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Prevalence of ruminants fascioliasis and their economic effects in Kashan, center of Iran

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PEER REVIEW

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Comments

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ABSTRACT

Objective: To determine the prevalence and economic losses of *Fasciola* spp. isolates and costs incurred due to liver condemnation from ruminants in Kashan region, center of Iran from 2012 to 2013.

Methods: In this cross-sectional study, a total number of 251 325 slaughtered sheep, goats and cattle (88 939 sheep, 151 924 goats and 10 462 cattle) were examined via necropsy for fascioliasis in industrial Kashan abattoirs located in center of Iran. The average weight was calculated as 1000 g for sheep, 900 g for goat and 5000 g for cattle in this study region. Based on market value, the average price of a kilo gram of normal liver at Kashan city during the study period was 8 USD. The amount of main nutrients and vitamins elimination in liver contaminated to fascioliasis was determined.

Results: Overall 3.28% of the livers were found to be infected. For total number of sheep, goats and cattle slaughtered annually in region study, it was estimated that 7505 livers were infected and total annual economic losses of fascioliasis of studied animals was 41 784 USD (based on market prices in study period). Of this, 23 360 USD, 30 240 USD and 15 400 USD were associated with the fascioliasis of sheep, goats and cattle, respectively.

Conclusions: This study indicated that the *Fasciola* sp. clearly remains prevalent and causes considerable economic losses in study region in sheep, goats and cattle and presumably, other areas and hosts of Iran, providing baseline data for the future monitoring of this potentially important parasitic infection in the country.

KEYWORDS

Economic losses, Cattle, Sheep, Goat, Prevalence, Fascioliasis

1. Introduction

Fasciolosis is a well known worldwide and an important helminthic disease of silvatic ruminants caused by liver fluke species of the genus *Fasciola*, which is one of the most neglected diseases that can lead to human infection^[1,2]. Fascioliasis has the widest geographic spread of any emerging vector-borne zoonotic disease occurring

in more than 51 countries worldwide^[1]. Epidemiological analysis of human and animal fascioliasis has been carried out in different parts of the world, including Iran and the results of these studies showed that 91 million people are at risk worldwide with 2.4 to 17 million individuals infected by *Fasciola hepatica* (*F. hepatica*) and today fascioliasis is classified as tropical disorder^[3–5]. The flukes species are hermaphroditic, localized in the bile ducts of the liver or

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gall bladder of infected animals; these species have similar life cycles, and cause severe damages which may lead to the death of the animals. Thus fascioliasis has traditionally been considered to be an important veterinary disease. The organism causes liver-rot among ruminants, which are the definitive hosts, and humans are incidental hosts. Humans are incidental hosts for *F. hepatica*, commonly known as the sheep liver fluke, and *Fasciola gigantica*; these flukes can also cause similar illnesses in animals who become infected by ingesting metacercariae on contaminated water. The illness occurs worldwide, particularly in regions with intensive sheep or cattle production[6]. Indeed, most analyses of the global impact of fascioliasis focus on the economic impact caused by infections in domesticated herd animals. Regarding the disease prevalence in a herd, these losses can be significant. The direct economic impact of fascioliasis infection is increased condemnation of liver meat, but the far more damaging effects are decreased animal productivity, lower calf birth weight, and reduced growth in infected animals[7]. The prevalence of *Fasciola* sp. infection depends on several factors related to the biology of the vectors, biology of the parasite and the management of flocks and herds. Among Asian countries, in Iran, according to review of available literature, it is strongly suggested that fascioliasis is the most common liver disease as the serious public health problem in almost all parts of Iran among domestic animals. The prevalence of fascioliasis in many parts of the country has been determined mainly in slaughter animals. Researchers clearly showed that the prevalence of liver fluke infection among domestic animals in the southern parts of the country are higher than those in the northern parts[8–10]. Recent studies have shown that human fascioliasis presents with marked heterogeneity, leading to different epidemiological patterns and transmission patterns in different endemic areas[5,11]. However, estimation of economic loss due to fascioliasis at national or regional level are limited. Considering the importance and widely distribution of domestic animals fascioliasis throughout Iran, and in order to know the current status of *F. hepatica* infection, this investigation was conducted to evaluate the prevalence of fascioliasis and their economic importance in the livestock of Kashan, center of Iran with agriculture and farming traditions.

