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Original Article

Molecular and Microscopic Detection of *Echinococcus granulosus* sensu lato and *Toxocara* spp. in Raw Vegetables from Central Iran: Implications for Food Safety

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Abstract

Background: The potential foodborne transmission of zoonotic parasite eggs through contaminated vegetables is a public health concern. We evaluated the occurrence of *Echinococcus granulosus* sensu lato (s.l.) and *Toxocara* spp. in raw vegetables from Yazd, Central Iran, to assess the potential food-safety implications.

Methods: Two hundred and fifty samples of lettuce and vegetables (basil, leek, radish, and chives) were collected. Parasitic eggs were isolated using washing-sedimentation and zinc sulfate flotation techniques, followed by microscopic detection. Identification was performed using the *rpb2* and *nad1* genes for *Echinococcus* spp., and the ITS2 region for *Toxocara* spp. Data were statistically analyzed using SPSS by descriptive statistics, chi-square test, and Fisher's exact test.

Results: The overall parasitic contamination rate was 17.2% (43/250), including two cases of co-contamination (45 total detections). Microscopically, *Toxocara*-type eggs and taeniid eggs were detected in 35 samples (14.0%) and 10 samples (4.0%), respectively. PCR confirmed *Toxocara cati* in 10 samples and *E. granulosus* s.l in three taeniid-positive samples. *Toxocara*-type egg contamination was significantly higher in mixed vegetables than in lettuce ($P<0.001$) and differed significantly by geographical area ($P<0.001$).

Conclusion: Detection of parasitic eggs, including taeniid eggs and *Toxocara*-type eggs, indicates that raw vegetables may represent a potential public health risk. Raw vegetables in Central Iran may serve as potential vehicles for exposure to zoonotic parasite eggs. The findings emphasize the need for improved hygiene practices, regular monitoring, and consumer education to reduce contamination risk.

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Introduction

Approximately 600 million cases of foodborne disease occur worldwide annually, resulting in 420,000 deaths (1). Foodborne parasitic infections may result from the consumption of raw or minimally processed foods contaminated with parasite eggs, oocysts, or cysts (2, 3). Among the parasitic agents of public health importance that may be transmitted through contaminated raw vegetables are *Toxocara* spp. and *Echinococcus* spp. *Toxocara canis* and *Toxocara cati* are zoonotic nematodes of dogs and cats, respectively, and humans may become accidental hosts following ingestion of embryonated eggs (4, 5). *Echinococcus granulosus* sensu lato (s.l.) is the principal species complex responsible for cystic echinococcosis (CE), whereas *E. multilocularis* is the causative agent of alveolar echinococcosis (AE) (6).

The presence of infected definitive hosts in Iran is considered an important factor in the spread of the above-mentioned parasitic infections. In some provinces of Iran, *Echinococcus* infection has been detected in 19.1% of examined stray dogs (7). The rate of this infection in shepherd dogs is up to 63.3% (8). Previous studies in Iran have reported infection rates ranging from 1.9% to 60% in dogs and from 8% to 86.27% in cats for *T. canis* and *T. cati*, respectively (9, 10). Previous surveys in Iran (11, 12) have reported the occurrence of parasitic elements on fresh produce by conventional microscopy, which cannot distinguish between taeniid eggs. Consequently, data on the molecular epidemiology of *E. granulosus* s.l. and *Toxocara* spp. in raw vegetables remain limited, particularly in the arid agricultural landscape of Yazd and Central Iran.

Therefore, we aimed to determine the microscopic occurrence and molecular identity of *E. granulosus* s.l. and *Toxocara* spp. in retail raw vegetables across Yazd, establishing baseline data on potential foodborne exposure in Central Iran.

Materials and Methods

Ethical statement

The study was approved by the Ethics Committee of Shahid Sadoughi University of Medical Sciences (ethical code: IR.SSU.SPH.1401.175).

