



# Bovine Cysticercosis with Special Attention to Its Prevalence, Economic Losses and Food Safety Importance in Kermanshah, West of Iran

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## Abstract

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**Background:** Bovine cysticercosis is one of the most important parasitic diseases caused by the metacestode stage of the human tapeworm *Taenia saginata*. The public health and economic consequences of this parasite may be considerable due to downgrading and the condemnation of carcasses. Therefore, this survey was designed to estimate the prevalence, economic losses and food safety importance of cattle cysticercosis at Kermanshah abattoir, west of Iran.

**Methods:** This study is a retrospective survey covering a period from March 2006 to March 2013. All daily condemnation records for cattle in the municipal abattoir of livestock animals in Kermanshah (the capital of Kermanshah province, west of Iran) were used as the sources of data. As part of an ongoing surveillance system, each slaughtered animal was examined individually by official meat inspectors. Statistical analysis was carried out using software SPSS version 16.0.

**Results:** From a total of 361787 cattle examined during this period, 284 (0.078%) were found infected with *Cysticercus bovis*; among those 183 (0.05%) of carcasses were treated and 101 (0.028%) of carcasses were condemned. Seasonal analysis revealed significantly higher ( $p < 0.05$ ) prevalence in summer. The rejected carcasses and infected organs were valued at 112302 USD over this period.

**Conclusion:** The findings obtained from this epidemiological investigation could be useful in order to design a comprehensive disease control strategy for cattle cysticercosis in this region of Iran.

## Introduction

Bovine cysticercosis is one of the most important parasitic diseases caused by the metacestode stage of the human tapeworm *Taenia saginata*. The public health and economic consequences of this parasite may be considerable due to downgrading and the condemnation of carcasses (Boone et al., 2007).

In the life cycle, *T. saginata* has two different stages in which larval stage (*Cysticercus bovis*) occurs in heart and skeletal muscles of cattle as intermediate host and adult

worm locates in intestine of human as final host (Garedaghi et al., 2012; Lees et al., 2002).

Cattle are infected after ingestion of feed or water containing the eggs expelled by the human feces. Although cysticercosis in cattle often has no clinical features, however, heavy infection may cause myocarditis. Human infection that occurs through consuming of infected raw or semi-cooked beef, may results in epigastric pains, diarrhea, nausea, weakness or loss of appetite (Lees et al., 2002; Neva et al., 1994).

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*T. saginata* has worldwide distribution, albeit at a very low prevalence in the developed countries. The moderate prevalence level is seen in southern Asia, while African countries have the highest prevalence rates and the parasite causes an important economic loss due to condemnation of meat in these countries (Cabaret et al., 2002).

Although some studies have previously been conducted in Iran in relation with bovine cysticercosis (Eslami et al., 2003; Jahed Khaniki et al., 2010; Oryan et al., 1995), there was not any data about this disease in the western Iran. Therefore, this survey was designed to estimate the prevalence, economic losses and food safety importance of cattle cysticercosis at Kermanshah abattoir, west of Iran for the period between 2006 and 2013.

## Materials and methods

### Study protocol and data obtaining

This study is a retrospective survey covering a period from March 2006 to March 2013. All daily condemnation records for cattle in the municipal abattoir of livestock animals in Kermanshah city (the capital of Kermanshah province, west of Iran) were used as the sources of data. As part of an ongoing surveillance system, each slaughtered animal was examined individually by official meat inspectors.

During post-mortem examination, the muscles and all visceral organs were examined in situ and then incised to detect cysticerci and observed pathological changes. Generalized infection was manifested by the presence of at least two or three cysts on each cut into the muscles of heart, mastication, diaphragm and its pillars or in muscles exposed during dressing procedures. Heavily, infected carcasses were condemned and those with light infection were treated by freezing for about 10 days at  $-10^{\circ}\text{C}$  or for application in meat industries (Herenda et al., 2000; Jahed Khaniki et al., 2010).

