Serologic detection of antibodies against *Fasciola hepatica* in native Korean goats (*Capra hircus coreanae*)

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ABSTRACT: The purpose of this study was to determine a nationwide seroprevalence of *Fasciola hepatica* in native Korean goats (*Capra hircus coreanae*). A total of 464 blood samples were collected from the three geographical regions (northern, central and southern regions) of the country between November 2009 and August 2011. Sera were separated from whole blood following standard procedures and analysed with an ELISA to detect antibodies against *F. hepatica*. The positive samples were further classified as mildly, moderately and strongly positive. Out of 464 goat sera samples assessed, five (1.1%) were seropositive. From these, three (0.6%) were mildly positive, two (0.4%) were moderately positive while no samples were observed to be strongly positive. All the five positive animals were adults (≥ 2 year old) rather than young goats (< 2 year old). There was no significant difference in seropositivity between age and regions. In conclusion, this study determined for the first time the seroprevalence of *F. hepatica* infection in native Korean goats. The findings also provide an update on the status of *F. hepatica* infection and can serve as a foundation for future investigations on the significance of this parasite in Korea.

Keywords: fascioliasis; seroprevalence; ELISA; native Korean goats; *Capra hircus coreanae*

Fasciola hepatica is an important parasite of sheep, goats and cattle that causes serious acute and chronic disease in various mammalian species including humans (Shu et al. 2012). Domestic ruminants, non-ruminant livestock and numerous wild mammals can serve as reservoirs for this parasite (Urquhart et al. 1996). *F. hepatica* causes great economic losses in livestock industries worldwide (Mas-Coma et al. 2005; Shu et al. 2012). According to a 2006 report by the World Health Organization (WHO), worldwide losses in animal productivity due to fascioliasis were conservatively estimated to be over USD 3.2 billion per annum. Furthermore, studies from different countries such as Iran (Ahmadi and Meshkehkar 2010), Turkey (Gul and Aydin 2008), Bangladesh (Mamun et al. 2011), Pakistan (Tasawar et al. 2007) and Ethiopia (Kifle and Hiko 2011) have also reported enormous production losses in the livestock industry. In addition, *F. hepatica* infection has been documented as a global public health concern (Talukder et al. 2010).

The distribution of *F. hepatica* is generally worldwide. However, it is limited to temperate areas and highlands in tropical and sub-tropical regions (Mas-Coma et al. 2005; Borji et al. 2012). *F. hepatica* infection is expected to be common in Korea given the temperate climate of this region. However, information on the distribution of *F. hepatica* infection and prevalence of this pathogen in livestock, particularly goats, is scarce and was reported two decades ago (FAO 1992; Lee et al. 1996). In addi-

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tion, the farming system in Korea has been dramatically changed from outdoor grazing to indoor confinement over recent decades. Feedstuffs have also been changed from forage grass to formula feed. With these changes to farming systems in mind, updates about the distribution of *F. hepatica* is a necessary precaution to protect public health and may significantly impact goat production.

In conjunction with the traditional coproscopic examination, serological techniques such as ELISA have been recently utilized for diagnostic and prevalence studies of *F. hepatica* in live animals. These serological methods can be used to detect circulating antibodies against *F. hepatica* antigen produced during the early stage of infection, thereby surpassing the traditional coproscopic examination modalities (Salimi-Bejestani et al. 2005). ELISA is less prone to inter-laboratory variation as reading is automated and it is appropriate for use in epidemiological surveys (Opsteegh et al. 2010).

The population of native Korean goats (*Capra hircus coreanae*) is comprised of approximately 562 000 animals (KOSIS 2005). Out of these, approximately 55% of the total goat population dwell in the southern region of Korea and relatively low populations have been recorded in the northern and central regions. The animals are raised mainly for meat and for use as a natural health supplement. Although *F. hepatica* has great veterinary and public health importance, there is a scarcity of reports on the prevalence of this parasite. Therefore, in this study, we conducted a large-scale serological survey on the prevalence of *F. hepatica* in native Korean goats using ELISA.

MATERIAL AND METHODS

Study area and goat population. The sampling areas were divided into three geographical regions (northern, central and southern regions) of Korea (34˚20'–37˚11' N, 126˚07'–129˚19' E) with a mean annual temperature of 13.6 °C and mean annual precipitation of 1500 mm. The study population consisted of approximately 14 800 goats distributed throughout the nation. An appropriate sample size with an expected prevalence of 50%, accepted error of 5% and confidence level of 95% was determined with a stratified simple random sampling design (Thrustfield 2005). Accordingly, a total of 464 goats were selected and blood samples were collected from the jugular vein from November 2009 to August 2011. The goats were kept under confinement and fed with formula feed. Goats are raised for up to three year before slaughter for meat. Male goats are usually put on the market after being raised for 1–1.5 year while females are put on the market after being raised for two year for gestation. Serum was separated according to standard procedures and stored at –20 °C until use.

Serological assay. The sera samples were analysed using an ELISA test kit (IDEXX, Montpellier, France) following the manufacturer's instructions to detect antibodies against the "f2" antigens of *F. hepatica*. The positive results were classified as mildly, moderately or strongly positive based on the intensity of the infection.

