Liver condemnation and economic losses due to parasitic infections in slaughtered animals in Iran

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Received: 26 May 2012 / Accepted: 31 August 2012 / Published online: 18 September 2012
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Abstract The prevalences of parasitic infections responsible for the condemnation of liver during meat inspection, and their economic implication were estimated in slaughtered animals in Iran. The liver organ was examined for the presence of parasitic lesions during meat inspection in cattle, camel, buffalo, sheep and goat. The parasitic agents observed in the condemned livers of these animals were *Fasciola* spp., *Dicrocoelium dendriticum*, *Cysticercus tenuicollis* and hydatid cyst. The average percentages of liver condemnation for three years period by *Fasciola* spp., *D. dendriticum*, *Cysticercus* and hydatid cyst were 2.12, 2.71, 0.04, and 2.88 %, respectively. The mean prevalence of *Fasciola* spp. in cattle, sheep, goat, camel and buffalo was 4.32, 1.85, 1.56, 1.31 and 9.31 %, respectively and the mean prevalence of *D. dendriticum* in those animals were 3.65, 2.66, 2.19, 5.09 and 3.90 %, respectively. Also, the mean prevalence of *Cysticercus* and hydatid cyst were 0.13 and 3.72 % in cattle, 0.04 and 2.85 % in sheep, 0.05 and 2.40 % in goat, 0.02 and 8.22 % in camel and 0.001 and 5.48 % in buffalo, respectively. The most contributing parasites to marketable liver condemnation were hydatid

cyst in sheep, goat and camel and *Fasciola* spp. in cattle and buffalo, and the average annual cost for condemned livers was 8.2 million USD.

Keywords Parasites · Liver · Slaughtered animals · Public health · Prevalence · Economic losses

Introduction

There are many known species of parasites in animals that can be important in livestock production. They have direct costs such as liver and carcass condemnation or medical expenses. Animals for slaughtering may show no clinical signs of diseases and they are detected at the slaughter house. True picture of these diseases could be obtained if they well condemned. The direct cost of infected organs is the loss of edible offal (mainly liver) from infected animals. The affected parts of the organ are trimmed or the whole organ might be condemned (Kara et al. 2009; Cadmus and Adesokan 2009).

Among parasites affecting livestock, liver flukes are very frequent. *Fasciola hepatica* (Kaplan 2001) and *F. gigantica* (Mungube et al. 2006) are well-known parasite of domesticated ruminants causing significant economic losses in the cattle and sheep industries of some countries. Clinical signs of digestive inefficiency are evident in young cattle with acute liver disease and in older cattle with chronic liver disease (Doyle 2003).

Dicrocoelium dendriticum is also liver fluke in different ruminants, as definitive host. When the definitive host eats the second intermediate host (ant) the metacercariae penetrate the intestinal wall and reach the liver where they mature and complete their life cycle (Soulsby 1982; Markell et al. 1992).

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Cysticercus tenuicollis is the larval stage of *Taenia hydatigena*, a tapeworm of dogs and wild carnivores. The *cysticerci* are found in liver and on peritoneum in sheep but also in other ruminants including wild ones and pigs. Hydatid cyst is larval stage of *Echinococcus granulosus*, the dog small tapeworm. Human and herbivorous intermediate hosts are infected to hydatid cyst by ingestion of eggs which are shed in the faeces of dogs. Hydatidosis in domestic ruminants such as sheep, goat, cattle and buffalo, inflicts enormous economic damage due to the condemnation of affected organs and lowering the meat, milk and wool production.

In Iran, *Fasciola* spp. and hydatid cyst are the common liver parasites in animals and also humans as serious public health problem (Rokni 2008; Baharsefat et al. 2007). To the lesser extent, *D. dendriticum* (Daryani et al. 2006a) and *C. tenuicollis* (Radfar et al. 2005) are also affecting liver of livestock. Cysticercosis (Jahed Khaniki et al. 2010) and sarcocystosis (Jahed Khaniki and Kia 2006) are also parasitic diseases that have been reported affecting the meat of domestic animals. Some studies had previously been conducted in some parts of the country about prevalences of hydatid cyst and other liver helminthes in cattle, sheep (Moshfe et al. 2003; Yakhchali and Ghobadi 2005), goat, camel (Radfar et al. 2006) and buffalo (Daryani et al. 2006b). These animal parasitic diseases have seriously affected the productivity of livestock production. However, in view of obtaining new information, this study was carried out to determine the conditions of liver condemnations by parasitic agents in slaughtered animals in Iran.

