

## Abattoir prevalence, organ distribution, public health and economic importance of major metacestodes in sheep, goats and cattle in Fars, southern Iran

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**Abstract.** Some of the metacestodes are not only zoonotic but are also responsible for severe tissue damage, reduction in milk and meat production, and considerable economic loss due to condemnation of the infected organs of the herbivorous animals. The aim of the present study was to determine the prevalence of *Cysticercus ovis*, *Cysticercus tenuicollis*, hydatid cyst and *Coenurus gaigeri* in sheep and goats and *Cysticercus bovis*, *Cysticercus tenuicollis* and hydatid cyst in cattle. A total of 1050 sheep, 950 goats and 500 cattle slaughtered at Shiraz Slaughterhouse were carefully examined for these metacestodes. *Cysticercus tenuicollis* was found in 184 (17.52%) sheep and 523 (55.05%) goats. The prevalence of *C. tenuicollis* was higher in males than females ( $P < 0.01$ ), and was higher in goats compared to sheep ( $P < 0.01$ ). Hydatid cyst was found in 478 (45.52%) sheep and 95 (10.0%) goats and its prevalence was higher in older animals compared to the younger ones. *Coenurus gaigeri* was found in 5 (0.48%) sheep and 17 (1.79%) goats and *Cysticercus ovis* was found in one male sheep only (0.09%). *Cysticercus bovis* was found in 3 male cattle (0.6%) and hydatid cyst was found in 58 (11.6%) cattle. The prevalence of hydatid cyst was higher in older cattle compared to the younger ones and higher in females than males. These results suggest that the high prevalence of the metacestodes infestations in this area is a great concern for both medical and veterinary authorities to design therapeutic and preventive programs to overcome this problem.

### INTRODUCTION

Cestodes of the family Taeniidae infect dogs as the definitive host and are transmitted to a wide range of intermediate host species where they cause coenurosis, hydatidosis, and cysticercosis. Infestations with the larval stage of some species of *Taenia* are not only of public health importance, but also of veterinary significance because they cause economic losses due to condemnation of infected offal or meat (Thompson, 1995). The infestation may lead to lower production and even death of the animals in cases of heavy infestations (Radfar *et al.*, 2005). *Cysticercus tenuicollis*, *Cysticercus ovis*, hydatid cyst and *Coenurus gaigeri* are reported in sheep and goats and *Cysticercus bovis* and hydatid

cyst are reported in cattle and buffalo from many parts of the world. Hydatidosis and Taeniasis are parasitic zoonoses that present major public health problems in lower income countries (Thompson, 1995; Mehrabani *et al.*, 1999; Ahmadi & Badi, 2011). Occurrence of *Taenia saginata* and hydatidosis have been reported in humans from different parts of the world (Mamo, 1988; Torgerson *et al.*, 2000; Kia *et al.*, 2005). Iran is an endemic area for cestodes of the family Taeniidae of dogs and wild carnivores as final hosts, and livestock and wild herbivores as intermediate hosts (Oryan *et al.*, 1994; Radfar *et al.*, 2005).

Hydatidosis is one of the major zoonotic diseases in Iran, because in the rural areas, the carcass wastes are easily accessible to scavenging dogs and other wild carnivores.

In addition, the Assyrian shepherd dogs are generally easily infected with this parasite and are the major source of hydatidosis of herbivorous animals and man in Fars Province, southern Iran. Clinical hydatid disease is uncommon in animals, but hydatid cysts in liver and other tissues at slaughter are widespread and cause condemnation and economic loss. There are numerous distinct strains of *Echinococcus granulosus* (Smith & Sherman, 2009; Sharifiyazdi *et al.*, 2011). *Echinococcus granulosus* and its metacestode in herbivores and humans have been identified as the most important helminthic zoonoses, with great economic and public health significances in developing countries (Mehrabani *et al.*, 1999). Hydatidosis is a common disease in the Middle East, especially in Iran and the neighboring countries (Dalimi *et al.*, 2002; Daryani *et al.*, 2007).