Study region

Yazd is the capital of Yazd Province in central Iran located in an arid desert region. In this study, the city of Yazd was divided into five geographic regions: North (Shohada Square and Shahid Madani Boulevard), South (Atlasi Square and Farhang Square), East (Niayesh Square and Namaz Square), West (Sanat Square and Kargar Boulevard), and Center (Azadi Square and Bahonar Square).

Sample size

The sample size was estimated using the following formula:

$$n = \frac{z^2 P(1-P)}{E^2}$$

where Z=1.96 represents the standard normal deviate for a 95% confidence level, *P*=0.20 represents the assumed expected prevalence of parasitic contamination, and *E*=0.05 represents the desired absolute precision. The minimum calculated sample size was 246. To ensure equal allocation across the five geographic regions, the final sample size was increased to 250 samples.

Study design and Sample collection

This cross-sectional study was conducted in Yazd, Central Iran, between May and Oct 2024. A total of 250 samples of fresh, unwashed raw vegetables (including lettuce) were collected from commercial greengrocers, open-air markets, and municipal distribution centers across five distinct municipal zones. Samples (200–250 g) were placed in sterile polyethylene bags and transported at 4 °C to the Parasitology Laboratory for immediate analysis.

Sample processing and microscopic detection

Vegetable samples were processed according to a modified protocol by Barlaam et al. (13). Briefly, produce was washed, and the re-

covered sediment was split for microscopic and molecular analyses. For microscopy, samples were examined using zinc sulfate flotation (specific gravity 1.35). Given the morphological ambiguity of taeniid eggs under light microscopy, such specimens were broadly classified as "taeniid eggs" prior to molecular identification.

DNA extraction

Samples that were positive or suspicious on microscopic examination were selected for DNA extraction using the *FavorPrep™ Stool DNA Isolation Mini Kit* (Favorgen, Taiwan) according to the manufacturer's instructions.

Species-specific PCR for Echinococcus spp.

E. granulosus s.l. and *E. multilocularis* were identified by PCR targeting the *rpb2* and *nad1* genes, respectively (14, 15) (Supplementary File 1). Each 20-µL reaction contained 1× PCR Master Mix (Ampliqon, Denmark), 0.5 µM of each primer (Pishgam Co., Tehran, Iran), and 5 µL of template DNA. Confirmed positive DNA from each target parasite and double-distilled water were included as positive and negative controls, respectively, in every run. Both assays began with denaturation at 94 °C for 5 min and ended with a final extension at 72 °C for 5 min. For *E. granulosus* s.l., amplification comprised 38 cycles of denaturation at 94 °C for 30 sec, annealing at 48 °C for 40 sec, and extension at 72 °C for 70 sec, producing an expected 1,233-bp amplicon. For *E. multilocularis*, 35 cycles were performed at 94 °C for 30 sec, 55 °C for 40 sec, and 72 °C for 60 sec, yielding an expected 395-bp product. PCR products were resolved by agarose gel electrophoresis (Akhtaryan Co., Mashhad, Iran) alongside a 100-bp DNA ladder (Thermo Fisher Scientific, USA).

Species-specific PCR for Toxocara spp.

For molecular identification of *T. canis* and *T. cati*, primers targeting the internal transcribed spacer 2 (ITS2) region were utilized (Supplementary File 1). Reactions (20 µL) contained 1× PCR Master Mix, 0.5 µM of each primer (Pishgam Co., Tehran, Iran), and 5 µL of template DNA, running on a Simpli-Amp thermal cycler (Applied Biosystems, USA) alongside validated positive and negative (ddH_2O) controls across three technical replicates. Both profiles shared an initial denaturation at 94 °C for 5 min and a final extension at 72 °C for 5 min, differing only in their cycling parameters: 35 cycles of 94 °C for 45 sec, 50 °C for 30 sec, and 72 °C for 30 sec for *T. canis* (yielding a 251-bp amplicon); and 32 cycles of 94 °C for 35 sec, 52.5 °C for 30 sec, and 72 °C for 25 sec for *T. cati* (yielding a 491-bp amplicon). Amplicons were subsequently resolved by agarose gel electrophoresis.

