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A RETROSPECTIVE STUDY OF ABATTOIR CONDEMNATION DUE TO PARASITIC INFECTIONS: ECONOMIC IMPORTANCE IN AHWAZ, SOUTHWESTERN IRAN

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ABSTRACT: A 5-yr retrospective study in livestock slaughtered in abattoirs was carried out in Khuzestan Province (southwestern Iran) to determine the prevalence of parasitic infections responsible for condemnation of slaughtered animals' carcasses and viscera. The economic importance of such infections in terms of lost meat and offal were also estimated. Between 20 March 2006 and 19 March 2011, 125,593 cattle, 1,191,871 sheep, 240,221 goats, and 25,010 buffalos were slaughtered in the study area; the livers of 58,753 (3.7%; 95% confidence interval [CI]: 3.7–3.8%), the lungs of 34,522 (2.2%; 95% CI: 2.1–2.2%), and the carcasses of 78 (0.0049% 95% CI: 0.0048–0.0049%) of these animals were condemned. Proportions of liver, lung, and carcass condemnations during the 5-yr study period in buffalos were significantly greater than the other species ($P < 0.001$). Frequency of liver condemnation during the 5-yr period for cattle was greater than sheep and goats ($P < 0.001$), but condemnation of lungs in goat was significantly greater than sheep and cattle ($P < 0.001$). The parasitic lesions observed in the condemned livers were attributed to *Echinococcus granulosus*, *Fasciola hepatica*, or *Dicrocoelium dendriticum*, or some combination of these species. All the parasitic lesions observed in the condemned lungs from cattle, sheep, goats, and buffalos are ascribed to *E. granulosus*. *Sarcocystis* spp. cysts were found in ovine and buffalo muscles, whereas *Taenia* sp. cysticerci were detected in bovine muscle. Muscles of goats were devoid of any parasitic lesions. Parasites were responsible for 54.1% of the condemned organs or carcasses, with a retail value (based on market prices in 2011) of $1,148,181 (U.S.) ($137,880 for cattle, $602,699 for sheep, $280,955 for goats, and $126,647 for buffalos). The parasites contributing most to the condemnation of otherwise marketable organs and flesh were *E. granulosus* (29.2%) and *F. hepatica* (18.6%). These parasites clearly remain the most common, causing considerable economic loss in Khuzestan Province and, presumably, other areas of Iran.

Parasitic diseases are considered as a major obstacle in the health and food safety with animal origin and cause economic loss in countries where livestock industry is an important segment of the agricultural products. Considering the economic significance resulting from parasitic diseases in Iran, financial losses were estimated at various levels in different locations. Hence, it would be essential to have information on the status of parasitic diseases with regard to its magnitude of occurrence and negative economic impact from different parts of the country to establish appropriate strategy for prevention and control. Yet, information regarding financial loss due to parasite-related condemnation of offal and meat is very limited in Khuzestan Province, which is an important livestock production area located in southwestern Iran. Therefore, the objectives of the current study were to determine the prevalence of parasitic infections responsible for the condemnation of carcasses and viscera during meat inspection, and their economic impact in this region.

MATERIALS AND METHODS

This study was based on a retrospective survey covering a 5-yr period (20 March 2006–19 March 2011) in an abattoir in Ahwaz, capital of Khuzestan Province. The study area has great potential for agricultural expansion because of large water reservoirs associated with the Karoun and Karkheh Rivers. In 2011, livestock populations included approximately 2,661,000 sheep, 1,369,000 goats, 399,000 cattle, and 102,000 buffalos (www.ivo.org.ir). Ahwaz has a semiarid climate with long, extremely hot summers and mild, short winters. The average annual rainfall in this area is about 230 mm and air temperature ranges between 4 and 50 C in cold and warm seasons, respectively.

