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Microbiological and Pathogenetic Features of Necrobacteriosis In Cattle: An Integrated Pathogenetic Model

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Abstract: This study provides a comprehensive analysis of the microbiological and pathogenetic characteristics of necrobacteriosis in cattle. The findings demonstrate that the development of necrobacteriosis is not limited to infection by Fusobacterium necrophorum alone, but represents a complex, multifactorial process involving endogenous and exogenous factors as well as polymicrobial associations.

Although F. necrophorum acts as the primary etiological agent in necrotic and inflammatory lesions of the distal hoof tissues, its pathogenic potential is significantly enhanced through synergistic interactions with opportunistic microorganisms.

Based on the obtained results, an integrated pathogenetic model of necrobacteriosis was developed, highlighting the need for a comprehensive approach to disease evaluation and control.

Keywords: Necrobacteriosis; dairy cattle; hoof pathologies; Fusobacterium necrophorum; polymicrobial infection; epizootiology; diagnosis; prevention.

Introduction: Necrobacteriosis in cattle has traditionally been regarded as a classical infectious disease caused by the anaerobic bacterium Fusobacterium necrophorum. However, recent advances in veterinary microbiology and pathophysiology indicate that the mechanisms underlying its development are considerably more complex and cannot be explained solely by the presence of a single pathogen.

Accumulating evidence suggests that necrobacteriosis should be considered not as a simple infectious process, but rather as a dynamic and multifactorial pathological condition resulting from intricate interactions between host-related factors, environmental conditions, and diverse microbial communities. In this context, the disease represents a complex pathogenetic system in which endogenous and exogenous factors collectively contribute to the initiation and progression of pathological changes.

Host-related factors such as immune status, metabolic balance, and physiological stress play a crucial role in determining susceptibility to infection. In high-yielding dairy cattle, metabolic disturbances, including subclinical acidosis and mineral deficiencies, can significantly reduce systemic and local immune resistance, thereby creating favorable conditions for the activation of opportunistic microorganisms.

Environmental and management-related factors are also of critical importance. Poor housing conditions, high humidity, inadequate hygiene, hard flooring, and limited animal movement contribute to mechanical damage of hoof tissues and disruption of their barrier function. These changes facilitate the penetration and colonization of microorganisms in the distal limb

tissues.

Furthermore, recent studies emphasize the polymicrobial nature of necrobacteriosis. Although Fusobacterium necrophorum plays a leading etiological role, it is rarely detected as a single pathogen. Instead, it commonly interacts synergistically with other opportunistic microorganisms, including Staphylococcus spp., Streptococcus spp., and enteric bacteria, which enhance inflammatory responses, accelerate tissue destruction, and prolong the disease course.

Taken together, these findings indicate that necrobacteriosis should be understood as a multifactorial and polymicrobial disease in which the interaction between host, environment, and microbial associations determines the clinical outcome. Such an approach necessitates a comprehensive reconsideration of diagnostic, preventive, and therapeutic strategies in modern dairy cattle production systems.

METHODS

The study was conducted on high-yielding dairy cattle raised in farms located in the Tashkent, Samarkand, Kashkadarya, and Syrdarya regions of Uzbekistan, which had been identified as epizootically unfavorable for necrobacteriosis and hoof diseases over the past six years.

In addition to field investigations, laboratory experiments were performed using laboratory animals (white mice) and various pathological materials obtained from affected cattle.

Isolation and identification of microorganisms involved in the pathogenesis of necrobacteriosis and hoof diseases were carried out in accordance with Bergey's Manual of Systematic Bacteriology and standard bacteriological methods.

Clinical and epizootiological data were analyzed based on established veterinary guidelines and relevant scientific literature.

Pathomorphological examinations included the analysis of hoof lesions, as well as parenchymal organs (liver, heart, lungs, and kidneys) and necrotic lesions in the gastrointestinal tract obtained from slaughtered animals. In live animals, pathological samples were collected directly from affected hoof tissues.

All pathological samples were examined using standard bacteriological and mycological techniques. A modified biological assay was applied for the isolation of the causative agent of necrobacteriosis, and the pathogen was subsequently re-isolated from laboratory animals.

Pathological materials were cultured on Kitt–Tarozzi medium, meat-peptone broth and agar, and Sabouraud medium. The diagnosis of necrobacteriosis was confirmed by the isolation of pathogenic strains of Fusobacterium necrophorum.

Based on the obtained results, different forms of lesions associated with necrobacteriosis and hoof diseases were classified according to clinical, pathomorphological, and laboratory diagnostic criteria.

RESULTS

The results of clinical, epizootiological, and laboratory investigations conducted in dairy farms across different regions of Uzbekistan demonstrated that necrobacteriosis and associated hoof diseases are widely distributed among high-yielding cattle populations. In several farms, these conditions were recorded across different physiological and production groups of animals.

The analysis revealed that necrobacteriosis and hoof pathologies were most frequently observed in productive dairy cows and heifers. A marked increase in disease incidence was recorded during the winter season, which was associated with unfavorable housing conditions, feeding imbalances, and insufficient compliance with veterinary and hygienic standards.

