Perspective

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Application of Transgenerational Epigenetic Technology in Animal Production

Sophia O'Malley*

Department of Animal Nutrition, University of Copenhagen, Frederiksberg C, Denmark

Corresponding author: Sophia O'Malley, Department of Animal Nutrition, University of Copenhagen, Frederiksberg C, Denmark, E-mail: O'Malley_s@gmail.com

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Description

The prohibition of antibiotics in animal feed, prevalent in numerous countries, arises from mounting concerns regarding bacterial resistance and food safety implications. The quest for antibiotic alternatives is imperative, prompting consideration of transgenerational epigenetic technology in animal production. This approach entails the transmission of environmental changes to offspring *via* epigenetic mechanisms, sans alteration of DNA sequences.

Animal production

We delineate the impacts of paternal transgenerational epigenetics on metabolism and immunity in farming animals, alongside proposing strategies to modulate male breeding livestock or poultry. Genetic selection for growth performance and nutrient optimization in domestic animals has substantially enhanced their growth while shortening growth cycles. However, this selection often coincides with heightened metabolic processes that may compromise immune capacity, fostering epidemiological diseases and impeding animal growth. To address these concerns, Antibiotics Growth Promoters (AGPs) have been extensively employed in feed industries to bolster gut health and enhance feed conversion efficiency.

Nevertheless, the gradual worldwide ban on AGPs is motivated by their detrimental effects on healthy intestinal microbiota and the development of antibiotic resistance. Despite these benefits, the discontinuation of AGP usage may elevate the risk of conditioned pathogen infection in domestic animals, escalate feeding costs and potentially heighten infection risks in humans. This underscores the urgency of exploring novel AGP alternatives capable of supporting productive potential and maintaining animal health.

Recent studies have proposed various AGP substitutes, including probiotics, prebiotics, antimicrobial peptides, polysaccharides and feed enzyme additives. However, these alternatives have not proven as effective as antibiotics in micro ecological modulation. Thus, novel approaches are warranted to mitigate immune and metabolic disorders associated with the absence of AGP usage.

Over the past century, a stable gene expression pattern has been established through genetic selection and AGP utilization. This continuous improvement has bolstered metabolism and feed utilization efficiency, directing energy and nutrients primarily towards muscle, bone growth and fat accumulation, at the expense of immune organ development and function. AGPs have historically aided in maintaining health and enhancing growth performance by mitigating potential issues stemming from decreased immune function, heightened metabolic heat production and reduced anti-stress ability, all inherent in the stable gene expression pattern.

To uphold the growth performance and health of domestic animals post the prohibition of Antibiotics Growth Promoters (AGPs), it is imperative to establish a novel and enduring gene expression pattern. This can be achieved through successive generations of domestic animals by enhancing nutritional supplementation. The interplay between gene expression patterns and environmental factors, particularly nutritional variations, constitutes a pivotal area of research. These patterns can be more readily correlated with animal growth performances and immune functions.

Epigenetic effects on animal growth

Therefore, the application of transgenerational epigenetic technology in animal production emerges as a viable alternative. This technology facilitates the transmission of altered nutritional supplementation to offspring *via* memory-like responses, employing epigenetic mechanisms without altering DNA sequences. Nutrients known for their efficacy in regulating animal metabolism and immunity include functional nutrients and non-nutritional additives such as amino acids, vitamins, polysaccharides, probiotics and prebiotics, which could potentially serve as candidates for epigenetic regulation. The primary focus lies in improving offspring growth and immunity, thus obviating the need for antibiotics in domestic animal husbandry.

Epigenetics encompasses the study of inherited alterations in gene expression without DNA sequence mutations during cell mitosis, meiosis, biological development and reproduction in animals. Mechanisms such as DNA methylation, histone modification, chromosome encoding and non-coding RNAs are implicated in the regulation and inheritance of these gene expression alterations. Research in livestock epigenetics primarily centers on two aspects: How environmental factors gradually induce epigenetic modifications in genomes, thereby regulating the expression of associated genes and how these modifications and corresponding phenotypes are transmitted to offspring, termed transgenerational epigenetics. The latter phenomenon underscores the influence of environmental factors on epigenetic modifications in germ cells.

In comparing transgenerational epigenetics with traditional genetics, both exhibit transgenerational inheritance capabilities. However, transgenerational epigenetics pertains to the gradual adaptation of gene expression alterations to environmental changes, which is likely continuous, unlike gene mutation or significantly increased genotyping frequency seen in traditional genetics.