Meat inspection records of an abattoir were provided by an experienced team of veterinarians. The number and type of organs or condemned carcasses, and the reason for each condemnation were recorded daily on standardized data sheets. For the present study, the condemnation data were gathered on a yearly (March–March) basis. In April 2011, with the use of information from meat markets in the study area, the average monetary values of sheep, goat, cattle or buffalo carcasses were $725, $725, $1,100 and $1,100 (U.S.), respectively. The prices of sheep, goat, cattle, and buffalo livers were $18, $18, $13.6, and $13.6 (U.S.), respectively. The lungs of sheep, goats, cattle, and buffalos were priced at $2.7, $2.7, $0.9, and $0.9 (U.S.), respectively. These commercial values were then used to estimate the economic loss represented by the parasite-related condemnations over a 5-yr study period.

For data analysis, version 16 of the SPSS software package (SPSS Inc., Chicago, Illinois) was used. Proportion of organ and carcass condemnations between, and within, species was compared with the use of a chi-square test. Annual trends in risks of liver, lung, and carcass condemnations across the 5-yr period were calculated (Armitage et al., 2002) for each host and parasite separately. $P \leq 0.05$ were considered as statistically significant.

RESULTS

Between 20 March 2006 and 19 of March 2011, 125,593 cattle, 1,191,871 sheep, 240,221 goats, and 25,010 buffalos were slaughtered. The livers of 58,753 (3.71%; 95% CI: 3.68–3.74%), the lungs of 34,522 (2.18%; 95% CI: 2.16–2.20%), and the carcasses of 78 (0.0049%; 95% CI: 0.00488–0.00491%) animals were judged unfit for human consumption.

After inspection of bovine carcass offal, 7.9% of livers, 3.4% of lungs, and 0.01% of carcasses were condemned due to parasite infection. The corresponding values were 2.5%, 1.5%, and 0.001% for sheep, 6.1%, 3.8%, and 0 for goats, and 15.0%, 10.8%, and 0.3% for buffalos (Fig. 1). Proportions of liver, lung, and carcass condemnations during the 5-yr study period in buffalos were significantly greater than other species ($P < 0.001$). Frequency of liver condemnation during the 5-yr period for cattle was greater than sheep and goat ($P < 0.001$), and lung condemnation in goats was significantly greater than sheep and cattle ($P < 0.001$). For all species, the proportion of liver condemnation was greater than those of lung and carcass condemnation ($P < 0.001$).

Livers

The parasitic lesions observed in the livers of the slaughtered cattle, sheep, and goats were caused by 3 species of parasites, i.e.,

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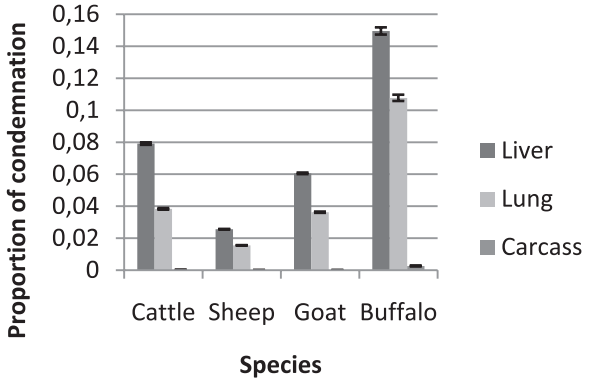

FIGURE 1. Proportion of liver, lung and carcass condemnation in Ahvaz abattoirs from 2006–2011.

Fasciola hepatica (adults), *Echinococcus granulosus* (hydatid cysts), and *Dicrocoelium dendriticum* (adults). Of the cattle livers inspected over the entire study period, 5.3% were condemned because they harbored *F. hepatica*. Percentages for sheep, goats, and buffalos were 0.9, 2.3, and 10.4%, respectively. The proportion of liver condemnation due to fascioliasis in buffalos was significantly greater than cattle, sheep, and goats. Also, condemnation for cattle was significantly greater than for sheep and goats ($P < 0.001$). The annual prevalence for these parasitic infections in the study period is shown in Figure 2A. The overall trends were significant for cattle, sheep, and buffalos ($P < 0.001$). The proportions of condemned liver due to hydatid disease in cattle, sheep, goats, and buffalos during the study period were 2.4, 1.4, 3.2, and 4.3%, respectively. The proportion of liver condemnation because of hydatid cysts in buffalos was significantly greater than cattle, sheep, and goats. In addition, this value for goats was significantly greater than for sheep and cattle ($P < 0.001$). The annual trends for these parasitic infections in the 5-yr period are shown in Figure 2B. The overall trends were significant for all species ($P < 0.01$). Percentage of liver infections with *D. dendriticum* in cattle, sheep, goats, and buffalos was 0.2, 0.2, 0.3, and 0.2%, respectively. The proportion of liver condemnation due to hydatid disease in goats was significantly greater than cattle, sheep, and buffaloes; its prevalence in cattle and buffaloes were significantly greater than for sheep ($P < 0.001$). The overall trends were significant for all species (Fig. 2C; $P < 0.001$).