Breed-related susceptibility was also identified as an important factor influencing disease prevalence. Holstein cattle exhibited a higher incidence of necrobacteriosis and hoof lesions compared to other breeds. Furthermore, the housing system significantly affected the occurrence of hoof pathologies, with a higher frequency observed in tethered systems than in loose housing conditions.

It was established that prolonged exposure to hard or uneven flooring, particularly under tethered conditions, contributed to mechanical stress on the hoof tissues. This resulted in disruption of the physiological growth and structural integrity of the hoof horn, predisposing animals to laminitis, pododermatitis, and white line disease.

In addition, technological factors associated with intensive dairy production, including increased load in milking facilities, were found to intensify aseptic inflammatory processes. Impaired microcirculation in hoof tissues under such conditions created a favorable anaerobic environment for the proliferation of pathogenic microorganisms, particularly Fusobacterium necrophorum.

Microbiological analyses confirmed that necrobacteriosis was predominantly associated with polymicrobial infections. Along with Fusobacterium necrophorum, a wide range of microorganisms were isolated from affected tissues, including micrococci, staphylococci, streptococci, enterococci, Escherichia

coli, Proteus spp., and other gram-negative bacteria.

These findings indicate that microbial associations play a significant role in enhancing inflammatory responses, accelerating tissue destruction, and prolonging the course of infection.

Clinically, the disease was most commonly observed in recently calved cows and heifers and was characterized by lameness affecting one or both limbs. In many cases, lesions were localized in the distal hoof region, presenting as ulcers, abscesses, and necrotic tissue destruction.

Additionally, epidemiological observations indicated that the introduction of new animals into herds without proper veterinary control, as well as the persistence of pathogens in contaminated housing environments, contributed significantly to the spread of infection.

DISCUSSION

The findings of the present study confirm that necrobacteriosis in high-yielding dairy cattle should not be regarded as a simple infectious disease but rather as a complex multifactorial condition influenced by a combination of host, environmental, and microbial factors.

The high prevalence of the disease observed in different regions indicates that necrobacteriosis remains a significant health and economic problem in modern dairy farming systems. The increased incidence during the winter period suggests a strong association with deteriorating housing conditions, increased humidity, and reduced hygienic standards, which create favorable conditions for pathogen survival and transmission.

The results also demonstrate that breed susceptibility plays an important role, with Holstein cattle being more prone to hoof diseases and necrobacteriosis. This may be explained by their high productivity levels, which are often associated with increased metabolic stress, reduced immune resistance, and greater mechanical load on the distal limbs.

The influence of housing systems further supports the multifactorial nature of the disease. The higher frequency of hoof lesions in tethered systems compared to loose housing conditions highlights the negative impact of restricted movement, prolonged standing, and uneven weight distribution on hoof health. These factors contribute to microtrauma, disruption of hoof integrity, and increased susceptibility to infection.

One of the most important findings of this study is the confirmation of the polymicrobial nature of necrobacteriosis. Although Fusobacterium necrophorum was identified as the primary etiological agent, it was rarely isolated as a single pathogen. Instead, it was consistently detected in association with other opportunistic microorganisms, including staphylococci, streptococci, enteric bacteria, and fungi.

Such microbial interactions likely result in synergistic effects, enhancing inflammatory responses, accelerating tissue necrosis, and complicating the clinical course of the disease. This observation is consistent with current concepts of polymicrobial infections, where disease severity is determined not only by the presence of a primary pathogen but also by the composition and activity of microbial communities.

Furthermore, the results indicate that environmental and management-related factors, such as poor hygiene, high stocking density, inadequate flooring conditions, and insufficient veterinary control, significantly contribute to disease occurrence and spread. The introduction of animals without proper quarantine measures and the persistence of pathogens in contaminated environments further exacerbate the epizootic situation.

Taken together, these findings emphasize the necessity of a comprehensive approach to the control of necrobacteriosis. Effective prevention and management strategies should not be limited to antimicrobial treatment but must also address underlying predisposing factors, including optimization of housing conditions, improvement of feeding practices, and strengthening of animal immunity.

Practical Recommendations

Based on the results of the present study, the following recommendations are proposed for improving the prevention, diagnosis, and control of necrobacteriosis and hoof pathologies in high-yielding dairy cattle:

– Regular clinical examination of the distal hoof region should be implemented in dairy farms to ensure early detection of necrobacteriosis and associated hoof diseases;

– Pathological samples collected from animals exhibiting lameness or inflammatory lesions of the hoof tissues should be subjected to bacteriological analysis for the identification of Fusobacterium necrophorum and associated microorganisms;

– Proper zoohygienic conditions must be maintained, including effective control of moisture, contamination, and flooring quality in livestock facilities;

– Regular hoof care, including trimming and the application of preventive hoof baths (both liquid and dry types), should be incorporated into routine herd management practices;

– Newly introduced animals should undergo strict veterinary inspection and quarantine procedures to

prevent the introduction and spread of infectious agents;

– Clinical and pathomorphological findings, as well as photographic materials obtained during the study, may be used as supplementary tools for improving field-lev

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