2. Materials and methods

2.1. Study animals and design

Cross-sectional and retrospective study designs were used to collect the required data for the study in the period 2012–2013 at an abattoir in Kashan region, Center Iran. Abattoir data were obtained from the District Veterinary Office, covering the study period. Overall 251 325 of

slaughtered sheep, goats and cattle during the study period were examined via necropsy of livers. Livers of all cattle, sheep and goats slaughtered were inspected for the presence of liver flukes. Besides, the numbers of infected organs for each host, worm count and the parasitic lesions observed in the livers of the slaughtered animals were carefully count and recorded on standardized data sheets. Furthermore, the prevalence of fascioliasis was evaluated for four seasons. The average weight of sheep, goats and cattle liver were determined by weighting 2 920 sheep livers, 4 200 goat livers and 385 cattle livers in different ages.

2.2. Estimation of financial loss

The total annual financial loss incurred due to liver condemnation at the abattoir was computed by multiplying the average number of cattle, sheep and goats slaughtered annually in the abattoir with the prevalence of fascioliasis obtained from the present survey and mean price of liver in the city. For each year, data were summarized to give the proportion of cattle, sheep and goat livers infected with *Fasciola*. An economic estimation was done for the losses due to liver condemnation from 2010 to 2012 with available complete data. Also, the total quantity of all costs was considered according to Iranian currency exchange to the US dollar (USD). The direct economic loss due to fascioliasis condemnation was calculated by the following formula:

$$DFL=N \times P \times W$$

Where DFL is direct financial loss, N is number of condemned livers, P is average liver price (dollar/kg), W is average liver weight (kg).

The average weights of sheep, goats and cattle livers were determined by weighting 88 939 sheep, 151 924 goat and 10 462 cattle livers. The average weight was calculated as 1 000 g for sheep, 900 g for goat and 5 000 g for cattle in this study region. The average sell prices for each kilogram of liver was 8 USD, acquired by interviewing local butchers in the study area.

2.3. Estimation of nutritional value

For each 100 g raw liver of sheep, goats and cattle, mineral elements and vitamins were calculated as previously described protocol[12].

2.4. Statistical analysis

Data collected for the studies were entered into a Microsoft excel worksheet and analyzed using the SPSS software package (Version 16). The prevalence of fascioliasis was calculated as the number of *Fasciola* sp. infected individuals divided by the total number of slaughtered animals and was then multiplied by 100. One-way ANOVA was used for analysis of differences in

the prevalence of fascioliasis. $P < 0.05$ was considered for statistical significance.

3. Results

An overall of 251 325 animals (88 939 sheep, 151 924 goats and 10 462 cattle) slaughtered at Kashan abattoir were examined for *Fasciola* parasites, of which 2.99% were found positive. The prevalence of *Fasciola* sp. infection in sheep, goats and cattle were 3.28%, 2.76% and 3.68% respectively (Table 1).

Table 1
Prevalence rate of liver condemnation due to fascioliasis in sheep, goats and cattle at Kashan abattoir in center of Iran.

| Host | Examined No. | Infected liver No. | Prevalence % |
|--------|--------------|--------------------|--------------|
| Sheep | 88 939 | 2 920 | 3.28 |
| Goat | 151 9924 | 4 200 | 2.76 |
| Cattle | 10 462 | 385 | 3.68 |
| Total | 251 325 | 7 505 | 2.99 |

The prevalence of fascioliasis was evaluated during four seasons and the results are shown in Table 2. Fascioliasis did not follow any seasonal pattern, and seasonal differences were not statistically significant ($P > 0.05$).

