DOI

Short communication

Epidemiological investigation of *Streptococcus bovis* in yaks in different regions of Tibet

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Abstract

Streptococcal diseases critically harm the health and productivity of animals as well as humans, and are generally considered an obstacle in the development of the breeding industry. However, there is little data on *Streptococcus bovis* in different seasons in different regions of Tibet. In this study, a total of 964 yak serum samples from three different cities in the Tibet Autonomous Region, comprising 326 samples from Lhasa city, 522 samples from Naqu City, and 116 samples from Xigatse city, were collected randomly. An enzyme-linked *S. bovis* ELISA kit (YJ233340) was used for detection. An overall seroprevalence of 1.87% was revealed in Tibet during 2021-2024, in which the seroprevalence of Lhasa city was 3.99%, followed by Naqu City (0.96%), and Xigatse City (0%). Seroprevalence was more frequent in the spring season (6.42%) and in 2024 (11.36%). The results of this study serve as a reference for the development of sustainable policies regarding the cattle raising industry and the preventive measures for *S. bovis* in the Tibet Autonomous Region.

Keywords: *Streptococcus bovis*, yak, epidemiology, Tibet

Introduction

Streptococcal diseases represent a significant category of bacterial illnesses in cattle, ranging from mild to severe infections. Members of the genus *Streptococcus* are considered part of the normal microbial flora in both animals and humans, typically inhabiting the mucosal surfaces of the respiratory and urogenital tracts, the mammary gland and the skin. Under specific environmental or physiological conditions, these organisms can transition into opportunistic pathogens, causing diseases that hinder the development of the livestock industry. There are many types of *Streptococci*, which can be divided into 35 serogroups according to serological classification (Kabelitz et al. 2021).

Streptococcus bovis (*S. bovis*) is a particularly noteworthy member of the group D streptococci, though it is frequently misidentified as *Enterococcus* or salivary Streptococcus in clinical settings. It is a group of gram-positive bacteria that existing widely in the upper respiratory tract, udder, intestine and external genitalia of cattle. Most of the interactions with host organisms, however do not cause disease (Andam and Hanage 2015). While *S. bovis* often exists as a commensal organism within the bovine gastrointestinal tract and respiratory system without causing immediate harm, its pathogenic potential is substantial. In livestock, common clinical manifestations include mastitis, septicemia, and endocarditis, all of which lead to decreased production performance and in severe cases, mortality (Gomes et al. 2016). Beyond veterinary concerns, *S. bovis* is a significant zoonotic pathogen; in humans, it has been linked to meningitis and spontaneous bacteremia, and there is a well-documented association with advanced colorectal neoplasms (Sharara et al. 2013). *S. bovis G* has also been linked to osteoarticular infections, urinary tract infections, meningitis, peritonitis, spontaneous bacteraemia in cirrhotic, neonatal infections and non-colorectal cancer (Deering et al. 2013). Despite the economic and social importance of yak farming in the Tibet Autonomous Region, there is currently a lack of comprehensive data regarding the seasonal and regional seroprevalence of *S. bovis* in these populations. This study was designed to fill that gap by investigating the epidemiology of *S. bovis* across different regions of Tibet from 2021 to 2024.

Materials and Methods

Sample collection

Whole blood samples were collected in three municipalities in Tibet from 2021 to 2024. A sample size of 384 at 95% confidence level was calculated using OpenEpi software, assuming 50% prevalence of *streptococcal* infection in the 950,000 yak population of the region. A convenience sampling method was employed for the inclusion of animals in the study. A total of 964 blood samples (*n*=964), comprising 326 samples from 2 sampling sites in Lhasa city (Table 1), 522 samples from 5 sampling sites in Naqu City (Table 2), and 116 samples from 2 sampling sites in Xigatse city, were collected (Table 3).

Serum detection

The collected blood samples were centrifuged at 4000 revolutions per minute (RPM) for 10 minutes for serum precipitation, and then stored in a refrigerator at -20 °C. *S. bovis* antibody ELISA kit (Enzyme-linked, Shanghai, China) was used in this experiment to detect antibodies against Streptococcus. The absorbance or optical density (OD) value was measured at 450 nm, and to ensure test validity, the average value of positive controls was ≥ 1.00; the mean value of negative controls was ≤0.20. The critical value (CV) was calculated as follows: CV = mean of negative controls +0.15, and OD ≥ CV was considered positive, while OD < CV was considered negative.

Statistical analysis

The results were analyzed using the chi-square (χ^2) test with SPSS (26.0). The differences were recognized as significant when the probability (P) value was less than 0.05.

Results and Discussion

The serological screening of 964 yak samples across three major municipalities revealed an overall *Streptococcus bovis* seroprevalence of 1.87% in the Tibet Autonomous Region. Significant regional variations were observed, with Lhasa City exhibiting the highest rate at 3.99%, followed by Naqu City at 0.96%, while Xigatse City recorded no positive cases (0%). A temporal analysis of the data shows a sharp increase in antibody detection in 2024, where the seroprevalence reached 11.36%, a marked rise following rates observed in 2022 (1.61%), 2023 (1.56%), and 2021 (1.30%), respectively (Table 4 & Table 5). This spike was particularly evident in Dangxiong County of Lhasa, where the rate jumped from 2.77% in 2021 to 16.13% in 2024. Other positive instances were recorded in Nimu (2.56%) within Lhasa, and Biru (3.45%), Lhari (1.64%), Nima (1.49%), and Nyainrong (0.31%) in Naqu, while Yadong and Saga counties in Xigatse remained entirely negative. Furthermore, seasonal trends indicated that spring (6.42%) was the peak period for seropositivity, significantly higher than Autumn (1.13%) and Summer (0.86%).

