Probiotics As a Strategy for Mitigating Heat Stress in Poultry: Enhancing Gut Health and Resilience

Susmita Thullimalli[1] and C. Anil Kumar

[1]Associate Professor, Poultry Science, NTR College of Veterinary Science, Sri Venkateswara Veterinary University.

[2]Assistant Professor, Department of Animal Nutrition, NTR College of Veterinary Science, Sri Venkateswara Veterinary University.

Corresponding Author: susmita.thullimalli@gmail.com

This article delves into the dietary supplementation of probiotics as a strategy to mitigate the negative effects of heat stress on poultry. Heat stress significantly impacts the health, welfare, and productivity of poultry, leading to economic losses estimated at $240 million annually in the U.S. It reduces feed intake, impairs nutrient absorption, disrupts gut structure, and weakens the immune system. As a result, effective management and nutritional strategies are crucial in alleviating these adverse effects in the poultry industry.

Understanding Heat Stress in Poultry

Heat stress occurs when poultry cannot regulate their body temperature effectively, typically when the ambient temperature exceeds their thermal neutral zone of 18°C to 30°C. This condition can manifest as acute or chronic stress, depending on the duration of exposure. Chronic exposure can be particularly damaging, leading to significant physiological and metabolic disturbances.

Impacts of Heat Stress on Gut Health

Heat stress compromises gut morphology and integrity, reducing digestive and absorptive capacity. The stress redirects blood flow away from the gut to dissipate heat, leading to ischemia (reduced blood flow) and hypoxia (oxygen deficiency) in the gut lining. This results in a weakened gut barrier and increased permeability to harmful antigens and toxins. Additionally, heat stress alters the gut microbiota composition, which can further impact gut health and overall bird performance.

Probiotics as a Strategy to Improve Gut Health

Probiotics have shown potential in improving gut health in heat-stressed poultry. They enhance microbial diversity, regulate inflammatory responses, and support the structural integrity of the gut. Specific strains like *Bacillus licheniformis* and Lactobacillus-based probiotics help maintain mucus-producing cells in the gut, improving its protective barrier function. Probiotics also help in restoring gut morphology by reversing the effects of stress-induced changes in villus structure and reducing gut permeability.

Mechanisms of Action of Probiotics

The paper discusses the key mechanisms by which probiotics exert their beneficial effects:

1. **Competitive Exclusion**: Probiotics compete with pathogenic bacteria for adhesion sites on the intestinal mucosa and for essential nutrients, thereby limiting pathogen colonization. They also produce antimicrobial substances like bacteriocins, hydrogen peroxide, and organic acids that inhibit the growth of harmful bacteria.
2. **Immune System Modulation**: Probiotics enhance both the innate and adaptive immune responses of the host. They stimulate immune cells such as macrophages and lymphocytes, leading to the production of antibodies and cytokines that protect against infections. Probiotics also strengthen the intestinal barrier by increasing the production of mucins and defensins, which act as a physical barrier against pathogens.
3. **Reduction of Toxin Bioavailability**: Probiotics, especially lactic acid bacteria, can neutralize and bind to toxins like mycotoxins, reducing their absorption in the intestine. This function helps protect poultry from the adverse effects of toxins in their diet.
4. **Production of Inhibitory Compounds**: Probiotics produce various antimicrobial compounds that target and inhibit specific pathogens. Bacteriocins, organic acids, and other metabolites alter the gut environment, making it less favorable for the growth of harmful microorganisms like *Clostridium perfringens* and *Escherichia coli*.

Effects on Physiology and Immune System

Heat stress can disrupt the physiological balance in poultry, leading to issues like electrolyte

imbalances, respiratory alkalosis, and a decrease in vital blood components. Probiotics can mitigate some of these effects by reducing stress hormones like corticosterone and increasing thyroid hormones, which in turn enhance metabolism. Additionally, probiotics help strengthen the immune system by improving antibody responses, reducing excessive inflammation, and supporting the development of immune cells, thus providing a better defense against infections.