Table 2
Seasonal prevalence rate of liver condemnation due to fascioliasis in sheep, goats and cattle at Kashan abattoir, center of Iran.

| Season | Slaughtered No. | Infected No. | Infected % |
|--------|-----------------|--------------|------------|
| Spring | 55 225 | 1 712 | 3.10 |
| Summer | 71 675 | 1 745 | 2.40 |
| Autumn | 63 093 | 1 975 | 3.10 |
| Winter | 61 322 | 2 703 | 4.40 |
| Total | 251 325 | 7 505 | 2.99 |

The average weight of sheep, goats and cattle liver were determined by weighting 2 920 sheep livers, 4 200 goat livers and 385 cattle livers in different ages. The average weights were calculated as 1 000 g for sheep, 900 g for goat and 5 000 g for cattle livers in all years study. Assessment of the market value showed that the average price of a kilogram of normal liver at Kashan city during the study period was 8 USD. The average annual value of the meat and offal lost due to parasite related condemnation in the study district over the study period was estimated to be 41 784 USD. Of this total loss, 23 360 USD was associated with the condemned sheep, 30 240 USD for goats and, 15 400 USD for cattle (Table 3).

Table 3
Annual economic losses of fasoliasis in sheep, goats and cattle at Kashan abattoir in center of Iran.

| Host | Examined No. | Infected liver No. | Economic loss (USD) |
|--------|--------------|--------------------|---------------------|
| Sheep | 88 939 | 2 920 | 23 360 |
| Goat | 151 924 | 4 200 | 30 240 |
| Cattle | 10 462 | 385 | 15 400 |
| Total | 251 325 | 7 505 | 41 784 |

Results of the amount of macronutrients (carbohydrates,

proteins, and fats) as well as vitamins and minerals elimination in liver of sheep, goats and cattle contaminated to *Fasciola* were showed in Tables 4 and 5.

Table 4
The amount of macronutrients, minerals and vitamin waste in liver contaminated to fascioliasis at a Kashan abattoir, center of Iran.

| Macronutrients and minerals | Sheep | Goat | Cattle | Total |
|-----------------------------|--------------|---------------|---------------|---------------|
| Weight of liver (g) | 2 920 000.00 | 3 780 000.00 | 1 925 000.00 | 8 625 000.00 |
| Energy (Kcal) | 3 700 224.00 | 4 435 200.00 | 4 878 720.00 | 13 014 144.00 |
| Carbohydrate (g) | 47 199.00 | 56 574.00 | 201 317.00 | 305 090.00 |
| Protein (g) | 535 850.00 | 642 286.00 | 691 615.00 | 1 869 751.00 |
| Fat (g) | 230 025.00 | 155 603.00 | 432 988.00 | 818 116.00 |
| Calcium (mg) | 185 065.00 | 221 824.00 | 244 006.00 | 650 895.00 |
| Phosphorus (mg) | 9 531 756.00 | 11 425 052.00 | 10 980 585.00 | 31 937 393.00 |
| Fe (mg) | 193 396.00 | 231 809.00 | 235 482.00 | 660 687.00 |
| Potassium (mg) | 823 616.00 | 9 872 101.00 | 11 223 135.00 | 21 918 852.00 |
| Sodium (mg) | 1 850 639.00 | 3 270 834.00 | 2 562 022.00 | 7 683 495.00 |
| Zinc (mg) | 122 149.44 | 146 411.90 | 135 412.20 | 403 973.54 |
| Copper (mg) | 183 224.16 | 125 826.00 | 320 093.35 | 629 143.51 |
| Magnesium (mg) | 555 296.40 | 665 595.00 | 442 559.16 | 1 663 450.56 |

Table 5
The amount of B group vitamins elimination in liver contaminated to fascioliasis at a Kashan abattoir, center of Iran.

