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ORIGINAL ARTICLE

# Pilot study on risk factors associated with caseous lymphadenitis and its seasonal prevalence in the Korean native goat

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Caseous lymphadenitis (CLA) is an endemic but not well-studied disease of Korean native goats (KNG) in Korea. *Corynebacterium pseudotuberculosis* is the causative agent of the contagious and chronic CLA found in goats. This study aimed to validate the potential risk factors associated with CLA and assess its seasonal prevalence to mitigate this disease in KNG. Data were collected through a questionnaire from four high- and four low-prevalence farms randomly selected based on a prior investigation. The monthly assessments of CLA were conducted in a goat abattoir located in Jeonnam Province, Korea, to evaluate its seasonal prevalence. The associated risk factors for CLA in KNG herds imply that herd size, scratching against pillars, pipes, or walls in the herd, and disinfection of goat herds are potential risk factors for CLA ($P<0.05$). The type of floor and entry of new goats into the herd, which are potential risk factors, affected CLA prevalence in the KNG herd ($P<0.2$). The prevalence of CLA in KNG was significantly higher in spring (29.34%) than in autumn (14.61%), summer (15.31%), and winter (19.48%) ($P<0.05$). Based on the risk factor assessment, attention should be to establishing accurate preventive measures by avoiding these identified potential risk factors.

**Key Words:** Caseous lymphadenitis, *Corynebacterium pseudotuberculosis*, Risk factors, Prevalence, Korean native goats

## INTRODUCTION

Caseous lymphadenitis (CLA), a chronic infectious disease that affects small ruminants (Kaba et al, 2011), is caused by *Corynebacterium pseudotuberculosis* (*C. pseudotuberculosis*). In addition to goats, other farm animals can also suffer from this debilitating or recurring disease (Dorella et al, 2006). It can manifest as abscesses in subcutaneous lymph nodes or as subclinical infections in internal lymph nodes and organs, such as the lungs, liver, and kidneys (Fontaine and Baird, 2008). CLA infection in goats is influenced by several environmental factors, including inadequate hygiene, herd size, housing conditions, and open skin wounds of the animals (Thongkwow et al, 2019). This infection can cause financial losses to the goat industry, affect animal health, downgrade carcass value, and increase inspection and trimming costs during slaughter (Barnabé et al, 2020).

Korean native goats (KNG) are indigenous breeds of goats in Korea known for their high productivity. Traditionally, they have been raised on native grass and agricultural byproducts in the mountains (Kim et al, 2019). However, the recent increase in goat husbandry activities (Kim et al, 2021) and KNG meat consumption (Jeong et al, 2006) has led to the growth and expansion of goat

farming in Korea. Unlike other breeds, KNGs have no specific breeding season, allowing year-round breeding opportunities for farmers to increase their profits (Song, 2003). Despite the high number of animals being produced, goat farming in Korea still faces productivity challenges and health issues. Among the infectious diseases, CLA requires special attention because it can severely impact the goat farming industry in Korea such as reduced productivity, carcass condemnation, and disease outbreak. The reason for this is the contagious nature and wide distribution of CLA, coupled with a lack of effective control measures. There has been limited information about the impact of CLA on the Korean goat industry, as this disease has remained understudied. However, studies from other countries namely, South Africa, Tanzania, Kenya, Mali, Nigeria, and Ethiopia have reported great economic loss due to CLA (Abebe and Sisay, 2015). In Thailand, they have indicated that CLA is a significant cause of economic loss because abscesses can downgrade the carcass price, increase the cost of carcass inspection, and lead to the condemnation of carcasses at the slaughterhouse (Thongkwow et al, 2019).

The increase in the production of KNG has led to an increase in the incidence of CLA in Korea, making this disease endemic to the country (Kim et al, 2021). Currently, there is a lack of scientific research addressing the control of CLA in KNG herds, and no national or regional surveillance tests have been conducted. Furthermore, no studies have assessed seasonal variations in CLA in KNG herds to identify the patterns or trends associated with this disease. This highlights the necessity for epidemiological research to identify the associated risk factors and determine the prevalence of CLA in KNG. Therefore, this study aimed to investigate the risk factors associated with caseous lymphadenitis and evaluate its seasonal prevalence in KNG.

## MATERIALS AND METHODS

### Ethical statement

The experimental protocol was approved by the Animal Care and Use Committee of Sunchon National University, Suncheon, Korea (approval no. SCNU IACUC-2020-3). Experiments were performed in compliance with the rules and regulations of the governing body.

