Serosurveillance of Viral Diseases in Korean Native Goats (Capra hircus)

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ABSTRACT. A total of 804 goat sera were collected from 144 goat farms in five regions of South Korea during a period between 2005 and 2006 and screened for the antibodies of viral pathogens in ruminants. The individual seropositive rates for each virus were 13.7% (110/804) for bovine herpesvirus-1 (BHV-1), 9.5% (76/804) for bovine parainfluenza type-3 virus (PI-3V), 5.5% (44/804) for Akabane virus (AKAV), 13.3% (107/804) for Aino virus (AINV), 2.0% (16/804) for Chuzan virus (CHUV) and 1.0% (8/804) for bovine coronavirus (BCoV). Compared with other areas, Chungcheong Province showed higher seropositive rates of 13.6% for PI-3V, 22.3% for AKAV and 28.2% for AINV. The results indicate that among the six viral diseases, BHV-1 infection is quite prevalent, while BCoV infection is less prevalent on domestic goat farms in Gyeongsang and Jeonla Provinces.

KEY WORDS: arbovirus, BHV-1, goat, serologic survey.

As the number of goats has increased in South Korea, infectious diseases have also caused great economic losses in the goat industry. Goats infected with BHV-1 develop mild disease signs such as pneumonia and conjunctivitis during acute infection [13, 14]. BHV-1 is also able to establish a latent infection in the trigeminal ganglia of goats [12]. Parainfluenza type-3 virus (PI-3V) is known as “shipping fever” in ruminants and sheep and is one of the important aetiological agents in naturally occurring caprine pneumonia in Turkey [17]. Goats inoculated with PI-3V intranasally developed clinical symptoms and lesions in the lung [1]. Akabane virus (AKAV), Aino virus (AINV) and Chuzan virus (CHUV) are responsible for reproductive disorders such as abortion, stillbirth and congenital malformation in cattle and goats [9]. Bovine coronavirus (BCoV) is a common agent in neonatal calf diarrhea and is associated with winter dysentery in adult cattle, and recently, it has been reported to cause neonatal enteritis in kids [10]. Until now, little data have been available on important transmissible viral diseases in Korean native goats. Seroepidemiological surveys of important infectious viral diseases are necessary for vaccine research as well as for developing measures to prevent virus transmission, either inter- or intraspecies. We have previously reported the sero-prevalence of Japanese encephalitis virus (JEV) and pestivirus in goats. In the present study, we conducted a serological survey of BHV-1, PI-3V, AKAV, AINV, CHUV and BCoV infections in domestic goats in South Korea.

NOTE. Virology


Approximately 523,000 goats are raised on 41,000 farms throughout South Korea (Korea MAF Official Statistics, 2005), and at present, two kinds of goat, the Korean native and British Saanen, are raised for meat and milk production. The BHV-1, PI-3V, AKAV, AINV and CHUV used for virus neutralization (VN) tests were the Pusan (isolated from cattle in South Korea in 1969 by researchers of NVRQS), SF-4 (ATCC VR281), 93FMX, KSA9910 and YoungAm strains, respectively [8]. The BCoV used for hemagglutination inhibition (HI) tests was the KV0501 strain, which was isolated from naturally infected cattle in 2005 [16]. The six viruses isolated from cattle were chosen for serological survey in goats because these viruses have not yet been isolated from Korean native goats, although most of the viruses have been reported to infect goats. The BHV-1 and PI-3 viruses were propagated in Madin-Darby bovine kidney epithelial (MDBK) cells, and AKAV, AINV and CHUV were grown in Vero cells. The BCoV was grown in HRT-18 cells derived from a human adenocarcinoma. These cells were maintained in α-minimum essential medium (MEM; Gibco-BRL, Grand Island, NY, U.S.A.) with antibiotics (100 IU/ml penicillin, 100 µg/ml streptomycin, antimycotic (0.25 µg/ml amphotericin B) and 5% fetal bovine serum (FBS). For the seroprevalence survey, blood samples were collected from 804 goats on 144 farms in five provinces of South Korea between May 2005 and March 2006. None of these farms inoculated any vaccine against BHV-1, PI-3V, AKAV, AINV, CHUV or BCoV. Clotted blood samples were centrifuged, and sera were stored at −20°C until use.