Lungs

The presence of hydatid cysts in lungs convinced the meat inspectors to reject 3.8, 1.6, 3.6, and 10.8% of cattle, sheep, goats, and buffaloes, respectively. The proportion of lung condemnation due to hydatid disease in buffalos was significantly greater than goat, sheep, and cattle; the rejection of cattle lungs was significantly greater than for sheep and goats ($P < 0.01$). The annual trends for these parasitic infections in the 5-yr period are shown in Figure 3. The overall trends were significant for all species ($P < 0.001$).

Carcasses

Each time a carcass of sheep, cattle, or buffalo was rejected, it was because of parasitic infection. Over the entire survey period, 10 (0.01%) of the inspected cattle carcasses and 9 (0.04%) of the inspected buffalo carcasses were condemned because of the presence of *Taenia* sp. cysticerci in the muscles. One of the

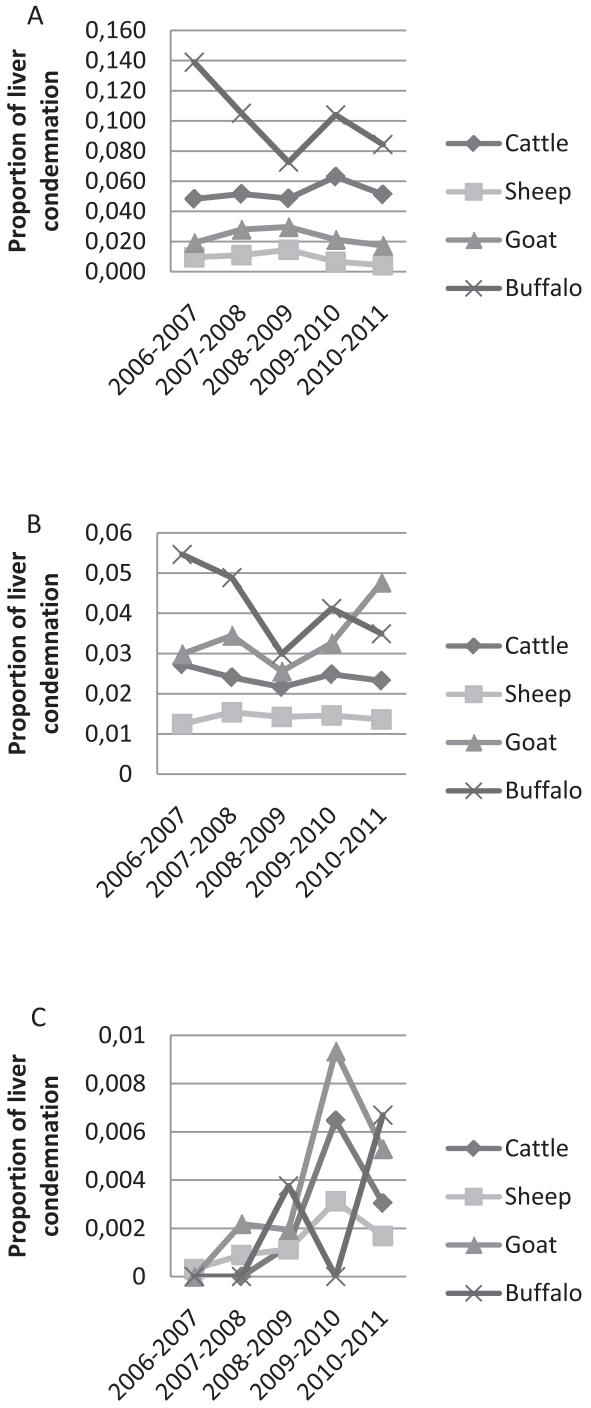

FIGURE 2. Annual trend of liver condemnation because of *Fasciola hepatica* (**A**), hydatid cyst (**B**), and *Dicrocelioum dendriticum* (**C**) infection in Ahvaz abattoirs from 2006–2011.

inspected sheep carcasses and 58 of the inspected buffalos carcasses were rejected because *Sarcocystis* sp. cysts were found in the muscles.

Economic losses

The total value of the meat and offal lost because of parasite-related condemnation in the study district over the 5-yr study period was estimated to be $1,148,181 (U.S.) (based on market

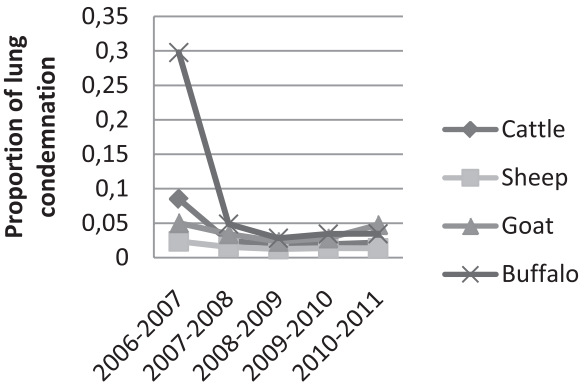

FIGURE 3. Annual trend of lung condemnation because of hydatid cyst infection in Ahvaz abattoirs from 2006–2011.

prices in 2011). Of this total, $137,880 was associated with the condemned cattle carcasses and viscera, $602,699 with the condemned sheep carcasses and viscera, $280,955.00 with condemned goat carcasses and viscera, and $126,647 with the condemned buffalo viscera only.

DISCUSSION