Cysticercosis, due to the metacestodes of *T. saginata* is cosmopolitan and occurs in developing as well as in industrialized countries and poses veterinary and public health problems (Oryan *et al.*, 1995, 1998; Dorny *et al.*, 2002). Bovine cysticercosis, a meat borne parasite, is an important cause of illness and economic loss. It is widely distributed throughout the country, especially in the rural areas of Iran (Oryan *et al.*, 1995; Kia *et al.*, 2005; Khaniki *et al.*, 2010). The World Health Organization (WHO, 1983) has classified prevalence of *T. saginata* in three different groups: highly endemic regions with their presence in human population above 10%; moderate prevalence with infestation rate between 0.1 and 10%; low prevalence with infestation rate below 0.1% or total absence of the endemic organism.

Adult *Taenia hydatigena* tapeworm is found in the intestine of carnivores. The eggs hatch in the small intestine of the intermediate hosts and the released oncospheres enter liver through blood circulation. The metacestode migrate through the hepatic parenchyma to the peritoneal cavity (Nourani *et al.*, 2010). It matures over a period of five to eight weeks and it is then found attached as a bladder worm called *C. tenuicollis* to the mesentery,

serosal surface of the abdominal organs, and omentum (Smith & Sherman, 2009).

Coenurosis, the bladder worm stage of *Taenia multiceps* predominantly develops in the brain and spinal cord of many mammal species, including human (Moghaddar *et al.*, 1992; Oryan *et al.*, 1994; Tafti *et al.*, 1997; Ing *et al.*, 1998; Sharma & Chauhan, 2006). However, there have also been rare reports of *Coenurus* cyst occurrence in the intramuscular or subcutaneous tissues and in the abdominal cavity in sheep and goats called *C. gaigeri* (Sharma *et al.*, 1995; Christodouloulos, 2007; Oryan *et al.*, 2010).

Study on the prevalence of the cestodes of the family Taeniidae in stray dogs and their metacestodes in herbivores has public health significance; it is dangerous for research personnel, and expensive and time consuming for the authorities of the research centers. The present study was designed to examine the prevalence, organ distribution and socioeconomic implications of the metacestodes in cattle, sheep and goats in Fars Province southern Iran.

## MATERIALS AND METHODS

### Study area

This study was undertaken from May to September 2011 in three different slaughter houses of Fars Province, southern Iran.

### Animals and post mortem examination

A total of 1050 sheep, 950 goats and 500 cattle carcasses of both sexes and of different age ranges slaughtered at slaughterhouses were examined. Visual inspection of the omentum, mesentery, peritoneal cavity, liver, lungs, kidneys, spleen, striated muscles, heart and subcutaneous area of each carcass was undertaken for the presence of *C. tenuicollis*, *C. ovis*, hydatid cyst and *C. gaigeri* in sheep and goats and for *C. bovis* and hydatid cyst in cattle. Inspection of the skulls, brains and spinal cord was not permitted due to the slaughter houses formalities; therefore it was not possible to assess the status of *Coenurus cerebralis*. Number of the

examined animals, their sex, and age ranges are shown in Table 2.

### Data analysis

All data were recorded in the Microsoft Excel program. Statistical analysis of the data by *t-test* and the  $X^2$  test established the level of significance between different species, sexes and age ranges. Differences of  $p < 0.05$  were considered significant.

## RESULTS

The prevalence of metacestodes and their distribution pattern in different organs of sheep and goats are presented in Table 1. The most common bladder worms of sheep were hydatid cysts (45.52%) and *C. tenuicollis* (17.52%), followed by *C. gaigeri* (0.47%) and *C. ovis* (0.09%). The lungs [252/478 (52.72%)] and liver [215/478 (44.98%)] of the sheep showed the highest rate of infestation for hydatid cyst followed by spleen (1.26%) and kidneys (1.05%). No hydatid cyst was found in the heart and striated muscles. Mesentery showed the highest prevalence for *C. tenuicollis* infestation in sheep followed by the liver, lungs and kidneys. Prevalence of metacestodes in sheep and goats according to sex and age is presented in Table 2. The rate of infestation was higher in animals over 3 years of age. The prevalence of infestation was significantly higher in males than