Sequencing and sequence analysis

To confirm species identity, representative PCR products were Sanger-sequenced (Gene Fanavaran, Tehran). Following sequence assembly, identification was verified via BLASTn comparison against NCBI GenBank, and multiple sequence alignments were performed using T-Coffee (16).

Phylogenetic analysis

Separate phylogenetic analyses (17, 18) were conducted for *E. granulosus* s.l. and *T. cati*. For each parasite, the generated sequence was aligned with relevant reference sequences retrieved from GenBank (Supplementary File 2) (Not published).

Statistical analysis

The data were statistically analyzed using SPSS ver. 26.0 (IBM Corp., Armonk, NY, USA) software by descriptive statistics, chi-square test, and Fisher's exact test. $P<0.05$ was considered significant.

Results

Microscopic detection

Microscopic examination revealed 43 (17.2%) positive samples out of 250, including two cases of co-contamination, resulting in 45 total parasitic egg detections. *Toxocara*-type

and taeniid eggs were identified in 35 (14.0%) and 10 (4.0%) samples, respectively (Fig. 1). Subgroup analysis indicated a significant association between sample type and *Toxocara*-type contamination, which was higher in mixed vegetables than in lettuce (21.6% vs. 6.4%; $P<0.001$). Conversely, taeniid egg prevalence did not differ significantly between sample types (3.2% in mixed vegetables vs. 4.8% in lettuce; $P>0.05$; Table 1).

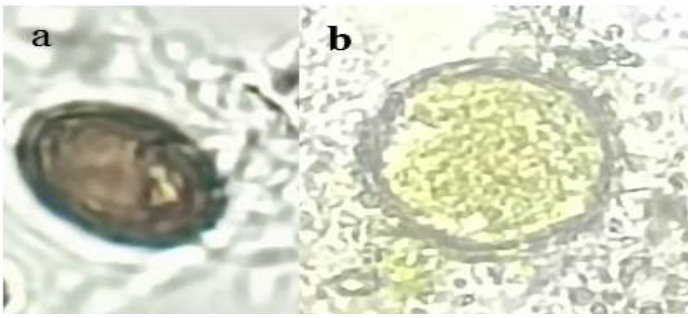


Fig. 1: Representative light micrographs of helminth eggs detected in raw vegetable samples. **(a)** Taeniid-type egg, **(b)** *Toxocara*-type egg (Originail)

Table 1: Occurrence of *Toxocara*-type and taeniid eggs across different raw vegetable types (N=250)

Sample type	Total examined (N)	*Toxocara* eggs No. (%)	Taeniid eggs No. (%)	Co-contamination* No. (%)	Overall positive samples† No. (%)	Total egg detections(n)
Mixed vegetables§	125	27 (21.6)	4 (3.2)	1 (0.8)	30 (24.0)	31
Lettuce	125	8 (6.4)	6 (4.8)	1 (0.8)	13 (10.4)	14
Total	250	35 (14.0)	10 (4.0)	2 (0.8)	43 (17.2)	45
P-value	-	<0.001	>0.05	-	0.004	

Data are presented as number (percentage). All findings presented in this table are based on microscopic examination.
*Co-contamination indicates samples simultaneously harboring both *Toxocara*-type and taeniid eggs.
†Overall positive samples represent the number of unique contaminated samples. Because two samples contained both *Toxocara*-type and taeniid eggs, the number of unique positive samples was calculated as 35+10−2=43.
§Mixed vegetables included basil (*Ocimum basilicum*), leek (*Allium ampeloprasum*), radish (*Raphanus sativus*), and chives (*Allium schoenoprasum*).
P-values were determined using the Chi-square test (or Fisher's exact test, as appropriate)

Geographical distribution revealed a significant variation for *Toxocara*-type eggs ($P<0.001$), with the highest prevalence in the western region (34.0%, 17/50) and the lowest in the east (2.0%, 1/50). No significant geographical association was observed for taeniid eggs (Table 2).