This survey illustrated the usefulness of meat inspection records in monitoring disease conditions and demonstrated possible annual trends. However, it must be remembered that the actual prevalence of the infection in slaughtered animals may be underestimated due to potentially inadequate meat inspection, rapid slaughter rates, and substandard training of inspectors. The present results, which provide useful baseline data for any future attempt at controlling the parasites involved, indicate that, in Khuzestan Province, several helminths (particularly *E. granulosus*) cause considerable economic loss because infected organs and flesh must be condemned.

The prevalence of *E. granulosus* infection recorded in the present study were, in general, lower than those reported from other regions of Iran (Oryan et al., 1994; Ansari-Lari, 2005; Arbabi and Hooshyar, 2006; Daryani et al., 2007; Borji and Parandeh, 2010; Ahmadi and Meshkehkar, 2011; Borji et al., 2012) and its neighbor countries, i.e., Saudi Arabia (Ibrahim, 2010), Iraq (Saeed et al., 2000), and Jordan (Kamhawi et al., 1995). Interestingly, slaughtered goats were almost 3-fold more likely to possess hydatid cysts as compared to sheep, but this may be due to a difference in genotypes of *E. granulosus* that infect goats and sheep (Varcasia et al., 2007). Moreover, the grazing behavior of goats is such that the roots of grass are grazed as well as the leaves, but sheep normally graze just the top parts of grasses. Although the prevalence of echinococciasis is known to be highly dependent on the age of the potential host (Torgerson et al., 1998; Lahmar et al., 1999), the abattoir records analyzed here did not include the age of the animals at slaughter. In Jordan, Torgerson et al. (1998) reported prevalence in 1-, 2-, and 3-yr-old sheep of 27%, 47%, and 62%, respectively, while the corresponding prevalence in goats were 6%, 11%, and 16%, respectively. If the slaughtered animals are mainly young, the prevalence of infection at slaughter may, therefore, be an underestimation of the total burden (and threat to the local human population) posed by echinococciasis. In the present study, hydatid cysts were found in about 1–2% of the sheep livers, 2–5% of the goat livers, 1–2% of the sheep lungs, and 2–6% of the goat lungs, indicating relatively low infection levels.