The VN tests for BHV-1 and PI-3V were performed in 96-well, flat-bottomed, cell culture microtiter plates using MDBK cells, and Vero cells were used for AKAV, AINV and CHUV [8, 11]. The VN titer was expressed as the reciprocal of the highest serum dilution completely inhibiting CPE in the wells. The serum dilution ranged from 1:2 to 1:64, and antibody titers of ≥1:4 were considered positive.

The HI test for detecting antibodies to BCoV was carried out according to standard microtiter procedures using mouse red blood cells [7, 15, 16]. Any goat sera showing a
HI titer equal to or greater than 1:20 was considered positive. A chi-square test was used to analyze differences in regional distribution of seroprevalence. A P-value less than 0.05 was considered statistically significant.

The survey results of the seroprevalence against the six viruses were shown in Table 1 and Fig. 1. Among the 144 goat farms screened, the positive incidence of AINV was 31.9%, and those of BHV-1, PI-3V, AKAV, CHUV and BCoV were 21.5, 17.4, 14.6, 8.3 and 2.4%, respectively. In addition, the individual seropositive rates for each virus were 13.7% (110/804) for BHV-1, 13.3% (107/804) for AINV, 9.5% (76/804) for PI-3V, 5.5% (44/804) for AKAV and 2.0% (16/804) for CHUV. Compared with other areas, Chungcheong Province showed overall high seropositive rates (P<0.05) of 28.2% for PI-3V, 22.3% for AKAV and 13.6% for AINV (Table 1). In addition, the BHV-1 infection rate was notably high (P<0.05) in Jeonla Province (21.7%).

Table 1. Regional distribution of seroprevalence against several viral pathogens in goats

<table>
<thead>
<tr>
<th>Province</th>
<th>BHV-1</th>
<th>PI-3V</th>
<th>AKAV</th>
<th>AINV</th>
<th>CHUV</th>
<th>BCoV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gyeonggi</td>
<td>3/59</td>
<td>1/59</td>
<td>1/59</td>
<td>1/59</td>
<td>3/59</td>
<td>0/59</td>
</tr>
<tr>
<td></td>
<td>(5.1%)</td>
<td>(1.7%)</td>
<td>(1.7%)</td>
<td>(1.7%)</td>
<td>(5.1%)</td>
<td>(0)</td>
</tr>
<tr>
<td>Gangwon</td>
<td>0/31</td>
<td>4/31</td>
<td>0/31</td>
<td>1/31</td>
<td>0/31</td>
<td>0/31</td>
</tr>
<tr>
<td></td>
<td>(0)</td>
<td>(12.9)</td>
<td>(0)</td>
<td>(3.2)</td>
<td>(0)</td>
<td>(0)</td>
</tr>
<tr>
<td>Chungcheong</td>
<td>3/103</td>
<td>14/103</td>
<td>23/103</td>
<td>29/103</td>
<td>0/103</td>
<td>0/103</td>
</tr>
<tr>
<td></td>
<td>(2.9%)</td>
<td>(13.6%)</td>
<td>(22.3%)</td>
<td>(28.2%)</td>
<td>(0)</td>
<td>(0)</td>
</tr>
<tr>
<td>Jeonla</td>
<td>87/410</td>
<td>46/410</td>
<td>20/410</td>
<td>39/410</td>
<td>13/410</td>
<td>4/410</td>
</tr>
<tr>
<td></td>
<td>(21.7%)</td>
<td>(13.6%)</td>
<td>(4.9%)</td>
<td>(9.5%)</td>
<td>(3.2%)</td>
<td>(1.0%)</td>
</tr>
<tr>
<td>Gyeongsang</td>
<td>15/201</td>
<td>11/201</td>
<td>0/201</td>
<td>14/201</td>
<td>0/201</td>
<td>4/201</td>
</tr>
<tr>
<td></td>
<td>(7.5%)</td>
<td>(5.5%)</td>
<td>(0)</td>
<td>(7.0%)</td>
<td>(0)</td>
<td>(2.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>110/804</td>
<td>76/804</td>
<td>44/804</td>
<td>107/804</td>
<td>16/804</td>
<td>8/804</td>
</tr>
<tr>
<td></td>
<td>(13.7%)</td>
<td>(9.5%)</td>
<td>(5.5%)</td>
<td>(13.3%)</td>
<td>(2.0%)</td>
<td>(1.0%)</td>
</tr>
</tbody>
</table>