### Estimation of economic losses

The direct economic loss due to treatment of carcasses

and the carcass condemnations was calculated by the below procedure:

$$\text{DFL} = \text{CT or CC} \times \text{P} \times \text{W}$$

DFL: Direct financial loss

CT/CC: Number of treated or condemned carcasses due to bovine cysticercosis

P: Average carcass price (USD/kg)

W: Average carcass weight (kg)

The costs of carcasses treatment contained the expenses of storage in freezers and the carcass weight loss during this period. The average weight of each Iranian native cattle carcass is approximately 150 kg and this amount was considered in estimation of economic losses. The total costs were also calculated according to Iranian currency (Iranian Rial) exchange to the USD (Jahed Khaniki et al., 2010).

### Statistical analysis

Chi square test was used for comparison of the prevalence rates of bovine cysticercosis between years and seasons. Differences were considered significant when  $p < 0.05$ , using computer software SPSS version 16.0.

## Results

The prevalence of bovine cysticercosis during 2006–2013 in Kermanshah abattoir is summarized in Table 1. From a total of 361787 cattle examined during this period, 284 (0.078%) were found infected with *Cysticercus bovis*; among those, 183 (0.05%) of carcasses were treated and 101 (0.028%) of carcasses were condemned. The prevalence of infected carcasses was decreased significantly from 0.13% in 2006 to 0.06% in 2013. Seasonal analysis revealed significantly higher ( $p < 0.05$ ) prevalence in summer than in other seasons (Table 2).

Average annual direct economic losses due to carcass condemnation or treatment of infected carcasses were estimated to be 359366400 Rial or equivalent 112302 USD (Table 3).

**Table 1:** Prevalence of bovine cysticercosis in slaughtered cattle in Kermanshah, Iran abattoir during 2006–2013

Year	Slaughtered cattle No.	Infected carcasses No. (%)	Condemned carcasses No. (%)	Condemned/infected ratio
2006	62232	82 (0.132)	37 (0.059)	0.45
2007	48613	29 (0.060)	10 (0.021)	0.34
2008	61974	45 (0.073)	16 (0.026)	0.35
2009	50433	17 (0.034)	10 (0.020)	0.59
2010	41822	10 (0.024)	3 (0.007)	0.30
2011	40771	39 (0.096)	6 (0.015)	0.15
2012	33508	47 (0.140)	16 (0.048)	0.34
2013	22434	15 (0.067)	3 (0.013)	0.20
Total	361787	284 (0.078)	101 (0.028)	0.35

**Table 2:** Seasonal variation of carcasses condemnation due to cysticercosis in slaughtered cattle in Kermanshah, Iran during 2006–2013

Year	Spring		Summer		Fall		Winter		Total	
	SCN*	ICN** No. (%)	SCN	ICN No. (%)	SCN	ICN No. (%)	SCN	ICN No. (%)	SCN	ICN No. (%)
2006	16421	14 (0.085)	17404	50 (0.287)	14414	12 (0.083)	13993	6 (0.043)	62232	82 (0.132)
2007	11013	3 (0.027)	13402	6 (0.045)	11246	6 (0.053)	12952	14 (0.108)	48613	29 (0.060)
2008	14349	13 (0.090)	18227	16 (0.088)	14941	11 (0.074)	14457	5 (0.035)	61974	45 (0.073)
2009	12614	4 (0.032)	13966	9 (0.064)	11828	2 (0.017)	12025	2 (0.017)	50433	17 (0.034)
2010	10523	1 (0.009)	11537	4 (0.035)	9595	0 (0)	10167	5 (0.050)	41822	10 (0.024)
2011	9749	6 (0.061)	12474	8 (0.064)	8455	13 (0.153)	10093	12 (0.119)	40771	39 (0.096)
2012	8225	12 (0.146)	10440	21 (0.201)	8076	7 (0.087)	6767	7 (0.103)	33508	47 (0.140)
2013	5108	4 (0.078)	6331	2 (0.032)	5558	7 (0.126)	5437	2 (0.037)	22434	15 (0.067)
Total	88002	57 (0.065)	103781	116 (0.112)	84113	58 (0.069)	85891	53 (0.062)	361787	284 (0.078)

\*SCN=Slaughtered Cattle Number

\*\*ICN=Infected Cattle Number

**Table 3:** Estimated annual economic losses (USD) associated with bovine cysticercosis in slaughtered cattle in Kermanshah, Iran during 2006–2013

