

Evidence of *Neospora caninum* exposure among native Korean goats (*Capra hircus coreanae*)

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ABSTRACT: *Neospora caninum* is a protozoan parasite that causes abortion in ruminants, including goats. The objective of the present study was to determine the seroprevalence of *N. caninum* in native Korean goats (*Capra hircus coreanae*). A commercial enzyme-linked immunosorbent assay kit was used to analyse 464 serum samples for the presence of *N. caninum* antibodies. Four samples (0.9%, 95% confidence intervals – CI: 0.0–1.7) were found to be positive for *N. caninum* antibodies. The seroprevalence was analysed according to age (less than to one year, young; more than or equal one year, adult; and unknown), sampling season (April to September, warm; October to March, cold), and region (northern, central, and southern). However, there were no statistically significant differences in seroprevalence according to age, season, and region ($P > 0.05$). This is the first report on the seroprevalence of *N. caninum* in native Korean goats. The results of this study indicate a nationwide distribution of *N. caninum* among goats, with a relatively low prevalence. Therefore, the implementation of integrated control strategies as well as measures for prevention and control of *N. caninum* infection among goats is recommended.

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

Neospora caninum is an obligate intracellular parasite that can infect and cause neosporosis in a wide variety of mammals. Neosporosis is an important cause of abortion in cattle and other ruminants including sheep, goats, and horses. Although the economic, clinical, and epidemiological significance of neosporosis in goats is not yet clear, its seroprevalence has been reported in various countries (Dubey and Schares 2011).

The only known definitive hosts for *N. caninum* are dogs, coyotes, and dingoes. Viable *Neospora* oocysts have been found only in dogs. Vertical transmission of *N. caninum* from parent to offspring is the major route of infection in cattle (Dubey and Schares 2011). In cattle, horizontal transmission among individuals in a group is not common, but infection from ingestion of experimentally contaminated colostrum has been reported (Davison et al. 2001).

Capra hircus coreanae is the indigenous goat of Korea and is reared primarily for meat (Gebeyehu et al. 2013). To the best of our knowledge, there are no data on the prevalence of *N. caninum* in native Korean goats. *N. caninum* has been isolated from the tissues of an aborted bovine fetus and a congenitally infected calf in Korea (Kim et al. 2000). In addition, *N. caninum* has been reported in dogs and raccoon dogs in Korea (Kim et al. 2003). The objective of the present study was to determine the seroprevalence of *N. caninum* in native Korean goats.

MATERIAL AND METHODS

Study area and blood sampling. During November 2009 and August 2010, a total of 464 caprine blood

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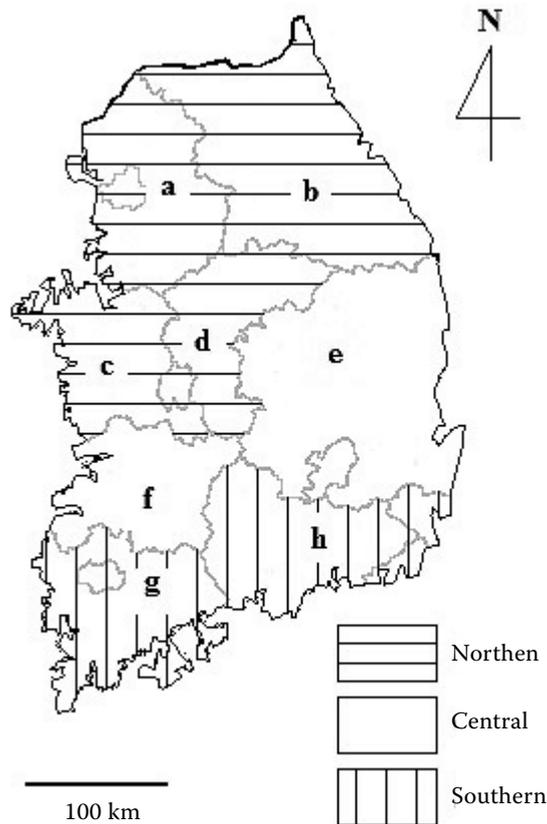


Figure 1. Map of Korea showing the study regions according to administrative boundaries where goat serum samples were collected to detect the presence of anti-*Neospora caninum* antibodies: northern [Gyeonggi-do (a), Gangwon-do (b), Chungcheongnam-do (c), and Chungcheongbuk-do (d)], central [Gyeongsangbuk-do (e) and Jeollabuk-do (f)], and southern [Jeollanam-do (g) and Gyeongsangnam-do (h)] regions

samples were collected from 40 farms throughout Korea. An average of 11 goat samples was randomly selected per farm. Sample data were recorded and

were grouped according to age (less than to one year, young; more than or equal one year, adult; and unknown), sampling season (April to September, warm; October to March, cold), and region (northern, central, and southern) as described previously (Figure 1) (Jung et al. 2014). The study area is located between 34°20'–37°11' northern latitude and 126°07'–129°19' eastern longitude. The blood samples were obtained by jugular vein puncture. The sera were separated by centrifugation at 1500 rpm for 10 min and stored at –20 °C until analysed.