| B group vitamins | Sheep | Goat | Cattle | Total |
|---|---------------|--------------|--------------|----------------|
| Vitamin B ₁ (Thiamin) | 9 250.560 | 11 088.00 | 8 523.90 | 28 862.460 |
| Vitamin B ₂ (Riboflavin) | 48 317.119 | 114 250.50 | 96 396.30 | 258 963.919 |
| Vitamin B ₃ (Niacin) | 423 896.400 | 508 095.00 | 441 787.50 | 1 373 778.900 |
| Vitamin B ₅ (Pantothenic acid) | 161 017.560 | 193 000.50 | 263 547.90 | 617 565.960 |
| Vitamin B ₆ (Pyridoxine) | 24 046.200 | 28 822.50 | 32 952.15 | 85 820.850 |
| Vitamin B ₉ (Folic acid) | 6 015 492.000 | 7 210 350.00 | 9 441 225.00 | 22 667 067.000 |
| Vitamin B ₁₂ (Cobalamin) | 2 368 879.200 | 2 839 410.00 | 2 391 196.50 | 7 499 485.700 |

4. Discussion

The results obtained in this study are an indication that *Fasciola* sp. infection occurs in the study area, with the prevalence rate of 2.99% which was moderately low. Results also showed that, the prevalence of fascioliasis in the goats were 2.76%, while the infection rate in cattle and sheep were 3.68% and 3.28% respectively. It seems that the animal husbandry condition for cattle including more contact with intermediate hosts of the parasite compared to sheep and goats is one of the major reasons of the high infection rate in cattle. On the other hand, it is possible that there is a hereditary resistance in sheep and goats. A study conducted by Khosravi *et al.* within the Ilam Province at abattoirs between 2007 and 2010, recorded a prevalence rate of 8.48% [8]. However, the prevalence rate of 3.28% recorded in this study is higher than the rate of 0.98% for Ilam Province abattoir located in West Iran in 2012 as reported by Abdi *et al.* [10]. A low prevalence of fascioliasis has been reported from some parts of Iran. Similar results were reported by Oryan *et al.* at abattoirs of Northeastern Iran. According to this study, the prevalence of fascioliasis in cattle, sheep and goats were 0.71%, 0.35%

and 0.20% respectively^[9]. Also, the result of the study is slightly different from the report of Khanjari who recorded a moderate rate of 6.6% of prevalence for *Fasciola* infection in sheep and goat slaughtered in Amol Abattoir, Mazandaran, Northern Iran^[13].

These differences in the prevalence of fasciolosis may be due to variation in the climatic and ecological conditions such as altitude, rainfall, seasons, temperature, sources and types of animals involved, the response of different host species against this parasite as well as the livestock management system among the study areas. By comparing these results and our present study, we can conclude that the prevalence of *F. hepatica* has certainly decreased in recent years in Iran, probably due to drought leading to unfavorable conditions for snails. The moderately low rate observed in this study could be attributed to many factors, such as better management of slaughtered animals. This implies that healthier animals are now reaching the Kashan, Iran markets. Mode of transportation of the slaughtered animal from the various areas would have as well influenced the result. Probably, with modernized means of transportation, the animals were restricted to the shepherd's choice of pasture coupled with their awareness of the economic consequences of leading the cattle to infected grazing grounds. *F. hepatica*, more than *Fasciola gigantica*, was liver fluke species recorded in the study. This may be associated with the existence of favourable ecological biotypes for *Lymnaea*, the recognized intermediate host of *F. hepatica* in Iran. This may be explained by the fact that most animal slaughtered came from high land and middle altitude zones. Infection with *F. hepatica* is an important factor causing economic loss in domestic animals in many parts of the world. The effects attributed to the fluke infestation include loss of condition, reduced growth, decrease in meat, wool and milk production, decrease in fertility and rendering of unsuitable livers for human consumption^[1]. Severe infestation may cause death either directly or indirectly by initiating or aggravating a bacterial infection, as in the case of black disease. Histopathological examination of liver infected revealed track-like lesions varying from acute hemorrhagic necrosis to active granulomas with organized fibrotic areas generated by eggs and worms in the parenchyma of the liver and mesenteric lymph nodes. Most of the chronic lesions showed the presence of lymphocytes and macrophages. In addition, liver, lungs, diaphragm, spleen, mesenteric lymph nodes, kidneys, pancreas, and small intestine also showed some foci of inflammatory infiltrates with mixed polymorphonuclear and mononuclear cells^[14]. Parasitized animals revealed higher values for some biochemical and hematological parameters changed and metabolic process of the liver is gradually reduced and may interfere with liver mineral status. Such parameters are inflammatory indicators attributable to an incipient cholangitis that characterizes the subclinical phase of distomatosis^[15]. Malnutrition is a major cause of human mortalities in the world and every effort must be made to conserve the available sources of protein for human well being. Animals especially livestock are a major source of