The epidemiological data revealed a significant temporal and regional shift in *S. bovis* seroprevalence, most notably the spike in 2024, where the overall rate reached 11.36%, compared to an average of ~1.5% in previous years. This increase was driven largely by Dangxiong County in Lhasa, which saw a jump from 2.77% in 2021 to 16.13% in 2024. This suggests a localized outbreak or a significant change in herd dynamics. On the Tibetan plateau, such spikes are often correlated with increased animal density during winter housing or changes in local management practices that may lead to compromised hygiene. The physiological

Table 1. Seroprevalence of *Streptococcus bovis* in yaks in Lhasa city.

Samples	2021	2022	2024	Total
	Dangxiong county	Nimu county	Dangxiong county	
No. of samples	217	78	31	326
No. of positives	6	2	5	13
%	2.77	2.56	16.13	3.99

Table 2. Seroprevalence of *S. bovis* in yaks in Naqu City.

Samples	2021	2022	2023		2024		Total
	Nyainrong county	Lhari county	Nima county	Biru county	Nyainrong county	Suo county	
No. of samples	323	61	67	58	6	7	522
No. of positives	1	1	1	2	0	0	5
%	0.31	1.64	1.49	3.45	0	0	0.96

Table 3. Seroprevalence of *S. bovis* in yaks in Xigatse city.

Samples	2022	2023	Total
	Yadong county	Saga county	
No. of samples	47	69	116
No. of positives	0	0	0
%	0	0	0

Table 4. Seroprevalence of *S. bovis* in yaks in different years.

Samples	2021	2022	2023	2024	Total
No. of samples	540	186	194	44	964
No. of positives	7	3	3	5	18
%	1.30	1.61	1.56	11.36	1.87

Table 5. Seroprevalence of *S. bovis* in yaks in different cities

Samples	Lhasa	Naqu	Xigatse	Total
No. of samples	326	522	116	964
No. of positives	13	5	0	18
%	3.99	0.96	0	1.87

Table 6. Seroprevalence of *S. bovis* in yaks in different seasons.

Samples	Winter	Spring	Summer	Autumn	Total
No. of samples	0	109	233	622	964
No. of positives	0	7	4	7	18
%	0	6.42	0.86	1.13	1.87

Winter – Dec-Feb, Spring – Mar-May, Summer – Jun-Aug, Autumn – Sep-Nov.

stress associated with the harsh high-altitude climate, particularly during the spring season when seroprevalence peaked (6.42%), can suppress the immune response of yaks, making them more susceptible to opportunistic pathogens such as *S. bovis* (Table 6).

The clinical implications of these findings are serious for the yak industry, as *S. bovis* is a known causative agent of bovine mastitis and endocarditis. A seroprevalence of 16.13% in a major breeding hub indicates high pathogen exposure that could manifest as subclinical mastitis, leading to reduced milk quality and significant economic losses. Moreover, the zoonotic risk to Tibetan breeders cannot be overlooked. Given the proximity between pastoralists and their herds and the consumption of raw yak milk products, the presence of *S. bovis* poses a public health threat. The well-documented correlation between *S. bovis* bacteremia and colorectal neoplasms and meningitis in humans adds a layer of urgency to these findings, necessitating a "One Health" approach to monitoring and hygiene education.

Statistically, while the sample size in Xigatse is smaller, the total absence of antibodies (0%) stands in stark contrast to Lhasa and suggests that these herds may be geographically or managementally isolated from primary transmission chains. In Lhasa, the higher frequency of animal movement and inter-herd commingling likely facilitates the spread of the pathogen. However, this must be interpreted with caution; a lack of antibody detection indicates that exposure levels were below the detection threshold of the ELISA kit rather than proving total absence. Variations between studies may also stem from intrinsic and extrinsic factors, including sampling of geographically distant farms and within herds in the same area, management of cattle farms, dwelling conditions, feed management, water quality, animal health, seasonality, environment, and climate (Vacheyrou et al. 2011, Boukria et al. 2020). It may also be due to the influence of human activities, spring and autumn are the seasons for crop planting and harvest, agricultural activities are frequent, chemical substances in agricultural production (such as pesticides, fertilizers) may affect animal health, especially in an environment that has not been fully cleaned and easy to bacterial multiplication is facilitated thereby increasing the probability of animal disease (Guo et al. 2021).

Finally, it must be noted that this study relied solely on ELISA, which identifies antibodies reflecting historical exposure rather than active infection or current bacterial shedding. To confirm active bacteremia and fully characterize the specific strains circulating in the Tibet region, future studies should supplement serological data with bacterial isolation and Polymerase Chain Reaction (PCR) testing. These results serve as a vital reference for developing sustainable preventive measures and public health policies to protect both the livestock industry and human populations in Tibet.

Conclusion

This study reported the epidemiology of *S. bovis* in Tibet and provided a reference for the prevention of *S. bovis* on the Tibetan Plateau.

Funding

This study was supported by the Key Research and Development Project of the Tibet Autonomous Region (XZ202201ZY007N-01) and the National Key Research and Development Plan (2022YFD1302101).

Ethics approval

This study was approved by the Institutional Animal Ethics committee of the Tibet Academy of Agriculture and Animal Husbandry Sciences (TAAAS2024007).

Use of generative artificial intelligence

No AI tool is used.

Conflict of interest

There is no conflict of interest.

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