Table 2: Geographical distribution of microscopically detected *Toxocara*-type and taeniid eggs across Yazd city (N=250)

Parasite egg type	North (n=50)	South	East	West	Center	Total (N=250) No. (%)	*P*-value
	No. (%)	(n=50)	(n=50)	(n=50)	(n=50)		
		No. (%)	No. (%)	No. (%)	No. (%)		
Taeniid eggs	0 (0.0)	4 (8.0)	1 (2.0)	1 (2.0)	4 (8.0)	10 (4.0)	> 0.05
***Toxocara*-type eggs**	9 (18.0)	5 (10.0)	1 (2.0)	17 (34.0)	3 (6.0)	35 (14.0)	< 0.001

Data are presented as number (percentage). All determinations were based on microscopic examination. The percentages in each geographic column were calculated using 50 samples per region; the total percentages were calculated using 250 samples

Molecular detection, species identification, and sequencing

Molecular analysis confirmed *Echinococcus granulosus* s.l. in three of the 10 taeniid-positive samples (1.2% overall; Supplementary File 3), whereas *E. multilocularis* was not detected. Regarding *Toxocara*-type eggs, 10 of the 35 microscopically positive samples yielded the expected 491-bp amplicon for *T. cati*; no *T. canis* was identified. Sanger sequencing of representative amplicons confirmed these species identities, with consensus sequences deposited in GenBank (accession numbers PP415528 and PP946868). The remaining PCR-positive samples exhibited consistent amplicon sizes.

Phylogenetic analysis

Phylogenetic relationships were inferred using the Maximum Likelihood method implemented in MEGA7 using 1,000 bootstrap replicates. The phylogenetic positions of the representative *T. cati* and *E. granulosus* s.s. sequences are shown in Figs. 2, 3, respectively.

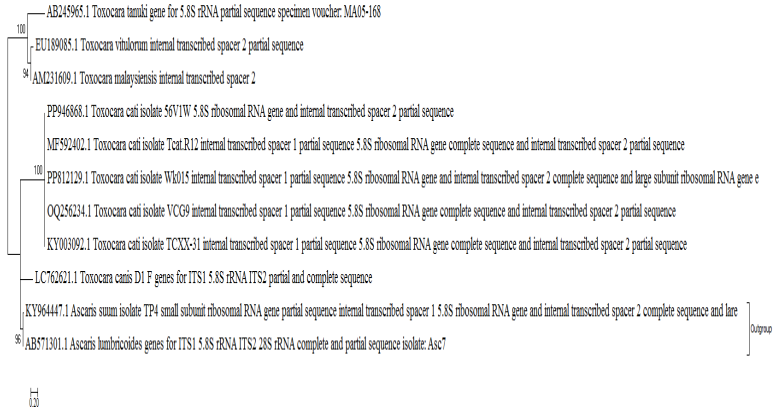


Fig. 2: Molecular phylogenetic analysis of *Toxocara cati* based on ITS2 nucleotide sequences. The dataset included 20 sequences, comprising one representative sequence generated in the present study and 19 reference sequences retrieved from the NCBI GenBank database. The evolutionary tree was inferred using the Maximum Likelihood method based on the Tamura–Nei model in MEGA7. Numbers at branch nodes represent bootstrap support values based on 1,000 replicates. The scale bar indicates nucleotide substitutions per site