### Epidemiological questionnaire

We randomly selected four high- and four low-prevalence farms based on the prior investigation of CLA prevalence to determine management differences among them. All farms included in the study were located in Jeonnam and Jeonbuk Province, Korea. Samples collected from all farms in the slaughterhouse were tested to confirm the presence of *C. pseudotuberculosis*. An epidemiological investigation was conducted by visiting the selected four high- and four low-prevalence farms and conducted survey using a questionnaire to gather information from each farm. The evaluated risk factors were those identified in previous studies that showed a significant effect on CLA prevalence (De farias et al, 2019; Alves et al, 2020). These factors were narrowed down and subsequently used to examine their influence on CLA prevalence in KNG farms. This included the type of floor (i.e., whether it is plastic slatted or ground floor); herd size; treatment of superficial abscesses; scratching against pillars, pipes, or walls; separation of infected animals; disinfection of goat sheds; entry of new goats from other farms into the herds; and the quarantine period before the entry of new animals into the herd. The KNG herd was initially categorized on an ordinal scale as small (<400 heads) or large (>400 heads) based on the number of animals reared on each goat farm.


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## Seasonal prevalence

The presence of CLA in KNG was assessed in a goat abattoir located in Hwasun-gun, Jeonnam Province, Korea. CLA lesions were collected twice a month. Animals that are sent to the slaughterhouse were assessed and those animals displaying lesions characteristic of CLA were detected over 12 months. The prevalence of CLA was analyzed for all four seasons. A total of 1,177 goats were examined, with samples collected during different seasons: 317 in March~May (Spring), 196 in June~August (Summer), 397 in September~November (Autumn), and 267 from December~February (Winter). A veterinary meat inspector examined all carcasses to observe the presence of CLA lesions. The collected CLA lesions were transported to the laboratory in an insulated cooler box maintained at 4℃ for further analysis. QIAamp DNA Mini Kit was used to extract the DNA of the samples following the manufacturer's recommendation. CLA detection was performed using Polymerase Chain Reaction (PCR) targeting the Phospholipase D (PLD) gene of the samples. The following primer used in the study includes PLD-F:ATAAGCGTAAGCAGGGAGCA and PLD-R2:ATCAGCGGTGATTGTCTTCCAGG which was outlined in the previous studies with slight modification (Domenis et al, 2018). The cycling conditions were 98℃ for 2 min of initial denaturation; 30 cycles of denaturation at 98℃ for 20 seconds, annealing at 56℃ for 20 seconds, and extension at 72℃ for 20 seconds; and a final extension at 72℃ for 3 minutes. PCR products were electrophoresed on a 1.5% (w/v) agarose gel using GreenStar nucleic acid staining solution (Bioneer, Republic of Korea) and visualized under ultra violet light.

## Statistical analysis

Frequencies and percentages were used to determine the potential link between CLA prevalence and distinct epidemiological risk factors. Statistical analysis was conducted using Pearson's chi-square test and SPSS software (version 20.0). Differences were considered significant at $P<0.05$ (Tables 1 and 2) and a tendency at $P<0.2$ (Table 1).

**Table 1.** Risk factors associated with CLA prevalence in Korean native goat herd

| Variables | Category | Prevalence | | *P*-value |
|---|---|---|---|---|
| | | Low N (%) | High N (%) | |
| Type of floor | Plastic slatted floor | 4 (100.0) | 2 (50.0) | 0.102 |
| | Ground floor | 0 (0.0) | 2 (50.0) | |
| Herd size | Small (<400) | 3 (75.0) | 0 (0.0) | 0.028* |
| | Large (>400) | 1 (25.0) | 4 (100.0) | |
| Treatment of superficial abscess | No | 3 (75.0) | 4 (100.0) | 0.285 |
| | Yes | 1 (25.0) | 0 (0.0) | |
| Scratching of goat against pillars, pipes, or walls in the herd | Low | 3 (75.0) | 0 (0.0) | 0.028* |
| | High | 1 (25.0) | 4 (100.0) | |
| Separation of infected animals | No | 2 (50.0) | 3 (75.0) | 0.465 |
| | Yes | 2 (50.0) | 1 (25.0) | |
| Disinfection of goat herds | No | 0 (0.0) | 3 (75.0) | 0.028* |
| | Yes | 4 (100.0) | 1 (25.0) | |
| Entry of new goats into the herd | No | 3 (75.0) | 1 (25.0) | 0.157 |
| | Yes | 1 (25.0) | 3 (75.0) | |
| Quarantine | No | 1 (25.0) | 2 (50.0) | 0.465 |
| | Yes | 3 (75.0) | 2 (50.0) | |

*$P<0.05$ was considered statistically significant; $P\leq0.2$ considered as a tendency of difference.
N, number of farm.