females ( $p < 0.05$ ) and in the older animals of more than 3 years than the younger ones ( $p < 0.05$ ). *Coenurus gaigeri* was detected in the striated muscle of 3 and subcutaneous areas of 2 sheep (Fig. 1). Only one sheep was infected with *C. ovis*. The most common bladder worms of the goats was *C. tenuicollis* (55.05%) (Fig. 2) then followed by hydatid cysts (10.0%) (Fig. 3) and *C. gaigeri* (1.78%). The mesentery of goats showed the highest rate of infestation [402/523(76.86%)] with *C. tenuicollis* and then followed by the liver, lungs and kidneys. The distribution pattern of hydatid cysts in the organs of the goats was almost similar to that found in sheep. Rate of the infestation with hydatid cysts found in the lungs, liver, spleen, and kidneys of the goats were 51.57%, 40.00%, 5.26%, and 3.15%, respectively (Table 1).

The prevalence of hydatid cysts and *C. bovis* in cattle was 11.6% and 0.6%, respectively. The distribution pattern of hydatid cysts in the organs of cattle was similar to sheep and goats. The distribution pattern of hydatid cysts in the lungs, liver, kidneys and spleen of cattle were [27/58 (46.55%)], [21/58 (36.20%)], [6/58 (10.34%)] and [4/58 (6.90%)], respectively. (These results are indicated in Table 3).

Statistically the prevalence of infestation for *C. tenuicollis* was significantly higher in male sheep and goats than females and for hydatid cyst and *C. gaigeri* the prevalence was higher in females than males ( $p < 0.05$ ).

Table 1. Prevalence of metacestodes and their distribution pattern in different organs in sheep and goats

| Organ         | Number of cases   |    |               |              |     |    |   |                 |                |   |              |                       |     |    |   |                 |
|---------------|-------------------|----|---------------|--------------|-----|----|---|-----------------|----------------|---|--------------|-----------------------|-----|----|---|-----------------|
|               | <i>C. gaigeri</i> |    |               | Hydatid cyst |     |    |   |                 | <i>C. ovis</i> |   |              | <i>C. tenuicollis</i> |     |    |   |                 |
|               | Mu                | SC | Total         | Li           | Lu  | Sp | K | Total           | Mu             | H | Total        | Li                    | Me  | Lu | K | Total           |
| Sheep<br>1050 | 3                 | 2  | 5<br>(0.47%)  | 215          | 252 | 6  | 5 | 478<br>(45.52%) | 0              | 1 | 1<br>(0.09%) | 80                    | 81  | 21 | 2 | 184<br>(17.52%) |
| Goat<br>950   | 15                | 2  | 17<br>(1.78%) | 38           | 49  | 5  | 3 | 95<br>(10%)     | 0              | 0 | 0<br>(0.0%)  | 99                    | 402 | 21 | 1 | 523<br>(55.05%) |

Li: liver    Lu: lungs    Sp: spleen    k: kidneys    Me: mesentery    Mu: muscle    H: heart  
 SC: subcutaneous    Level of significance:  $P < 0.01$ .

Table 2. Overall prevalence and distribution of metacestodes in different organs of sheep and goats in relation to age and sex

