

Large-Scale Serological Survey of Caprine Arthritis-Encephalitis Virus (CAEV) in Korean Black Goats (*Capra hircus aegagrus*)

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ABSTRACT. A national serological survey of caprine arthritis-encephalitis virus (CAEV) infection was conducted using an enzyme-linked immunosorbent assay (ELISA) and an agar gel immunodiffusion (AGID) test. A total of 658 black goats of various breeds were sampled from 59 farms in three regions of Korea. The CAEV-positive goats were predominantly detected in the Southern region (n=17) as compared with the Northern (n=1) and Central regions (n=0) ($\chi^2=6.26$, $P=0.044$). Among 658 goats tested, 18 were positive in both ELISA and AGID, indicating a CAEV prevalence of 2.73% (95% confidence interval: 1.74–4.28). These results indicate that CAEV is present in Korean black goats.

KEY WORDS: caprine arthritis-encephalitis virus, goat, serological survey.

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Caprine arthritis-encephalitis virus (CAEV) belongs to the genus *lentivirus*, family *Retroviridae*. CAEV is a persistent disease in goats characterized by polyarthritis, mastitis and pneumonia in adults and leukoencephalomyelitis in kids [4, 6]. CAEV has been reported in most goat-rearing countries [1, 13]. Live animal trading across national boundaries is considered an important cause of horizontal CAEV transmission, whilst ingestion of colostrums and milk represent important causes of transmission from mother to offspring [3, 4]. In 2002, CAEV was identified in Japan [10]. Infected goats develop anti-CAEV antibodies and develop a persistent, lifelong infection. Korea was considered free from CAEV; however, CAEV RNA was detected in Korean dairy goats in 2008 [12], and an outbreak of CAEV was reported on a Korean goat farm in 2010 [14].

The period between CAEV infection and the detection of antibodies and onset of clinical signs may vary from months to years [3]. Several diagnostic techniques are used to detect CAEV infections. These are based on the detection of either antibodies or virus [9]. Virus isolation and cell culture detection techniques have been used but cannot be extensively applied, as specific cell types are replication-restrictive to particular strains [15] and CAEV heterogeneity and low viral loads have hampered the use of the polymerase chain reaction (PCR) as a reference technique. In addition, positive PCR results have been obtained in some seronegative animals [9]. Thus, the diagnosis of infection is typically performed by serological testing [9] including enzyme-linked immunosorbent assays (ELISA), and

agar gel immunodiffusion (AGID) tests, with PCR used to complement serological methods. ELISA represents a more sensitive technique than AGID testing for the detection of CAEV antibodies. Western blotting, radioimmunoassay, and radioimmunoprecipitation are also used as supplementary tests to discriminate for indeterminate results obtained from screening assays.

In Korea, the black goat population contains approximately 266,000 animals distributed in 21,000 herds [11]. Approximately 55% of the total goat population lives in the Southern region. Relatively low populations have been recorded in the Northern and Central regions. Although regional serological and virological investigations in dairy goats have been performed [12], no large-scale serological survey has been reported in Korean black goats. In this study, we conducted a large-scale serological survey to investigate the CAEV status in Korean black goats. A total of 658 black goats of various breeds were sampled from 59 farms from November, 2009 to August, 2011. Only farms with 100 or more goat herds were included in the study. Approximately 10 goats were randomly selected and sampled from each farm. Serum samples were divided into three geographical regions (Northern, Central, and Southern regions). Sera were stored at -20°C until screened.

The CAEV/MVV Antibody Test Kit (IDEXX, The Netherlands) based on an ELISA was used to detect CAEV-specific antibodies in serum. All serum samples were retested and confirmed by an AGID test. AGID tests were performed as recommended by the manufacturer (Veterinary Laboratory Agency, Weybridge, U. K.). ELISA and AGID results were compared for individual goats. However, none of the known methods, including ELISA, AGID and PCR, are considered a “gold standard” due to generation of false-positive and/or false-negative reactions. Thus, when the ELISA and AGID results correlated, they were considered reliable.

Chi-square analysis was used to analyze regional dif-

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ferences for herds and individual goats. A value of $P < 0.05$ was considered statistically significant. The accuracies of ELISA and AGID were compared, and the agreement levels between the test results were determined by calculating the kappa values (proportion of chance-corrected test agreement). The kappa value can range between 0.0 and 1.0, with values > 0.75 representing excellent agreement beyond chance, values between 0.4 and 0.75 indicating fair to good agreement and values < 0.4 denoting poor agreement beyond that due to chance alone.

Among the 658 goats tested, 18 were positive in both ELISA and AGID tests, making the CAEV prevalence 2.73% (95% confidence interval: 1.74–4.28). The numbers of goats tested by region were 138, 78 and 442 for the Northern, Central and Southern regions, respectively. The mean numbers of goats sampled per herd were 10.62 (± 2.87), 9.75 (± 3.63) and 11.65 (± 3.29) for the Northern, Central and Southern regions, respectively. CAEV-positive goats were predominantly detected in the Southern region ($n=17$), as compared with the Northern ($n=1$) and Central regions ($n=0$). Differences in the numbers of positive goats among the regions were statistically significant ($\chi^2=6.26$, $P=0.044$).

This study used 13, 8 and 38 herds from the Northern, Central and Southern regions, respectively. CAEV prevalence in the Southern region (23.68%) was higher than in the Northern (7.69%) and Central (0%) regions ($P > 0.05$). However, these differences were not statistically significant due to the small herd numbers ($\chi^2=4.52$, $P=0.104$).

A summary of ELISA and AGID results is shown in Table 1. Agreement between ELISA and AGID results was obtained for 636 serum samples (97% of total samples). The results showed that 618 serum samples were negative and 18 sera samples were positive by both tests. Discrepancies were observed in 22 serum samples (3.34% of total samples); 17 samples were AGID-/ELISA+, and 5 samples were AGID+/ELISA-. ELISA sensitivity and specificity were 78.4 and 97.3%, respectively, whilst those of AGID were 51.4 and 99.2%, respectively. These data indicate that the ELISA sensitivity exceeded that of AGID in this study. Thus, ELISA detection is useful for the identification of CAEV-infected goats under field conditions and has the potential for use in control and eradication programs in Korea.

The prevalence of CAEV in dairy goats in the Southern regions of Korea was previously investigated and determined to be 23.7% [12]. The majority of dairy goats for milk production in Korea are imported. We hypothesize that the higher frequency of CAEV in dairy goats is due to their importation from countries where CAEV is prevalent and by bulk milk feeding using infected milk. The majority of dairy goats are reared in the Southern region of Korea. This suggests that CAEV has been transmitted from imported dairy goats to Korean black goats in this region. In the present study, the prevalence of CAEV in Korean black goats was more than eight-fold lower. The CAEV prevalence in Korea that was calculated in the present study is lower than values reported in the United States [7], United Kingdom [8], Spain [5] and Brazil [2]. This may indicate that either CAEV was recently introduced into Korean black goats or those Korean

Table 1. Caprine arthritis-encephalitis virus (CAEV) serology results based on enzyme-linked immunosorbent assays (ELISA) and agar gel immunodiffusion (AGID) tests

AGID	ELISA		Total
	Positive	Negative	
Positive	18	5	23
Negative	17	618	635
Total	35	623	658

black goats are resistant to CAEV.

This is the first report of a large-scale serological survey of CAEV prevalence in the Korean goat industry. This study clearly indicates that CAEV infection originally occurred among Korean black goats. Further studies should focus on explaining the risk factors associated with CAEV prevalence in the Korean goat population in an attempt to control new infections.

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