**Table 2.** Seasonal prevalence of CLA in Korean native goat herd

| Season | No. of examined goat | No. of infected goat | Prevalence (%) | *P*-value |
|---|---|---|---|---|
| Spring (March～May) | 317 | 93 | 29.34[b] | 0.01* |
| Summer (June～August) | 196 | 30 | 15.31[a] | |
| Autumn (September～November) | 397 | 58 | 14.61[a] | |
| Winter (December～February) | 267 | 52 | 19.48[a] | |
| | n=1,117 | n=233 | 19.79 | |

*$P$<0.05 was considered statistically significant.
n, total number.

# RESULTS

## Risk factors analysis

Table 1 presents the risk factors associated with CLA in KNG herds based on the epidemiological data obtained in this study. Among the identified epidemiological risk factors, the analysis revealed that herd size; scratching against pillars, pipes, or walls; and disinfection of goat herds were significantly associated with the prevalence of CLA in the KNG herd ($P$<0.05). Additionally, the type of floor and entry of new goats into the herd also represented risk factors and contributed to variations in its prevalence ($P$<0.2). Conversely, treatment of superficial abscesses, separation of infected animals, and quarantine were not associated with the occurrence of CLA in high- or low-prevalence farms.

## Seasonal prevalence

The seasonal prevalence of CLA in KNG peaked predominantly during spring (29.34%) and was significantly different from that in the other seasons ($P$<0.05) (Table 2). The prevalence of CLA during summer, autumn, and winter did not vary significantly. However, winter (19.48%) had a higher prevalence than summer (15.31%) and autumn (14.61%).

# DISCUSSION

In recent years, the prevalence of caseous lymphadenitis (CLA) has increased, particularly among goat breeders in Korea, as it has become endemic (Jung et al, 2015; Kong et al, 2019). Furthermore, the presence of *C. pseudotuberculosis* in animals within the herd causes the rapid spread of CLA (Pathirana et al, 2022). Previous studies only focused on the seroprevalence in which 57.30% (Jung et al, 2015) and 43.00% (Kong et al, 2019) animals were seropositive and isolating the causative agents, leaving a gap in understanding the risk factors contributing to the infection. Thus, there is a critical need to gain a comprehensive understanding of the epidemiology of CLA on Korean goat farms and the risk factors associated with its spread within the herd.

CLA prevalence was significantly associated with herd size; scratching against pillars, pipes, or walls; and disinfection of the herd. The results showed that herd size and CLA occurrence in KNG were significantly correlated. A previous study found higher CLA prevalence in larger than smaller herds (Kaba et al, 2011). Large animal densities competing for space within the herd increase contact among animals. Increased contact can significantly increase the transmission rate from infected animals to animals with wounds. The scratching against pillars, pipes, or walls by goats has also been shown to be significantly associated with CLA prevalence. Goat habits such as licking, rubbing, and scratching their shoulders and heads against walls, fences, or any hard objects may cause wounds in these body parts, resulting in a high percentage of superficial abscesses in the parotid, mandibular, and prescapular lymph nodes (Yitagesu et al, 2020). The walls and pillars on which animals rub their bodies may also be infected with pathogens. Disinfection is crucial for reducing CLA


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prevalence in goat herds, as there is a significant relationship between CLA prevalence and disinfection of goat herds. The information gathered in this study and findings from other research showed that disinfection is vital for controlling CLA. It emphasized that farms that neglect proper disinfection practices increase the likelihood of CLA transmission and occurrence (Guimarães et al, 2011).