|            |        | Goats  |                   |       |           |       |                |       |                     |       |
|------------|--------|--------|-------------------|-------|-----------|-------|----------------|-------|---------------------|-------|
|            |        | Number | <i>C. gaigeri</i> | Prev. | Hyd. cyst | Prev. | <i>C. ovis</i> | Prev. | <i>C. tenuiclis</i> | Prev. |
| Infected   |        |        | 17                | 1.79  | 95        | 10.00 | 0              | 0.0   | 523                 | 55.05 |
| Sex        | Male   | 475    | 5                 | 1.05  | 25        | 5.26  | 0              | 0.0   | 343                 | 72.21 |
|            | Female | 475    | 12                | 2.53  | 70        | 14.74 | 0              | 0.0   | 180                 | 37.89 |
| Age (year) | ≥2     | 317    | 3                 | 0.95  | 23        | 7.26  | 0              | 0.0   | 98                  | 30.91 |
|            | 2-3    | 317    | 5                 | 1.58  | 25        | 7.89  | 0              | 0.0   | 212                 | 66.88 |
|            | 3≥     | 316    | 9                 | 2.46  | 47        | 12.84 | 0              | 0.0   | 213                 | 67.41 |
|            |        | Sheep  |                   |       |           |       |                |       |                     |       |
| Infected   |        |        | 5                 | 0.47  | 478       | 45.52 | 1              | 0.09  | 184                 | 17.52 |
| Sex        | Male   | 525    | 2                 | 0.38  | 207       | 29.90 | 1              | 0.19  | 77                  | 23.34 |
|            | Female | 525    | 3                 | 0.57  | 271       | 61.14 | 0              | 0.0   | 107                 | 11.81 |
| Age (year) | 2≥     | 350    | 1                 | 0.29  | 77        | 22.00 | 0              | 0.0   | 51                  | 14.57 |
|            | 2-3    | 350    | 1                 | 0.29  | 145       | 41.43 | 0              | 0.0   | 46                  | 13.14 |
|            | 3≥     | 350    | 3                 | 0.86  | 256       | 71.14 | 1              | 0.29  | 87                  | 24.86 |