a) BHV-1= bovine herpes virus, PI-3V=parainfluenza type 3 virus, AKAV= Akabane virus, AINV= Aino virus, CHUV=Chuzan virus and BCoV=bovine coronavirus.

b) Number positive/Number tested (% positive).

![Fig. 1. Seroprevalence against viral pathogens from goats in South Korea between 2005 and 2006.](image)

The present study was a nationwide survey for the presence of antibodies to viral diseases in domestic goats. In this study, the positive rate (13.7%) for BHV-1 was similar to those reported previously for goats in Louisiana in the U.S.A. and red deer in six selected national parks in Germany [2, 3]. The BHV-1 antibody positive rate (21.7%) in the Jeonla Province samples was greater than those of the other provinces (P<0.05). We assume that many goats raised in Jeonla Province may be infected with BHV-1 due to close contact with BHV-1-infected cattle in the surrounding area. It is important to understand the epidemiology of goat viral diseases. Although goat farms breeding on a small scale have decreased since 2000 in South Korea, small scale goat farms still exist. There is high possibility that goats have the opportunity to come into contact with cattle.
on small scale farms. The pathogenesis of caprine herpesvirus (CpHV-1) infection in goats and BHV-1 infection in calves are known to be very similar. However, CpHV-1 infection has not been identified in South Korea.

PI-3 virus is comparatively common in cattle and is widely distributed. Although PI-3V can cause interstitial pneumonia, in which inflammation is usually present only in the anterior lobes of the lung, goats infected with PI-3V in the field are generally subclinical. Antibodies to PI-3V in goats were detected in 76 of the 804 (9.5%) tested samples. Some high incidence rates (17% and 21.1%) to PI-3V have been reported for goats and chamois, respectively [3, 4]. Therefore, vaccination against the above-mentioned respiratory diseases may be required for domestic goats. AKAV is known to cause reproductive disorders mainly in ruminants. However, an AKAV strain was recently isolated from the aborted fetuses of swine in Taiwan [6]. AKAV has also been confirmed as an etiological agent of congenital abnormalities in Korean native goats, with a 30% seropositive rate [5]. Although arthropod-borne viral agents, including AKAV, AINV and CHUV, are mainly transmitted through vectors, such as Culex spp. and Culicoides spp., in the field, the nationwide seroprevalence in goats has not been investigated. In this study, serosurveillance was performed on the same arthropod viral diseases as mentioned above. Among the three major arthropod-borne viruses, the highest seropositive rate was shown for AINV (13.3%), and the number of samples showing an antibody titer ≥1:32 were also higher than those of other viruses. In addition, further study to determine the species of mosquito associated with arboviral transmission in Korean native goats is required.

Although BCoV infection has been reported mainly in cattle, its seroprevalence has also been detected in sheep and white tail deer, with the prevalence ranging from 4.4 to 19% [15]. In addition, coronavirus infection has been detected in kids with neonatal enteritis [10]. In this study, only 1.0% of goats were found to have an HI antibody titer of ≥1:20 against BCoV, indicating that a small number of goats in some restricted area face the danger of BCoV infection. The low incidence of BCoV infection might be attributable to raising goats in a pen over 1 meter above ground.

Among the six viral diseases surveyed, BHV-1 infection was quite prevalent, while BCoV infection was not prevalent in Korean native goats. There are few reports concerning isolation of the above mentioned viruses in Korean native goats. Therefore, further research on isolation and genetic characterization of viral agent transmission in Korean native goats is required.

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