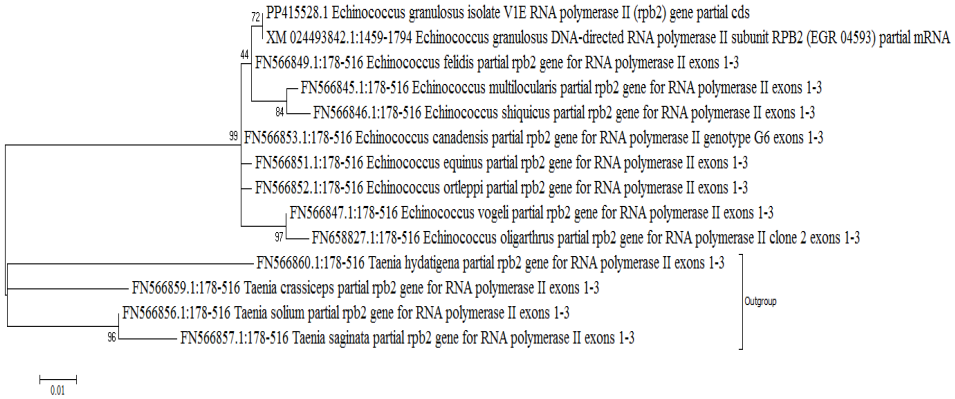


Fig. 3: Molecular phylogenetic analysis of the representative *Echinococcus granulosus sensu stricto* sample based on *rpb2* sequences. The evolutionary history was inferred by using the Maximum Likelihood method based on the Tamura-Nei model. All positions containing gaps and missing data were eliminated. Evolutionary analyses were conducted in MEGA7. Numbers at nodes represent bootstrap support values based on 1,000 replicates. The scale bar indicates nucleotide substitutions per site

Discussion

Here, microscopic screening alongside molecular assays demonstrated notable contamination of retail vegetables with zoonotic helminth eggs in Central Iran. Overall, 43 of the 250 samples (17.2%) tested microscopically positive for parasite eggs, yielding 45 detections due to dual contamination in two samples. *Toxocara*-like eggs were identified in 35 samples (14.0%) and taeniid eggs in 10 (4.0%). Given that taeniid eggs cannot be reliably differentiated by light microscopy alone (19), species-level confirmation depended on PCR; this confirmed *E. granulosus* s.l. in three samples, with sequencing verifying *E. granulosus* s.s. Interestingly, samples from western Yazd showed significantly higher *Toxocara* rates. Similar Iranian surveys have reported variable contamination levels; for instance, Isazadeh et al. (11) found 25.8% positivity across lettuce and raw produce in Tehran, slightly exceeding our rate—a difference likely driven by distinct recovery techniques and a wider parasite target panel. Likewise, Heidari et al. (12) recorded a higher contamination rate (37.5%) in Karaj, which likely stems from differences in local agricultural irrigation sources as well as the wider scope of target parasites examined.

In Tabriz, 1620 samples of 10 types of vegetables were collected. 19.5% of samples were contaminated with parasites (20), which is in accordance with our results. In Shahroud, parasitic contamination was observed in 38% of the collected raw vegetable samples, which was higher than the total parasitic contamination rate observed in the present work. In the same study, the reported contamination rate with tapeworm/taeniid eggs was 6.7%, which was slightly higher than the rate of taeniid eggs detected microscopically in the present study (4.0%) (21). Beyond Iran, global investigations have similarly evaluated vegetable contamination using combined microscopic and molecular approaches. For instance, a recent Swiss study detected *T. cati* and *E. multilocularis* in 2.5% and 1.2% of 157 samples, respectively, which likely stem from methodological variations and differing climatic conditions (22). Similarly, research in southern Thailand reported a 2.6% *Toxocara* contamination rate across 265 fresh produce samples (23). This lower rate may reflect seasonal sampling differences, regional climate, and soil characteristics.