Materials and methods

Descriptive of study

The study was carried out as a descriptive and cross-sectional study from 2005 to 2007 in Iran. Various municipality abattoirs throughout the country were referred to by Veterinary Organization and the data was gathered from all these sites. Slaughtered animals including sheep, goat, cattle and calves, buffalo and camel were subjected to routine meat inspection carefully by veterinary medicine doctor or veterinary technician after slaughter practices. Liver of every animal was thoroughly inspected for common parasitic agents after one or more incisions and observation examinations.

Whole infected liver or infected parts of liver was condemned and destroyed. Judgment was dependent on the extent of the parasite lesions in liver. If the parasitic lesions in the liver were clearly circumscribed, the liver was salvaged after trimming of affected tissue; otherwise it was condemned. Liver of infested animals with heavily lesions

were condemned according to FAO regulations (Herenda et al. 2000).

Statistical analysis and liver condemnation

Prevalence of liver condemnation was calculated as the number of livers found to be untrimmed with parasites, expressed as a percentage of the total number of cattle slaughtered. A percentage to measure prevalence was the statistical tools applied. The economic significance of the problem was analyzed based on the information obtained from market and calculated on annual basis.

Estimation of economic loss

The economic losses of infected livers were calculated from the liver condemnations according the mean liver weight of slaughtered sheep, goat, cattle, buffalo and camel in Iran. Also, the total quantity of all costs was considered according to Iranian currency (Iranian Rial) exchange to US dollar (USD).

Results and discussion

Analysis of the meat inspection records in Iran abattoirs are presented in Tables 1 and 2. The number of sheep, goat, cattle, buffalo and camel slaughtered and inspected for liver infestation at abattoirs in Iran, during 2005–2007, has shown in Table 1. During this period a total of 26,104,864 sheep, 7,268,063 goats, 4,534,105 cattle and calves, 141,249 buffalo and 60,792 camels were slaughtered and examined at abattoirs for liver infestation with parasites. The highest and least number of slaughtering is related to sheep and camel, respectively.

The prevalences of parasitic agents of liver in slaughtered animals in Iran during 2005–2007 are shown in Table 2. In postmortem findings, *F. hepatica*, *F. gigantica*, *D. dendriticum*, *Cysticerci* and hydatid cyst were the parasitic agents of liver condemnation in slaughtered animals. Since for every infected liver no discrimination was performed for *F. hepatica* and *F. gigantica*, and for species of *Cysticercus*, the results of infectivity with the two earlier species were pooled and presented as *Fasciola* spp. and the later as *Cysticerci*.

The annual economic loss associated with liver condemnations by parasitic agents has been presented in Table 3. For all parasitic agents and all 3 years the most annual economic loss is related to cattle liver condemnations. The total quantity of liver amounted to an economic loss value as USD by *Fasciola* spp., *D. dendriticum*, *Cysticerci* and hydatid cyst were USD 7,948,332, USD 8,099,418, USD 93,726 and USD 8,655,154, respectively.

Table 1 Number of slaughtered animals in abattoirs of Iran

Years	Sheep	Goat	Cattle and calves	Buffalo	Camel	Total
2005	8,058,000	2,250,081	1,626,586	44,941	20,118	11,999,726
2006	8,514,627	2,234,199	1,427,663	50,293	16,235	12,243,017
2007	9,532,237	2,783,783	1,479,856	46,015	24,439	13,366,330
Total	26,104,864	7,268,063	4,534,105	141,249	60,792	38,109,073

Table 2 Frequency of parasitic agents causing liver condemnations in slaughtered animals

