ascaris lumbricoides* eggs have adhesion properties that by ordinary washing don't clear from vegetables, therefore researchers need to determine which detergent has fewer side effects for human and can clean vegetables from parasitic contamination and can be used in home.

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