Probiotics and Improved Performance

Probiotics have been found to positively influence growth performance and metabolism in poultry under heat stress. They boost digestive enzyme activity, enhance protein digestibility, and improve the feed conversion ratio. Probiotic blends, such as combinations of *Bacillus subtilis*, *Lactiplantibacillus plantarum*, and *Lactobacillus* strains, have been shown to support growth and increase feed intake. In laying hens, these supplements also improve egg production and overall productivity, counteracting the performance decline caused by heat stress.

Probiotic Strains Effective Against Heat Stress

Here are some of the probiotic strains that have been studied for their role in mitigating heat stress effects in poultry:

Lactobacillus acidophilus:

- *Effect*: Supplementation of *Lactobacillus acidophilus* has been shown to improve feed conversion ratios (FCR) and enhance the gut health of poultry under heat stress conditions. It supports better nutrient absorption, leading to improved growth and production even in high-temperature environments.
- *Mechanism*: It helps stabilize the gut microbiota, modulate immune responses, and reduce oxidative stress markers.

Bacillus subtilis:

- *Effect*: *Bacillus subtilis* supplementation can improve growth performance, reduce mortality, and support gut health during heat stress. It has been found to maintain higher body weight gain (BWG) and reduce stress markers in poultry.
- *Mechanism*: This strain acts as an antioxidant and helps maintain a balanced gut flora, which reduces the negative impacts of heat stress on intestinal integrity and overall health.

Lactobacillus plantarum:

- *Effect*: *Lactobacillus plantarum* is known for its antioxidant capabilities, which help mitigate the oxidative stress caused by high temperatures. It has been shown to reduce the inflammatory responses in poultry subjected to heat stress.
- *Mechanism*: By reducing oxidative damage and enhancing gut health, this strain supports better feed efficiency and overall resilience against heat stress conditions.

Saccharomyces cerevisiae (Yeast):

- *Effect*: Yeast probiotics like *Saccharomyces cerevisiae* have been shown to improve intestinal morphology and reduce the adverse effects of heat stress on growth performance. They enhance nutrient utilization and stabilize gut flora.
- *Mechanism*: Yeast produces beneficial metabolites and contributes to the maintenance of gut health, which is critical for coping with stressors like high temperatures.

Clostridium butyricum:

- *Effect*: *Clostridium butyricum* supplementation can improve growth performance and immune function in heat-stressed broilers. It enhances gut integrity, reducing the negative effects of stress-induced intestinal permeability.
- *Mechanism*: It produces butyrate, a short-chain fatty acid that is beneficial for gut health, and reduces the inflammatory responses associated with heat stress.

Research Findings and Benefits

- **Growth Performance**: Studies have shown that probiotics like *Bacillus subtilis* and *Lactobacillus acidophilus* can enhance feed intake and weight gain in poultry under heat stress by maintaining a stable gut environment and improving nutrient absorption.
- **Immune Response**: Probiotic supplementation has been associated with higher levels of immunoglobulins and better responses to vaccinations in heat-stressed

poultry, which are critical for maintaining flock health.

- **Reduced Mortality Rates**: In broilers subjected to high temperatures, probiotics like *Bacillus* strains have been found to reduce mortality rates by supporting better gut health and reducing the physiological impacts of heat stress.
- **Improved Antioxidant Status**: The antioxidant activity of probiotics helps in neutralizing oxidative stress in heat-stressed poultry, leading to lower levels of stress indicators like malondialdehyde (MDA) and higher levels of antioxidant enzymes like superoxide dismutase (SOD).

Conclusion

Probiotic supplementation appears to be a promising strategy for mitigating the adverse effects of heat stress in poultry. By improving gut health, maintaining physiological balance, and supporting the immune system, probiotics help counteract the negative impacts of high environmental temperatures on bird performance. However, further research is needed to optimize probiotic dosages and combinations for maximum efficacy in different poultry production systems.

* * * * * * * * *