Prev.: Prevalence      Hyd: Hydatid cyst

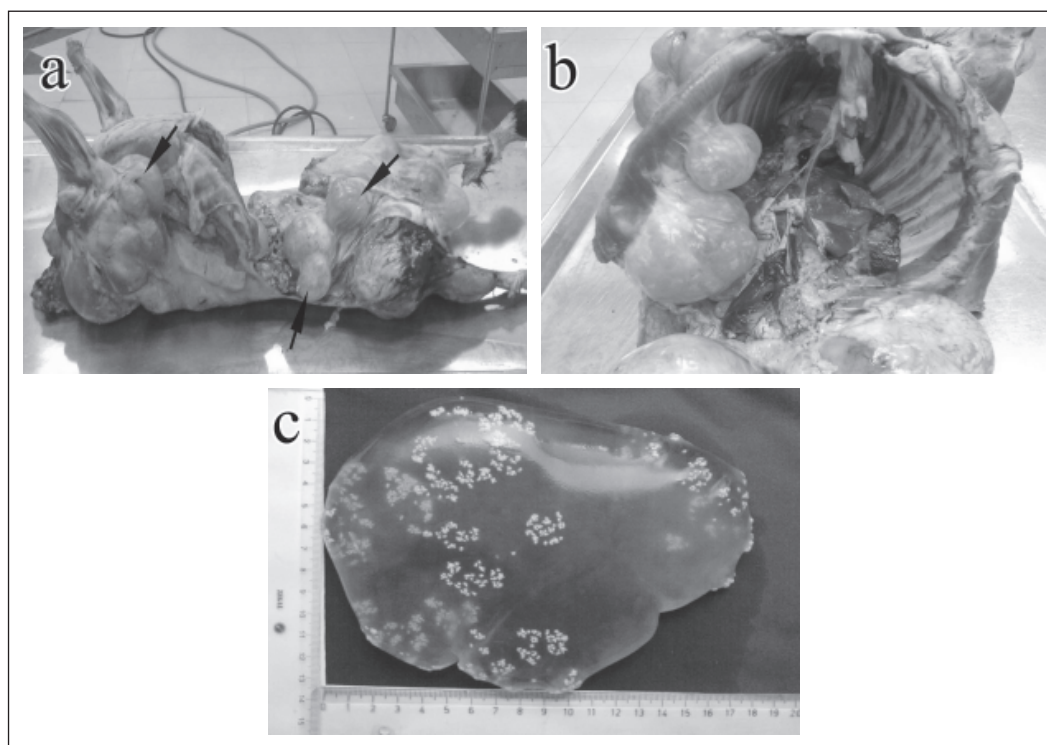


Figure 1. a. Carcass of a sheep heavily infected with *C. gaigeri* (arrows). The metacestodes are located in the muscles of locomotory system, subcutaneous areas of thoracic and abdominal cavity and in the diaphragm and intercostal muscles. b. Cysts of *C. gaigeri* in the thoracic cavity of a sheep located in diaphragm and intercostal muscles. c. An isolated cyst of *C. gaigeri*. Wall of the cyst is thin and translucent and the cyst is filled with a transparent water consistency fluid. The daughter cysts are tightly attached to the germinal layer and are not easily separated

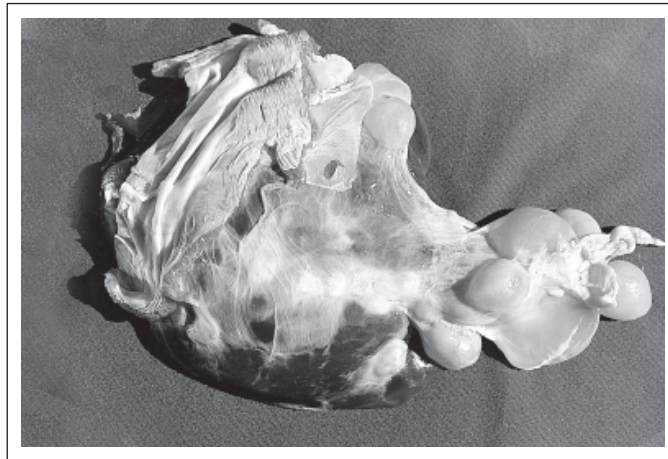


Figure 2. Few bladder metacestods of *Cysticercus tenuicollis* are attached to the peritoneal wall of a goat



Figure 3. Liver of a goat heavily infected with hydatid cysts

Table 3. Abattoir prevalence of metacestodes and their distribution pattern in different organs of cattle in Fars, southern area of Iran

|            | Number of cases |   |          |              |    |    |   |            |                       |    |   |    |          |  |
|------------|-----------------|---|----------|--------------|----|----|---|------------|-----------------------|----|---|----|----------|--|
|            | <i>C. bovis</i> |   |          | Hydatid cyst |    |    |   |            | <i>C. tenuicollis</i> |    |   |    |          |  |
|            | Mu              | H | Total    | Li           | Lu | Sp | K | Total      | Li                    | Mu | K | Lu | Total    |  |
| Cattle 500 | 2               | 1 | 3 (0.6%) | 21           | 27 | 4  | 6 | 58 (11.6%) | 0                     | 0  | 0 | 0  | 0 (0.0%) |  |

Li: liver      Lu: lungs      Sp: spleen  
 k: kidneys    H: heart      Mu: muscle

## DISCUSSION

The present investigation showed high prevalence of infestation with *C. tenuicollis* in goats (55.05%) and sheep (17.52%) in the study area. Grazing behaviour and management can be considered as the major reasons for the higher infestation rate in goats than in sheep (Radfar *et al.*, 2005). Liver, mesentery, kidneys and lungs of the sheep and goats of the present study were infected by *C. tenuicollis*. Normally, migration out of the liver, mesentery and other abdominal organs is not usual, however, aberrant migrants, similar to that of the present study, sometimes occur with cysticerci found in the lungs or other organs (Smith & Sherman, 2009). Prevalence of 5.6% and 25.0% of *C. tenuicollis* have previously been reported in wild sheep (Eslami *et al.*, 1981) and wild boar in Iran, respectively (Solaymani-Mohammadi *et al.*, 2003). This suggests that a sylvatic cycle between wild carnivores and wild herbivores occurs and that interaction between domestic cycle and sylvatic cycles may occur in this country (Radfar *et al.*, 2005). However, the prevalence of *C. tenuicollis* in sheep in the present study was comparable to those of the previous studies in Iran and other Afro-Asian countries, but the prevalence of infestation was comparatively higher in goats in the present study.