One of the most common causes of liver condemnation in the present study was the presence of trematodes, especially *F. hepatica.* In comparison to data from an earlier study conducted in Khorasan Province, northeast of Iran (Borji and Parandeh, 2010), the prevalence of *D. dendriticum* infection detected in the livers of the cattle (0.2%), sheep (0.2%), goats (0.4%), and buffalos (0.2%) included in the present study were slightly lower, and the corresponding prevalences of *F. hepatica* infection were 5.3%, 0.9%, 2.3%, and 10.2%, respectively, slightly higher. In Iraq, an abattoir-based survey in Basrah revealed hepatic fascioliasis in 0.1% of cattle, 0.7% of sheep, and 3.3% of goats brought to slaughter (Mahdi and Al-Baldawi, 1987). In a later, but similar, study in Saudi Arabia, the corresponding prevalences were 1.2%, 0.1%, and 0%, respectively (Over et al., 1992).

It appears that *F. hepatica* in livestock kept n the Ahwaz area is more prevalent than those in the north of Khorasan, but the annual trends for this parasitic infection in the 5-yr period had decreased. The differences in the prevalence of *F. hepatica* between the present study and north of Khorasan may be associated with rainfall, humidity, temperature, and altitude differences in the 2 areas. The cause of high prevalence of *F. hepatica* in Ahwaz could be attributed to the higher humidity and temperature as compared to Khorasan. Although *F. hepatica* is widely distributed throughout the world, the extent of infection is particularly common in countries with temperate climates and in the highlands of tropical and subtropical countries. On the other hand, *D. dendriticum* is more prevalent in livestock in the north of Khorasan than those in Ahwaz. Conversely, prevalence of *D. dendriticum* infection in Ahwaz shows an opposite trend in that it has increased over the last 5 yr. This could be due to the intrinsic characteristic of *D. dendriticum* eggs being more resistant to drought conditions than those of *F. hepatica* (Taylor et al., 2007).

The parasitic lesions observed in ovine and buffalo muscles from Ahwaz were caused by *Sarcocystis* sp. cysts that were seen in low numbers of the slaughtered sheep and buffalos, whereas those observed in sheep meat north of Khorasan Province exhibited higher prevalence (Borji and Parandeh, 2010). No *Sarcocystis* cysts were detected in any of the slaughtered cattle, but this result is based only on macroscopic examinations by meat inspectors. Recently, Nourollahi Fard et al. (2009) examined 480 cattle from Kerman, in south-central Iran; although they did not detect *Sarcocystis* sp. cysts by initial gross examination in any of the animals, further investigation with the use of tissue digestion and microscopy revealed infection in all of the macroscopically clean animals. Prevalence of cattle cysticercosis in the present study (0.01%) was lower than numbers reported in other regions of Iran (Oryan et al., 1994; Khaniki et al., 2010), but higher than those reported from north of Khorasan Province (Borji and Parandeh, 2010).

There are indications that the prevalence of cysticercosis and sarcocystosis (detectable by macroscopic examination) in the cattle and sheep brought to abattoir in the study area have decreased over the last 5 or 6 yr. The elimination of stray dogs in the national antirabies program and an increasing awareness of consumers about disease risks may have led to these improvements.

In conclusion, in the present study area, parasites were found to be responsible for 54.4% of offal/carcass condemnations and an associated economic loss approaching $1.2 million. Current estimation of the economic loss caused by parasites here is a gross underestimate of the total financial loss as it does not consider premature deaths, body weight losses, and suboptimal milk and wool yields (Perry and Randolph, 1999). Thus, in spite of the fact that the losses resulted from parasite-related meat condemnation are probably too low to justify a region-wide campaign for the treatment of livestock with anthelmintics, public health considerations are foremost important and may be a rationale to deploy in an anthelmintic campaign.

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