Statistics. A chi-squared test was used to analyse the differences among the variables. $P < 0.05$ were regarded as statistically significant. The GraphPad Prism version 5.04 software package (GraphPad Software Inc., La Jolla, CA, USA) was used for the statistical analysis.

RESULTS

Out of 464 goats examined, five (1.1%) animals were positive for antibodies against *F. hepatica* antigen. No samples were found to be strongly positive. The rate of mildly positive cases was higher than that of moderately positive animals (Table 1).

The distribution of seropositives between age groups showed that all the positive animals (1.6%,

Table 1. Seroprevalence of *Fasciola hepatica* in 464 native Korean goats

Degree of infection	Number of positive	Prevalence (%)	CI (%)
Mildly positive	3	0.6	0.2–1.9
Moderately positive	2	0.4	0.1–1.5
Strongly positive	0	0	0
Total	5	1.1	0.5–2.5

CI = confidence interval

Table 2. Seroprevalence of *Fasciola hepatica* in 464 native Korean goats according to age and region

Variable		Number of tested	Prevalence (%)	CI (%)
Age	young (< 2 year old)	154	0 (0)	–
	adult (≥ 2 year old)	310	5 (1.6)	0.7–3.7
Region	northern	145	1 (0.7)	0.2–3.7
	central	77	0	–
	southern	242	4 (1.6)	0.7–4.2
Total		464	5 (1.1)	0.5–2.5

CI = confidence interval

n = 310) were adults (≥ 2 year old); no seropositivity (0%, *n* = 154) was observed among the young goats (< 2 year old). However, the difference in seroprevalence between adult and young animals was not significant (Table 2).

Further analysis of *F. hepatica* seroprevalence in the three regions of the country revealed that a relatively higher seroprevalence (1.6%) was observed in southern regions compared to northern (0.7%) and central (0.0%) regions. However, the difference was not significant ($P > 0.05$). The results for the seroprevalence according to age groups and regions are summarised in Table 2.

DISCUSSION

Fascioliasis has significant health and economic impacts on ruminants in endemic areas. The present study is the first to report the seroprevalence of *F. hepatica* in native Korean goats. The seroprevalence rate observed in the present study, however, was much lower than the prevalence (32%) previously reported in an abattoir survey of *F. hepatica* infection (FAO 1992) and the prevalence (22.9–37.1%) reported by Lee (1993) in goats in Korea. This dramatic decrease in the current study is expected and could clearly be attributed to improved farm management practices, indoor confinement, formula feed, and frequent de-worming programs implemented in goat farms. Similarly, the prevalence of *F. hepatica* infection observed in the present study was lower than that (32%) reported in Bangladesh (Mamun et al. 2011).

The relatively higher infection rate observed among adult goats compared to young animals in our study appears to be in agreement with the findings of earlier studies conducted in Bangladesh, Ethiopia and Turkey (Ahmadi and Meshkehkar 2010; Kifle and Hiko 2011; Mamun et al. 2011). This could be due to husbandry practice; the movement of young goats is mostly limited, while adults are permitted longer grazing times outside. However, this hypothesis is contradicted by another study conducted in Bangladesh showing that the prevalence of *F. hepatica* in young goats (35.71%) was higher than in adults (18.18%; Tasawar et al. 2007).

Similar studies conducted in other countries such as Pakistan, Turkey, Egypt, Ethiopia and Iran showed prevalence rates of *F. hepatica* of 28.75%, 41.21%, 5.4%, 0.8% and 4.4–2.8%, respectively (El-Shazly et al. 2005; Tasawar et al. 2007; Gul and Aydin 2008; Ahmadi and Meshkehkar 2010; Kifle and Hiko 2011). Based on these findings, our study could be categorised as showing a low rate of infection compared to other countries. The discrepancies observed in the prevalence of *F. hepatica* infection in different areas compared to the present study might be due to differences in livestock feeding systems, indoor confinement and frequent de-worming programs. For example, animals that graze in marshy areas have a high risk of *Fasciola* infection compared to housed goats that do not graze. Another possibility may be differences between various goat breeds given that some breeds are reported to be more resistant to helminth parasite infection than others (Tasawar et al. 2007). Other factors like rainfall, humidity, temperature and altitude could also affect the prevalence of *F. hepatica* infection in different areas (Borji et al. 2012).

The lack of significant differences in seroprevalence among the three regions could be attributed to the relatively similar climatic conditions throughout the country. This might also be due to the similar management systems of the farms from which the samples are collected.

In conclusion, the present study reports the first large-scale serological survey on the prevalence of

F. hepatica in native Korean goats. Our findings provide an update about the status of *F. hepatica* infection and can serve as a basis for future investigations on the significance of this parasite in Korea. The infection rate observed in the current study was lower compared to those from previous reports, indicating the impact of improved herd management practices in the country. Nevertheless, *F. hepatica* still poses a significant concern for goat farms in Korea and other countries worldwide.

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