Parasitic agent	Years	Sheep no. (%)	Goat no. (%)	Cattle no. (%)	Buffalo no. (%)	Camel no. (%)	Total no. (%)
<i>Fasciola</i> spp.	2005	141,081 (1.8)	29,803 (1.3)	60,986 (3.75)	4,081 (9.10)	489 (2.43)	236,440 (1.97)
	2006	139,487 (1.64)	32,567 (1.46)	65,871 (4.61)	4,745 (9.43)	130 (0.80)	242,800 (1.98)
	2007	202,171 (2.12)	53,059 (1.91)	68,124 (4.60)	4,323 (9.39)	169 (0.69)	327,846 (2.45)
	Total	482,739 (1.85)	115,429 (1.56)	194,981 (4.32)	13,149 (9.31)	788 (1.31)	807,086 (2.12)
<i>Dicrocoelium dendriticum</i>	2005	194,383 (2.41)	41,420 (1.84)	66,601 (4.1)	975 (2.17)	2,655 (13.20)	306,034 (2.55)
	2006	230,044 (2.71)	53,434 (2.39)	47,992 (3.36)	3,379 (6.72)	154 (0.95)	335,003 (2.74)
	2007	272,279 (2.86)	65,366 (2.35)	51,707 (3.49)	1,295 (2.81)	272 (1.11)	390,919 (2.92)
	Total	696,706 (2.66)	160,220 (2.19)	166,300 (3.65)	5,649 (3.90)	3,081 (5.09)	1,031,956 (2.71)
<i>Cysticerci</i>	2005	2,183 (0.03)	505 (0.02)	5,050 (0.31)	1 (0.002)	0 (0)	7,739 (0.07)
	2006	2,834 (0.03)	1,096 (0.05)	376 (0.03)	0 (0)	11 (0.07)	4,317 (0.03)
	2007	5,756 (0.06)	1,908 (0.07)	528 (0.04)	0 (0)	0 (0)	8,192 (0.03)
	Total	10,773 (0.04)	3,509 (0.05)	5,954 (0.13)	1 (0.001)	11 (0.02)	20,248 (0.04)
Hydatid cyst	2005	217,807 (2.70)	41,645 (1.85)	47,019 (2.89)	1,677 (3.73)	2,533 (12.59)	310,681 (2.59)
	2006	231,902 (2.72)	52,287 (2.34)	59,080 (4.14)	4,063 (8.08)	1,020 (6.28)	348,352 (2.84)
	2007	299,509 (3.14)	84,140 (3.02)	60,953 (4.12)	2,137 (4.64)	1,416 (5.79)	448,155 (3.35)
	Total	749,218 (2.85)	178,072 (2.40)	167,052 (3.72)	7,877 (5.48)	4,969 (8.22)	1,107,188 (2.88)

Table 3 Estimated annual economic losses (USD) associated with liver condemnations by parasitic agents in slaughtered animals

Parasitic agent	Years	Sheep (USD)	Goat (USD)	Cattle (USD)	Buffalo (USD)	Camel (USD)	Total (USD)
<i>Fasciola</i> spp.	2005	561,206	79,036	1,347,757	81,170	14,589	2,083,758
	2006	633,346	98,581	1,780,297	113,221	5,059	2,630,504
	2007	962,719	168,441	1,982,445	113,222	7,243	3,234,070
	Total	2,157,271	346,058	5,110,499	307,613	26,891	7,948,332
<i>Dicrocoelium dendriticum</i>	2005	773,236	109,843	1,471,845	19,392	79,212	2,453,528
	2006	1,044,524	161,746	1,297,081	82,192	5,994	2,591,537
	2007	1,296,567	207,511	1,504,701	33,917	11,657	3,054,354
	Total	3,114,327	479,100	4,273,627	135,501	96,863	8,099,418
<i>Cysticerci</i>	2005	7,767	1,339	11,160	20	0	20,286
	2006	12,869	3,317	10,162	0	428	26,776
	2007	27,421	6,060	13,183	0	0	46,664
	Total	48,057	10,716	34,505	20	428	93,726
Hydatid cyst	2005	866,410	110,440	1,039,094	33,355	75,572	2,124,871
	2006	1,052,960	158,274	1,596,757	98,830	39,697	2,946,518
	2007	1,426,233	267,111	1,773,765	55,969	60,687	3,583,765
	Total	3,345,603	535,825	4,409,616	188,154	175,956	8,655,154

A considerable economic loss of liver worm infections is related to condemnation of edible organs such as liver. Therefore, it is important to present reliable data for

monitoring epidemiologic aspects of hepatic infections. In the present study, the parasitic agents observed in the condemned livers of cattle, camel, buffalo, sheep and goats