The level of *Toxocara* egg contamination of fruit and raw vegetable samples in Ethiopia was 15.83% (24), which is almost similar to the findings of the present study. Salavati et al. reported *Toxocara* egg contamination in unwashed raw vegetables collected in Kermanshah, Iran (25). Recent findings from Abadeh City, Iran, demonstrated persistent environmental reservoirs of *Toxocara* spp. despite a low human seroprevalence, suggesting that contaminated soil may represent an important reservoir for transmission (5). Iran is an endemic country for CE, with notable regional variations in disease frequency (26). Recent epidemiological forecasting based on Global Burden of Disease estimates indicates that CE will remain a persistent public health concern in Iran up to 2040 (27). The detection of *E. granulosus* s.l. DNA in raw vegetables indicates a potential food-associated exposure pathway. However, whether such contamination contributes to human infection cannot be determined from the present study because egg viability, infectivity, and actual human exposure were not assessed. Taeniid eggs may persist in the environment for prolonged periods, although their survival is influenced by temperature, humidity, solar radiation, soil characteristics, and other environmental factors (28). Therefore, the possible contribution of Yazd's hot and arid climate to the lower detection of taeniid eggs remains speculative and requires direct environmental and viability studies.

In Poland, out of 103 fruit, vegetable and mushroom samples collected, 23.3% of the samples contained *E. multilocularis* DNA (29),

which is inconsistent with our results. The higher detection rate may reflect the study location in a region of Poland with a higher reported environmental prevalence of *E. multilocularis*. In addition, differences in the type of samples as well as the geographical situation and soil type of the region are also factors affecting this statistical difference. However, in a similar study conducted by Lass et al. (30) in a non-endemic area of *Echinococcus*, out of 104 vegetable, fruit and mushroom samples, *Echinococcus* DNA was found in only 6.7% of the samples, which is closer to the findings of the present study.

In Switzerland, *E. granulosus*-related DNA was detected in two of 141 samples of lettuce, vegetables, and fruits. This finding confirms the feasibility of molecular detection of taeniid contamination in fresh produce; however, direct comparison with our findings should be made cautiously because of differences in sample size, target species, and diagnostic protocols (31). In Libya, 26% of 126 salad-green samples were contaminated with *T. cati*, 18% with *T. canis*, and 22% with taeniid-type eggs (32). The higher contamination rates reported in study may be related to the use of wastewater for irrigation, lower hygienic standards, and differences in post-harvest handling and retail practices.

Several limitations should be considered when interpreting our findings. First, we did not assess egg viability or infectivity; hence, the detected eggs demonstrate produce contamination rather than verified transmission risk. Second, standard light microscopy cannot discriminate among taeniid species; thus, microscopic records were classified broadly as taeniid eggs, with species-level identity established solely through PCR and sequencing of representative amplicons. Third, because bidirectional Sanger sequencing was performed only on selected representative amplicons, species identification cannot be directly extrapolated to every PCR-positive specimen. Fourth, molecular testing was restricted to samples that were microscopically positive or suspicious, rather than the entire 250-sample dataset. Because light microscopy can miss low-intensity contamination, universal PCR screening of all samples in future work would yield a more precise epidemiologic picture.

The observed contamination may reflect several possible transmission pathways, including the use of contaminated irrigation water, application of raw manure, contact with contaminated soil, and inadequate hygiene during harvesting, transport, storage, and retail handling. These pathways may be particularly relevant for vegetables consumed raw or insufficiently washed. However, because egg viability and infectivity were not assessed in the present study, the findings should be interpreted as indicating a potential route of exposure rather than confirmed foodborne transmission. Accordingly, improved sanitation, good agricultural and hygienic practices, regular monitoring, and appropriate washing of raw vegetables are warranted.