Other identified risk factors that showed a potential association with increased CLA prevalence included the type of floor and the entry of new goats into the herd. Farms that used plastic slatted floors showed a potential association with decreasing CLA prevalence compared to farms that used ground-floor systems ($P<0.2$). This may be due to the relatively low accumulation of feces and organic matter when a plastic-slatted floor system is used, which lowers bacterial growth and maintains good sanitary conditions (Radostits et al, 2006). Since the husbandry system for goats in Korea follows an intensive system, which means that goats stay inside the barn most of the time, the floor system is an important factor affecting CLA transmission and prevalence within the herd. Another factor that showed the potential for higher CLA prevalence was the entry of new animals into the herd ($P<0.2$). Research has revealed that CLA prevalence increases when farmers neglect to implement measures when introducing new goats into their herds for expansion purposes (Thongkwow et al, 2019). Since *C. pseudotuberculosis* can cause infections in the subacute phase, it is important to observe the presence of any clinical signs in new animals during the quarantine period before introducing them to the herd to prevent disease transmission (Kuria et al, 2001) thereby reducing CLA prevalence. The entry of new animals from CLA-free herds has been shown to reduce the rate of CLA transmission into herds (Smith and Sherman, 2009).

Quarantine, separation of infected animals, and treatment were not significantly associated with CLA prevalence. Other studies have claimed that these three risk factors are important in reducing the risk of CLA (Alves et al, 2020; Selim et al, 2021). Quarantining for at least 20 days before introduction into a CLA-free herd may prevent CLA transmission (Kuria et al, 2001). Furthermore, other studies have claimed that treating CLA abscesses and separating infected animals from the herd significantly reduced the prevalence of CLA in goat herds (De Farias et al, 2019). The results of this pilot study differ from previous findings because of the limited number of farms examined. Furthermore, the intensity of production and management practices for the KNG were not evaluated, warranting further research with a larger sample size to verify the results.

In terms of seasonal prevalence, data showed that CLA had a significantly higher prevalence during the spring season, with 29.34% of the animals testing positive compared to other seasons. Possible reasons for the high incidence rate of CLA during spring may be the breeding season, consumer demand for goat meat, and the limited land area for rearing. KNGs have no breeding season, and females can reproduce throughout the year. The breeding season of KNG varies depending on the region and climatic conditions (Son, 1999). However, farmers tend to breed goats during spring to meet the consumer demand for goat meat during summer as a source of healthy food. There is high market demand for goat meat during the summer season in Korea. Farmers usually prefer to rear goats in a larger population during the spring season to meet demand, as well as its increased market price. This is the reason for the observed reproduction rate of 50% in spring compared with other seasons (Song, 1997). Additionally, the rearing density of goats is high because of the limited land available for goat farming. Although our study showed no significant difference in CLA prevalence among the other seasons, its occurrence was higher in winter than in summer and autumn. This is probably due to the prolonged environmental survival period of *C. pseudotuberculosis* and the reduced immunity in animals at low temperatures (Augustine and Renshaw, 1986). Moreover, the close contact of infected goats due to the husbandry practice of growing KNGs in dense populations inside barns for warmth may also contribute to the transmis-

sion of CLA in the winter (Jung et al, 2015).

This pilot study validated the identified risk factors associated with CLA prevalence to assess whether they have a similar impact on Korean native goats and to identify which season affects the occurrence of CLA in KNG herds. The research findings revealed significant risk factors and a suggestive trend for possible risk factors related to CLA prevalence. A limitation of this study is the number of farms examined, which may have caused bias in the results. Therefore, future research focusing on an epidemiological study of CLA in KNG should include farms from other regions of Korea to represent nationwide prevalence and evaluate the true status of CLA in Korea. Furthermore, further research with a larger scale of epidemiological studies is necessary to create more specific and precise information about the involvement of risk factors, their effect on CLA occurrence and transmission, and the correlation of different seasons in the prevalence of CLA in KNG.

## CONCLUSION

A pilot study was conducted to analyze the risk factors and association of the season with CLA prevalence in KNG. Large herd sizes and scratching against pillars, pipes, or walls significantly increased CLA prevalence, whereas disinfection of goat herds significantly reduced CLA prevalence ($P<0.05$). Risk factors that had a tendency ($P<0.2$) to affect CLA prevalence were the type of flooring, entry of new goats into the herd, treatment of superficial abscesses, separation of infected animals, and quarantine, which did not affect CLA occurrence. Moreover, this study provides the first seasonal prevalence report of CLA in KNG herds in Korea, where CLA prevalence was significantly higher during spring than during the other seasons ($P<0.05$). Further research with a larger sample population of farms should be conducted in the future for a more intensive study involving risk factors for CLA prevalence and how seasons affect CLA occurrence in KNG.

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## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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