were *Fasciola* spp., *D. dendriticum*, *Cysticercus* and hydatid cysts. Mean prevalence of fasciolosis in cattle, sheep and goats was 4.32, 1.85 and 1.56 %, respectively. On the other hand, mean prevalence of dicrocoeliosis in those animals was 3.65, 2.66, and 2.19 %, respectively. Also, the mean prevalence of *Cysticerci* and hydatid cyst were 0.13 and 3.72 % in cattle, 0.04 and 2.85 % in sheep, 0.05 and 2.40 % in goat, 0.02 and 8.22 % in camel and 0.001 and 5.48 % in buffalo, respectively. The highest rate of infectivity with hydatid cyst was found in camel (8.22 %), and for *Fasciola* spp. was found in buffalo (9.31 %). Ahmadi and Meshkekar (2010) reported the frequency of fasciolosis and dicrocoeliosis in Khuzestan Province of Iran about 35.01 and 2.28 % of total liver condemnations, respectively. Ansari-Lari and Moazzeni (2006) performed a retrospective survey of liver fluke disease in livestock based on abattoir data in Fars Province, south of Iran and found that fasciolosis and dicrocoeliosis were responsible for 54 and 21 % of total liver condemnations, respectively. In a survey, Moghaddam et al. (2004) carried out a study in slaughtered animals of Mazandaran Province and reported the infection rate of *Fasciola* spp. with 4.6 % in cattle, 5.7 % in sheep and 1.6 % in goats. Also, in a slaughter house survey in Ardabil Province, the occurrence of *F. hepatica* and *D. dendriticum* was reported 25.9 and 10.6 % in cattle, 5.3 and 6.8 % in sheep, and 4.9 and 12.4 % in goats, respectively (Daryani et al. 2006a). Radfar et al. (2005) reported that the rate of *C. tenuicollis* in slaughtered sheep and goats in south-eastern Iran was 12.87 and 18.04 %, respectively. In sheep 84.85 % and in goats 82.14 % of the cysts were located in the omentum and this cite predilection was significant ($P < 0.05$). The results of the current study indicated that *C. tenuicollis* was the least prevalent parasite of liver in all animals; this is in agreement with the result of the mentioned study. Daryani et al. (2006b) found that the prevalence rate of hydatid cyst in slaughtered cattle, buffalo, sheep and goats in Northwest Iran was 38.3, 11.9, 74.4 and 20 %, respectively.

In this survey, liver infection with mentioned parasites in slaughtered cattle was almost two times more than those observed in sheep and goats; and in buffalo and camel it was more than those of cattle. The epidemiologic implication of this finding might be attributed at least partly to the sources of their main food and also to shorter age of sheep and goat at the time of slaughtering. Total condemnation of liver caused by fasciolosis in cattle, buffalo and camel was more than that observed for dicrocoeliosis and total condemnation of liver caused by *Cysticerci* in cattle was more than other animals. Total liver condemnation occurred by hydatid cyst in sheep was more than that observed in other animals due to the higher number of slaughtered sheep. Also, the total liver condemnation occurred by hydatid cyst in camel was more than that

observed in slaughtered cattle. This reason can be related to the high sensitivity of camel to hydatid cyst infection and their higher age at the time of slaughtering. Also, contrary to the hydatid cysts in cattle which are mostly unfertile, cysts in camel are mainly fertile (Sharbatkhori et al. 2011) which helps to increase the load contamination in camel (Ibrahim and Craig 1998; Ahmadi 2005).

According to the results of the present study liver infection by *C. tenuicollis* was much less than other parasites. In addition to low tendency of this parasite to liver, its prevalence in Iran is less than that reported from other countries (Radfar et al. 2005). The high economic losses from liver condemnation is induced by hydatid cyst, *D. dendriticum* and *Fasciola* spp. The annual economic loss associated with these parasites reach to million dollars which can be important for livestock industry in Iran. Considering the medical impotence of fasciolosis, which imposed two human outbreaks at last decade in northern parts of the county, and hydatid cyst, which constitutes approximately 1 % of all admission to surgical wards (Rokni 2008), the importance of livestock infectivity with these parasites and their role in spread of infection to the environment is emphasized.

Conclusions

It must be mentioned that the observable liver inspection is the only public health measure implemented to control transmission to humans, but it lacks sensitivity and objectivity. The data obtained from abattoirs are not so accurate and definitely cases with low parasite burden are missed. However, this survey can assist to illustrate the usefulness of meat inspection records in situations of liver parasitic infection in Iran, especially for hydatid cyst and *Fasciola* spp. which are medically important human parasites in the country. Also, it can provide a preliminary baseline data for the future monitoring of these potentially important parasitic diseases for improving animal health, prevention of disease and reduction of economic losses by liver condemnations.

Acknowledgments The authors would like to thank Dr. Parviz Golrang and Mr. Ali Mohammad Khani from Iranian Veterinary Organization and Afsaneh Motevalli Haghi and Mina Selseleh from Tehran University of Medical Sciences for their kind assistance.