Serological assay. A serological survey was carried out to detect the presence of antibodies against *N. caninum* using a commercial *Neospora* antibody ELISA Test kit (IDEXX, USA). The test results were measured as an optical density index and were interpreted as positive or negative. The sensitivity and specificity of this kit for tests in cattle were reported as 97.6% and 98.5%, respectively (Wu et al. 2002).

Statistical analysis. Data were compared by performing chi-square analysis or Fisher's exact test with the statistical software program SPSS 21.0 (IBM Co., USA). Statistical significance was defined as $P < 0.05$ and confidence intervals (CI, 95%) were calculated.

RESULTS

Of the 464 caprine serum samples tested, 4 (0.9%; 95% CI: 0.0–1.7) were found to be seropositive for *N. caninum* antibodies (Table 1). With respect to age, two out of 164 (1.2%; 95% CI: 0.0–2.9), two out of 269 (0.7%; 95% CI: 0.0–1.8), and none out of 31 samples were seropositive in the young (less than to one year), adult (more than or equal one year),

Table 1. Seroprevalence of *Neospora caninum* in 464 native Korean goats according to age, season, and region

Group	Number of positive/total (%)	95% CI
Age	young (< 1 year)	2/164 (1.2)
	adult (≥ 1 year)	2/269 (0.7)
	unknown	0/31 (0)
Season	cold (October – March)	1/122 (0.8)
	warm (April – September)	3/342 (0.9)
Region	northern	2/109 (1.8)
	central	0/77 (0)
	southern	2/278 (0.7)
Total	4/464 (0.9)	0.0–1.7

CI = confidence interval

and unknown groups, respectively. The seasonal prevalence observed was one out of 122 samples (0.8%; 95% CI: 0.0–2.4) and three out of 342 samples (0.9%; 95% CI: 0.0–1.9) for the cold season and warm season, respectively. With respect to region, two out of 109 (1.8%; 95% CI: 0.0–4.4), and two out of 278 (0.7%; 95% CI: 0.0–1.7) samples were seropositive in the northern and southern regions, respectively. No positive samples were detected in the central region. No statistically significant differences were observed for age, season, and region ($P > 0.05$).

DISCUSSION

N. caninum has a worldwide distribution and has been detected in various animal hosts. The seroprevalence of *N. caninum* in goats reported in countries other than Korea were as follows: 17 out of 300 (5.7%) in Jordan (Al-Majali et al. 2008), 18 out of 116 (15.5%) in Slovakia (Cobadiova et al. 2013), 26 out of 375 (6.9%) in Greece (Diakou et al. 2013), and 72 out of 667 (10.7%) in Brazil (Andrade et al. 2013). These results were obtained using ELISA. In the Czech Republic, the seroprevalence was reported to be 15 out of 251 (6.0%) using ELISA and the immunofluorescence antibody test (Bartova and Sedlak 2012). The prevalence in our present study was lower than that reported for other countries. This might be attributed to differences in the following factors: the number of definitive hosts (dogs and/or other canids in the study area), climate, age, frequency of dogs defecating in the study area, farm management systems, and/or regional ecology (Hobson et al. 2005; Dubey et al. 2007; Al-Majali et al. 2008).

High temperature and humidity favour faster sporulation and enhanced survival of *N. caninum* oocysts in the environment. This increases the risk of postnatal infection (Thurmond et al. 1995; Dubey et al. 2007). Our study has several limitations. An accurate assessment of seasonal prevalence was difficult because antibodies against *N. caninum* can persist for several months. In addition, minimal information was available on the presence of *N. caninum* hosts, grazing conditions, and farm management systems, all of which may have affected the seroprevalence of *N. caninum*. The low seroprevalence found in this study prevented the determination of the association between seasonal variation and seroprevalence. A larger sample size and more detailed information on goat breeding

conditions would be needed to obtain more reliable data on seasonal variability and seroprevalence.

Despite our finding of low prevalence of *N. caninum* in native Korean goats, these results are worth noting because *N. caninum* infection in cattle has been associated with a high proportion of abortions (25.0%; 45/180) in Korea (Kim et al. 2002). The seroprevalence of *N. caninum* in dogs in Korea has been reported at 10.3% (35/340) and specifically in rural dogs at 21.6% (11/51) (Kim et al. 2003). Although inter-species transmission has not been reported, risk of horizontal transmission from cattle to goats through a definitive host of *N. caninum* and vice versa should not be excluded. Transmission can occur through experimentally infected colostrum or milk replacer (Davison et al. 2001).

In conclusion, to the best of our knowledge, the present study is the first to reveal that *N. caninum* can be found among native Korean goats. Although the seroprevalence of this study was lower than that reported in other studies, further investigation regarding goat breeding conditions and the molecular methods used to evaluate the seroprevalence of *N. caninum* is warranted.

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