A prevalence of 37.03% for *C. tenuicollis* in sheep and 27.29% in goats in India (Pathak & Gaur, 1982), 21.4% in sheep, 34.2% in goats in Nigeria (Nwosu *et al.*, 1996), 18.04% in goats (Radfar *et al.*, 2005) and 28.4% in sheep in Iran (Oryan *et al.*, 1994) has previously been reported. However, higher prevalence rates of infestation with *C. tenuicollis* have previously been reported in the neighbouring and the African countries. A prevalence of 24.1% for *C. tenuicollis* in sheep from Bursa, Turkey (Senlik, 2008), 79.0% in sheep and 53.0% in goats from eastern Ethiopia (Sissay *et al.*, 2008), has previously been reported. In addition, the present findings showed that compared to a previous study that was undertaken 18 years ago by the same authors, the prevalence of *C. tenuicollis* is still high

in this area and serious systemic therapeutic and control programs has not taken place during the last two decades. No incidence for *C. tenuicollis* was present in cattle of the present investigation. However, no report on the infestation of cattle with *C. tenuicollis* is available in the literature. Influence of sex on the host indicated that similar to Senlik (2008) and Anwar *et al.* (1993) findings, the prevalence of *C. tenuicollis* infestation in male sheep and goats was higher than females.

The prevalence of *C. gaigeri* infestation in Iranian goats and sheep in the present study was 1.78% and 0.47%, respectively. Prevalence of 1.1% and 2.41% coenurus of *Multiceps gaigeri* in goats from India (Sadarnashipur & Lalgola, 1991; Sharma *et al.*, 1995) and 1.7% and 2.6% in goats and sheep from Iran (Gharagozlou *et al.*, 2003; Oryan *et al.*, 2010) have previously been reported. Cattle of the present study were not infected with *C. gaigeri*, however, infestation of cattle to *C. gaigeri* has not previously been reported. It has been shown that goats and sheep have been infected by both intramuscular (88% in goats, 60% in sheep) and subcutaneous coenuriasis (12% in goats, 40% in sheep) and it has been suggested that such an intramuscular and subcutaneous metacestode may belong to a different species of *Taenia* which is host specific for goats and sheep (Sharma & Chauhan, 2006). The prevalence of *C. gaigeri* indicated that goats of the present study showed significantly higher prevalence than sheep ( $p < 0.01$ ). This result is in accordance with those of Varma & Malviya (1989) in India and Gharagozlou *et al.* (2003) and Oryan *et al.* (2010) in Iran.

Information regarding *C. gaigeri* infestation is very scanty (Sharma *et al.*, 1995, 1998; Gharagozlou *et al.*, 2003; Oryan *et al.*, 2010) and it has been reported in sambhar, largest Oriental deer (Varma *et al.*, 1994), gemsbok (Bohrmann, 1990), sheep (Moghaddar, 2007), lower eyelid of kid (Raidurg & Reddy, 2009) and subcutaneous and muscles of fore and hind limbs of domestic goats (Oryan *et al.*, 2010). It has been reported that a massive infestation with

*C. gaigieri* cysts resulted in a progressive failure of locomotion that led to recumbency (Ramadan *et al.*, 1978). However, in most cases, the lightly infected animals remain normal and show no clinical signs, so the infestation could only be diagnosed at necropsy (Gharagozlou *et al.*, 2003; Oryan *et al.*, 2010).