these proteins, but livestock production is hampered by constraints such as inadequate feed availability and the various diseases prevalent in these tropical environments^[16].

At present, the knowledge about liver mineral elements and vitamins in animals infected is very little to be known, and there is no review of the related literature on the tissue. It seems very important to know the relationship of fascioliasis and economic loss especially nutritional elements deleted from cycle nutrition of human during parasite infection. Unfortunately, there are no published records of economic losses caused by fascioliasis from this part of Iran. Considering the amount of liver and carcass weight loss detected in this survey, which is valued approximate 41 784 USD, the economic loss is substantially high. Liver condemned in Kashan city abattoir represent a considerable loss of valuable protein and revenue. Attempts should be made to retrieve some of the livers condemned so that they could be processed to commercial meat meal to be used as pet food or otherwise. This indicated that the estimated loss due to the disease in the abattoir was quite considerable.

It is worth noting that realistic economic loss assessment due to *Fasciola* infection is difficult and our estimated data and procedure used in this study should be interpreted with caution. To be able to accurately evaluate economic losses, vital parameters such as mortality rates due to disease, chronic ill effects (weight gain, feed conversion efficiency, intercurrent disease, poor carcass conformation, malnutrition, decreased fertility and milk yield), anthelmintic treatment costs should be available and consulted^[17]. These vital parameters were not employed in this study due to various reasons including the inadequacy of general livestock production and disease data. Therefore our estimates are likely to be at variance with the true losses.

Fascioliasis, due to *Fasciola* sp. was found to be a highly prevalent and economically important disease of sheep, goat and cattle at Kashan abattoir. The annual economic loss obtained in this study was relatively very high yet. The level of infection observed in this study suggests the existence of suitable climatic conditions for the development and survival of the parasite in the area of origin of the study animals. Outcomes of the study signified severity of the problem and the need for effective control measures that should be supported through studies on the economic importance of the infection in small ruminant species and local epidemiology of the disease.

Conflict of interest statement

We declare that we have no conflict of interest.

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Comments

Background

Fascioliasis remains a major tropical parasitic disease worldwide, and it is a major public health concern of great economic and healthy importance. It is of great need to investigate the prevalence and economic loss caused by the *Fasciola* infections.

Research frontier

The present study investigated the prevalence of ruminants fascioliasis and their economic effects in Kashan, Central Iran.

Related report:

The nutritional value was estimated using the previously described protocol.

Innovations and breakthroughs

This is the first study of this kind indicating that fascioliasis remains too prevalent and causes considerable economic losses in region study in sheep, goats and cattle and, presumably, other areas and hosts of Iran and provides baseline data for the future monitoring of this potentially important parasitic infection in the country.

Applications

From this cross-sectional survey, we are informed that fascioliasis remains a major public health problem in Iran, which causes huge economic losses. Based on this study, an effective control program is required to be implemented to reduce the social, economic and disease burdens.

Peer review

This is a cross-sectional study, for the first time, to investigate the prevalence and economic loss of fascioliasis in Iran, providing baseline data for the future monitoring of this potentially important parasitic infection in the country.

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