Year	Condemnation of carcasses	Treatment of infected carcasses	Total
2006	2289	1900	4186
2007	7220	812	8032
2008	13860	1512	15372
2009	10395	680	11075
2010	3740	480	4220
2011	8972	2246	11218
2012	28705	3214	31919
2013	6458	1224	7682
Total	102134	10168	112302

## Discussion

It is known that some parasitic infections such as bovine cysticercosis cause considerable economic losses in cattle due to the condemnation of carcasses and organs (Hajimohammadi et al., 2014; Shahbazi et al., 2014). Based on the literature, *T. saginata* cysticercosis is prevalent in cattle in many parts of Iran including Fars, Mazandaran, Lorestan and Ardabil provinces (Eslami et al., 2003; Garedaghi et al., 2012; Jahed Khaniki et al., 2010). Moreover, there are numerous reports of bovine cysticercosis from different countries particularly in southern Asia and Africa and also to a lesser extent in Europe (Boone et al., 2007; Dorny et al., 2002; Oryan et al., 1995).

During the present study period, bovine cysticercosis was detected in only 0.078% of cattle presented for slaughter at Kermanshah abattoir, west of Iran. The prevalence of this infection recorded in the present study was generally lower than those reported from other regions of Iran (Jahed Khaniki et al., 2010). In Iran, the highest rate of bovine cysticercosis has been reported in the northern provinces. In the study done by Amini and Siadat (1960) the prevalence rate of cysticercosis in cattle were 17% and 14% in

Mazandaran and Gilan provinces, respectively. In the other study, 35% of residents of a village in Mazandaran discharged *Taenia* proglottids after administration of anti-Taenia drug (Farahmandian et al., 1973). In a study performed in the slaughterhouse of Shiraz in Fars province, 7.7% of cattle were infected with *T. saginata* (Oryan et al., 1995). In a recent study in Fars province, the rate of bovine cysticercosis has been announced 0.6% (Oryan et al., 2012). According to abattoir surveys, the prevalence rate of bovine cysticercosis in Ardabil province was 3% (Garedaghi et al., 2012).

Since human is the only definitive host for *T. saginata*, the higher rate of human taeniasis in recent years throughout the country has also resulted to the increase of bovine cysticercosis in the mentioned area (Kia et al., 2005). However, it seems that the lower rate of bovine cysticercosis in Kermanshah province may have been the result of a real decrease of infections or of a less careful inspection of the carcasses in the abattoirs. Alternatively, some biological features may explain a lower risk of infection in Kermanshah. This province has an overall lower

demographic pressure—fewer tapeworm carriers resulting in lower *T. saginata* eggs pressure—compared to the other investigated provinces.

The highest prevalence of infection in this investigation was in summer and the lowest one was in winter. These findings disagree with the results of Oryan et al., (1995), who also recorded the highest incidence during spring and autumn and lowest in summer and winter in Fars province, Iran. It should be noted that the suitable temperature and humidity in late spring and during summer play an important role in the epidemiology of this infection in the west of Iran.

In our study, average annual direct economic losses due to bovine cysticercosis were estimated as high as 112302 USD. Regarding to the economic losses of *T. saginata*, it is so important to conduct some strategies such as control of the infection by treatment of tapeworm carriers on the farms and considering personal hygiene including the use of latrines which are likely to reduce the transmission in this area. Farmers should be fully supported and informed of the life cycle of *T. saginata* and potential risk factors for cattle to become infected. Moreover, the status of *Taenia* infestation in humans needs to be properly investigated and the control measures such as public awareness and education programs, revision and upgrading of meat inspection legislations and procedures and proper condemnation of the infected offal should be considered. On the other hand, it has been shown that determination of geographical regions where cattle are infected to cysticercosis is an effective strategy to control the disease in every country. This approach has been recently studied by Dupuy et al. (2015) who carried out spatial analysis of cysticercosis in cattle slaughtered in France.

## Conclusion

The findings obtained from this epidemiological investigation could be useful in order to design a comprehensive disease control strategy for cattle cysticercosis in this region of Iran.

## Conflicts of interest

The authors declare no conflicts of interest.

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