References

- Ahmadi NA (2005) Hydatidosis in camels (*Camelus dromedarius*) and their potential role in the epidemiology of *Echinococcus granulosus* in Iran. J Helminthol 79:119–125
- Ahmadi NA, Meshkekar M (2010) Prevalence and long term trend of liver fluke infections in sheep, goats and cattle slaughtered in Khuzestan, south western Iran. J Paramedical Sci 1:26–31

- Ansari-Lari M, Moazzeni M (2006) A retrospective survey of liver fluke disease in livestock based on abattoir data in Shiraz, south of Iran. *Prev Vet Med* 73:93–96
- Baharsefat M, Massoud J, Mobedi I, Farahnak A, Rokni MB (2007) Seroepidemiology of human hydatidosis in Golestan Province Iran. *Iran J Parasitol* 2:20–24
- Cadmus SIB, Adesokan HK (2009) Causes and implications of bovine organs/offal condemnations in some abattoirs in Western Nigeria. *Trop Anim Health Prod* 41:1455–1463
- Daryani A, Alaei R, Arab R, Sharif M, Dehghan MH, Ziaei H (2006a) Prevalence of liver fluke infections in slaughtered animals in Ardabil province. *J Anim Vet Adv* 5:408–411
- Daryani A, Alaei R, Arab R, Sharif M, Dehghan MH, Ziaei H (2006b) Prevalence of hydatid cyst in slaughtered animals in Northwest Iran. *J Anim Vet Adv* 4:330–334
- Doyle E (2003) Food borne parasites: a review of the scientific literature. Food Research Institute, University of Wisconsin, Madison, p 28
- Herenda D, Chambers PG, Ettriqui A, Seneviratna P, da Silva P (2000) Manual on meat inspection for developing countries. FAO Animal production and health, paper 119
- Ibrahim MM, Craig PS (1998) Prevalence of cystic echinococcosis in camels (*Camelus dromedarius*) in Libya. *J Helminthol* 72:27–31
- Jahed Khaniki GhR, Kia EB (2006) Detection of *Sarcocystis* cysts in meat supplied for hamburger in Iran by histological method. *J Med Sci* 6:18–21
- Jahed Khaniki GhR, Raei M, Kia EB, Motevalli Haghi A, Selseleh M (2010) Prevalence of bovine cysticercosis in slaughtered cattle in Iran. *Trop Anim Health Prod* 42:141–143
- Kaplan RM (2001) *Fasciola hepatica*: a review of the economic impact in cattle and considerations for control. *Vet Ther* 2:40–50
- Kara M, Gicik Y, Sari B, Bulut H, Arslan MO (2009) A slaughterhouse study on prevalence of some helminths of cattle and sheep in Malatya Province, Turkey. *J Anim Vet Adv* 8:2200–2205
- Markell EK, Voge M, John DT (1992) Medical Parasitology, 7th edn. WB Saunders, Philadelphia, pp 195–196
- Moghaddam AS, Massoud J, Mahmoodi M, Mahvi AH, Periago MV, Artigas P, Fuentes MV, Bargues MD, Mas-Coma S (2004) Human and animal fascioliasis in Mazandaran Province, northern Iran. *Parasitol Res* 94:61–69
- Moshfe AA, Bagheri M, Mohebi Nobandeghany Z (2003) Prevalence of *Fasciola hepatica* in slaughtered livestock in Yasuj's slaughterhouse, 2001–2002. *Armaghan Danesh* 30:25–32
- Mungube EO, Bauni SM, Tenhagen BA, Wamae LW, Nginyi JM, Mugambi JM (2006) The prevalence and economic significance of *Fasciola gigantica* and *Stilesia hepatica* in slaughtered animals in the semi-arid coastal Kenya. *Trop Animal Health Prod* 38:475–483
- Radfar MH, Tajalli S, Jalalzadeh M (2005) Prevalence and morphological characterization of *Cysticercus tenuicollis* (*Taenia hydatigena* cysticerci) from sheep and goats in Iran. *Veternarski Arhiv* 75:469–476
- Radfar MH, Ebrahimi MA, Sharifi BA (2006) A report of camel parasitic infection from Kerman slaughterhouse. *Vet Res J* 61:165–168
- Rokni MB (2008) The present status of human helminthic diseases in Iran. *Ann Trop Med Parasitol* 102:283–295
- Sharbatkhori M, Fasihi Harandi M, Mirhendi H, Hajialilo E, Kia EB (2011) Sequence analysis of *cox1* and *nad1* genes in *Echinococcus granulosus* G3 genotype in camels (*Camelus dromedarius*) from central Iran. *Parasitol Res* 108:521–527
- Soulsby EJ (1982) Helminths, arthropods and protozoa of domesticated animals, 7th edn. Bailliere Tindall and Cassel, London, pp 24–26
- Yakhchali M, Ghobadi K (2005) Investigation of liver worm infection in sheep in Isfahan abattoir and estimation of economic losses. *Iran Vet J* 9:60–65