The present study showed that the prevalence of hydatid cyst in sheep, goats and cattle were 45.52%, 10.00% and 11.60%, respectively. Dalimi *et al.* (2002) reported a mean prevalence of 8.1% hydatidosis in sheep, 38.3% in goats and 12.0% in cattle of various parts of Iran. Whereas, Daryani *et al.* (2007) reported prevalence values of 74.4%, 20.0%, and 38.3% hydatidosis in sheep, goats, and cattle in North of Iran, respectively. Various prevalence of hydatidosis infestation has previously been reported from the neighboring countries of Iran, including 0.2–11.2% in sheep, 5.0% in goats, 32.5–40.2% in cattle in Kuwait (Hassounah & Behbehani, 1976), 8.3% in sheep, 7.5% in goats and 5.5–9.6% in cattle in Pakistan (Khan *et al.*, 2001) and 4.5–44% in sheep, 3.1–26.7% in goats and 4.3–13.9% in cattle in Iraq (Saeed *et al.*, 2000). Other neighboring countries of Iran are also highly infected with hydatid cyst. Prevalence of 26.6% in sheep, 22.1% in goats and 13.5% in cattle in Turkey (Umur, 2003), 2.3–93.3% in sheep, and 1.1–72.7% in goats and 9.7–68.9% in cattle in India (Deka *et al.*, 1985), 4.5% in sheep, 2.3% in goats and 5.2% in cattle in Syria (Dajani, 1978) and 12.9% in sheep, 12.7% in goats, and 11.0% in cattle in Jordan (Kamhawi *et al.*, 1995) have previously been reported. A prevalence of 74.4% hydatid cyst in sheep, 20.0% in goats, 38.3% in cattle and 11.9% in buffaloes from Lorestan Province West of Iran (Daryani *et al.*, 2007) and a prevalence of 9.3%, 2.0% and 3.5% hydatidosis in sheep, goats and cattle in Ghom Province central Iran has previously been reported (Fakhar & Sadjjadi, 2007).

*Cysticercus ovis* was found only in the striated muscles of one sheep (0.095%). *Cysticercus ovis* is the larval stage of *Taenia ovis*, which is found in the small intestine of the canidae. The significance of this

parasite is financial loss in the meat industry (Soehl, 1984). Prevalences of 26.0% *C. ovis* infestation in sheep and 22.0% in goats from eastern Ethiopia (Sissay *et al.*, 2008), 20.5% in sheep in Western Australia (White, 1976) and 0.2% in sheep from southern Iran (Oryan *et al.*, 1994) have previously been reported.

High prevalence of metacestodes infestation in the present study could be due to high population of carnivores particularly stray dogs in the grazing area of domestic ruminants and lack of proper efforts in segregating domestic and wild carnivores from livestock or their grazing areas. Feeding offal of ruminants to dogs also enhance completion of the life cycle. The results of the present study indicate the importance of metacestodes infestation in this area. Their significance is not only because they have great economic importance resulting in losses due to condemnation of the infected organs and downgraded carcasses but it is also because of the zoonotic aspects of some of these infestations such as cysticercosis, hydatidosis and coenurosis. In addition, substantial economic loss due to treatment of human taeniasis remains to be evaluated.

Prevalences of 0.5–3% human infestations with *T. saginata* have recently been reported from different parts of Iran (Kia *et al.*, 2005; Solaymani *et al.*, 2011). In another study Daryani *et al.* (2008) reported that 14% of vegetables imported to and 16% of those cultivated in Ardabil, north-western Iran were contaminated with *T. saginata* eggs. Human cases of hydatidosis are regularly reported from different regions of Iran and it is one of the most important zoonotic diseases prevalent in different parts of this country (Mamishi *et al.*, 2007; Rafiei *et al.*, 2007; Ahmadi & Hamidi, 2008; Sarkari *et al.*, 2010; Ahmadi & Badi, 2011). Population studies on human hydatidosis, using serological and ultrasonographical methodologies, have shown 3.5–5.9% infestation in different areas of Iran (Sadjjadi, 2006; Sarkari *et al.*, 2010). Although there are reports of human coenurosis in the world (Antonios & Mina 2000) but this condition have not yet been reported in Iran.

In conclusion, this study has shown that some metacestodes are highly prevalent in sheep, goats and cattle raised in southern Iran. Due to the high prevalence of hydatid cysts, it is possible that hydatidosis is of public health importance in this region. Therefore, the status of hydatidosis infestation in humans in Iran needs to be properly investigated and the control measures such as public awareness and education programmes, revision and upgrading of meat inspection legislations and procedures, proper condemnation of the infected offal and effective control measures need to be introduced to reduce the stray dog population.

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