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Gene Expression in The Bovine Gastro-Intestinal Tract During Nematode Infection

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Abstract

Gastrointestinal nematodes are among the most significant diseases impacting the American cattle industry, causing economic losses of over $2 billion each year. These parasitic worms, comprising more than 41 identified species, predominantly affect the abomasum, small intestine, and large intestine of cattle. Addressing these challenges requires a comprehensive understanding of the molecular mechanisms regulating acquired immunity, immunosuppression, and innate resistance. This knowledge is essential for advancing novel control strategies, such as vaccines and genetic selection for resistant herds. Studies have shown that nematode infections significantly alter the host's gene expression patterns. This chapter explores four key areas: - Recent advancements in understanding cytokine expression patterns during nematode infections. The function of cell adhesion molecules, such as collectins, galectins, and cadherins, in modulating immune responses. The impact of mucins and their biosynthesis on the progression of nematode infections. Alterations in regulatory pathways and networks caused by parasitic infections. The findings offer valuable insights into cattle-parasite interactions, contributing to the development of more effective strategies to strengthen immunity and resistance against gastrointestinal nematodes.

Introduction

Gastrointestinal nematodes pose a significant health concern to cattle, leading to reduced productivity and greater economic burden on the dairy industry. These parasites inhabit various sections of the GI tract, with certain species, like *Haemonchus contortus* and *Trichuris ovis*, causing more severe impacts under specific conditions. Transmission is influenced by environmental factors and host immune responses, with infection rates frequently corresponding to periods of forage growth. Although anthelmintics were initially successful, their extensive use has resulted in resistance. As a result, alternative strategies, including biological controls, vaccine development, and selective breeding, are being investigated to lessen reliance on chemical treatments. Gaining deeper insights into the molecular mechanisms governing host resistance and parasite evasion is crucial for advancing these approaches.

Cytokine expression during infection

Cytokines, essential regulators of the immune response, play a pivotal role in managing nematode infections. Key research findings include: - Th2 Dominance: Infections caused by species like *Haemonchus contortus* trigger strong Th2 responses, marked by increased levels of interleukin (IL)-4, IL-5, and IL-13. Th1/Th2 Interaction: In *Ostertagia*

ostertagi, the immune response involves a complex interplay between Th1 and Th2 pathways, highlighting species-specific immune adaptations. Immune Evasion: Some nematodes suppress cytokine expression to enhance their survival within the host.

Cell adhesion molecules

The immune system's ability to identify and react to parasitic infestations depends on cell adhesion molecules. Key findings include: - The function of galectins and collectins is to trigger immune responses by binding to molecular patterns derived from nematodes. Resistance is correlated with genetic variations in collectins, including conglutinin. Vaccine Potential: Targeting these molecules may offer novel approaches for vaccine development.

Mucins and mucin biosynthesis

The main components of the mucus barrier in the GI tract are mucins, it plays a vital role in defending against nematode infections. Key findings include: - Enhanced Mucus Production: Goblet cell hyperplasia in infected cattle results in increased mucin secretion and nematode expulsion. Gene Regulation: During infections, mucin genes such as MUC2 and MUC5B are markedly increased in expression. Immune Modulation: Mucins contribute to immune responses, facilitating the mechanical clearance of parasites.

Perturbations in regulatory networks

High-throughput genomic studies have uncovered the impact of nematode infections on host biological pathways: - Immune Disruptions: Parasites modify signaling networks associated with inflammation and apoptosis, undermining the host's defense mechanisms. Metabolic Alterations: Infections affect lipid metabolism, particularly fatty acid and phospholipid pathways, potentially impairing immune function. Nutritional Intervention: Supplementing polyunsaturated fatty acids (PUFAs) may enhance immunity and help reduce the parasitic burden.

Conclusions

Bovine health is greatly impacted by gastrointestinal nematode infections because they change immunological pathways and gene expression. Knowledge of these processes can direct the creation of long-term control strategies, such as immunization and selective breeding. To increase cow resistance and productivity, further molecular research on host-parasite interactions is necessary.

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