Conclusion

The raw vegetables may serve as potential vehicles for exposure to zoonotic parasite eggs and therefore warrant continued food-safety surveillance. Taeniid eggs were detected microscopically in 10 samples, but *E. granulosus* s.l. was confirmed by species-specific PCR in only three samples. This finding emphasizes the importance of molecular confirmation because taeniid eggs cannot be differentiated reliably by light microscopy. Because egg viability and infectivity were not assessed, the findings should be interpreted as evidence of potential contamination rather than confirmed infective risk. To reduce this potential risk, an integrated One Health strategy is needed, including improved sanitation, management of stray and free-roaming dogs and cats around agricultural areas, regular monitoring of parasitic contamination in vegetables, education of

farmers and food handlers regarding good agricultural and hygienic practices, and public awareness regarding thorough washing and, where appropriate, cooking of vegetables before consumption.

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Data Availability Statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. The representative nucleotide sequences identified in this study have been deposited in the NCBI GenBank database under accession numbers PP415528 and PP946868.

Conflict of interest

The authors declare that there is no conflict of interests.

References

1. FAO, WHO. The burden of foodborne diseases and the benefits of investing in safe food. Geneva: World Health Organization; 2019. https://openknowledge.fao.org/bitstreams/43be824d-069a-4396-bd21-26fbd079622e/download
2. Bahramian B, Afshari A, Kiani B, et al. The prevalence of foodborne parasites in raw vegetables in Iran: a comprehensive systematic review and meta-analysis. J Environ Health Sci Eng. 2021;19(2):2027–2045.
3. Maganira JD. Environmental contamination with taeniid cestode eggs: A systematic literature review. Food Waterborne Parasitol. 2025;41:e00294.
4. Abbaszadeh Afshar MJ, Zahabiun F, Heydarian P, et al. A systematic review and meta-analysis of toxocariasis in Iran: is it time to take it seriously? Acta Parasitol. 2020; 65: 569–584.
5. Siyadatpanah A, Nikoo MR, Labana RV, et al. Low human seroprevalence but persistent environmental reservoirs of *Toxocara* spp.: a One Health assessment in Abadeh City, Iran. J Parasit Dis. 2026;50(2):362-71.
6. CDC. Echinococcosis. 2019 [updated July 15, 2019; cited 2024 Oct 10]. Available from: https://www.cdc.gov/dpdx/echinococcosis/index.html
7. Ghatee MA, Nikaein K, Taylor WR, et al. Environmental, climatic and host population risk factors of human cystic echinococcosis in southwest of Iran. BMC Public Health. 2020;20:1611.
8. Eslami A, Hosseini SH. *Echinococcus granulosus* infection of farm dogs of Iran. Parasitol Res. 1998; 84:205–207.
9. Gharekhani J. Study on gastrointestinal zoonotic parasites in pet dogs in Western Iran. Turkiye Parazitol Derg. 2014;38:172–176.
10. Yakhchali M, Hajipour N, Malekzadeh-Viayeh R, et al. Gastrointestinal helminths and ectoparasites in the stray cats (Felidae: *Felis catus*) of Ahar municipality, Northwestern Iran. Iran J Parasitol. 2017;12: 298–304.
11. Isazadeh M, Mirzaii-Dizgah I, Shaddel M, et al. The prevalence of parasitic contamination of fresh vegetables in Tehran, Iran. Turkiye Parazitol Derg. 2020;44:143–148.
12. Heidari A, Hezarosi M, Nasserkhail E, et al. The parasitic contamination of edible raw vegetables in Karaj, Iran in 2017. Iran J Public Health. 2020;49:2435–2437.
13. Barlaam A, Temesgen TT, Tysnes KR, et al. Parasitic contamination of fresh produce sold on the Italian market with Cyclospora cayetanensis and *Echinococcus multilocularis*. Food Microbiol. 2021;98:103792.
14. Hajimohammadi B, Dalimi A, Eslami G, et al. Occurrence and genetic characterization

of *Echinococcus granulosus* sensu lato from domestic animals in Central Iran. BMC Vet Res. 2022;18:22.
15. Rahimi M, Sarvi S, Daryani A, et al. Application of multiplex PCR for the simultaneous detection of *Taenia* spp. from domestic dogs in the north of Iran. Helminthologia. 2016;53:285-289.
16. Notredame C, Higgins DG, Heringa J. T-Coffee: a novel method for fast and accurate multiple sequence alignment. J Mol Biol. 2000; 302:205–217.
17. Kumar S, Stecher G, Tamura K. MEGA7: molecular evolutionary genetics analysis version 7.0 for bigger datasets. Mol Biol Evol. 2016;33:1870–1874.
18. Tamura K, Nei M. Estimation of the number of nucleotide substitutions in the control region of mitochondrial DNA in humans and chimpanzees. Mol Biol Evol. 1993;10: 512–526.
19. Larkins A, Knight B, Keokhamphavanh B, et al. Sensitivity and specificity of microscopic and molecular techniques for the diagnosis of taeniasis. Acta Trop. 2024;260:107414.
20. Balarak D, Ebrahimi M, Modrek MJ, et al. Investigation of parasitic contaminations of vegetables sold in markets in the city of Tabriz in 2014. Glob J Health Sci. 2016;8:54811.
21. Nazemi S, Raei M, Amiri M, Chaman R. Parasitic contamination of raw vegetables in Shahroud, Semnan. Zahedan J Res Med Sci. 2012;14:e93274.
22. Guggisberg AR, Alvarez Rojas CA, Kronenberg PA, et al. A sensitive, one-way sequential sieving method to isolate helminths' eggs and protozoal oocysts from lettuce for genetic identification. Pathogens. 2020;9:624.
23. Punsawad C, Phasuk N, Thongtup K, et al. Prevalence of parasitic contamination of raw vegetables in Nakhon Si Thammarat province, southern Thailand. BMC Public Health. 2019;19:34.
24. Bekele F, Shumbej T. Fruit and vegetable contamination with medically important helminths and protozoans in Tarcha town, Dawuro zone, South West Ethiopia. Res Rep Trop Med. 2019;10:19–23.
25. Salavati Z, Chalehchaleh AA, Rezaei F. Parasitic infections in raw vegetables of Kermanshah, Western Iran and their relation with season and washing procedures. J Food Qual Hazards Control. 2017;4:37-41.
26. Mahmoudi S, Mamishi S, Banar M, et al. Epidemiology of echinococcosis in Iran: a systematic review and meta-analysis. BMC Infect Dis. 2019;19:929.
27. Ahmadi B, Olfatifar M, Badri M, et al. Future Projection of Cystic Echinococcosis in Iran to 2040: A Secondary Analysis Based on Global Burden of Disease (2021). Health Sci Rep. 2026;9(7):e72725.
28. Jansen F, Dorny P, Gabriël S, et al. The survival and dispersal of *Taenia* eggs in the environment: what are the implications for transmission? A systematic review. Parasit Vectors. 2021;14:88.
29. Lass A, Szostakowska B, Myjak P, et al. The first detection of *Echinococcus multilocularis* DNA in environmental fruit, vegetable, and mushroom samples using nested PCR. Parasitol Res. 2015;114:4023–4029.
30. Lass A, Szostakowska B, Myjak P, et al. Detection of *Echinococcus multilocularis* DNA in fruit, vegetable, and mushroom samples collected in the non-endemic territory of the Pomerania province and comparison of the results with data from rural areas of the neighboring highly endemic Warmia-Masuria province, Poland. Acta Parasitol. 2017;62: 459–465.
31. Federer K, Armua-Fernandez MT, Gori F, et al. Detection of taeniid (*Taenia* spp., *Echinococcus* spp.) eggs contaminating vegetables and fruits sold in European markets and the risk for metacestode infections in captive primates. Int J Parasitol Parasites Wildl. 2016;5:249–253.
32. Abougrain AK, Nahaisi MH, Madi NS, et al. Parasitological contamination in salad vegetables in Tripoli-Libya. Food Control. 2010;21:760-762.