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A Review about Behavioral Indicators of Stress in Broilers: Insights from Digital Monitoring Technologies

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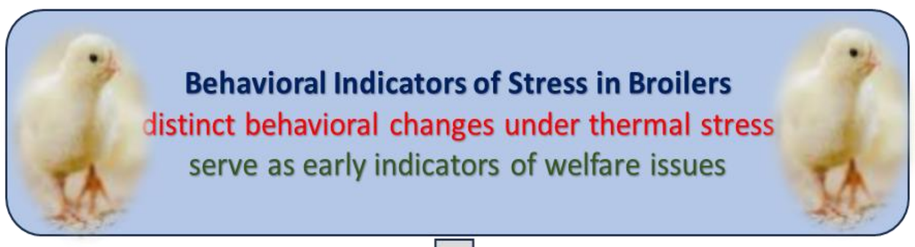
Abstract: *Early detection and management of stress are very important to ensure welfare in broiler production systems and significantly influences poultry's health, behavior, and productivity. Main stress-related behaviors, such as social interaction, excessive pecking, increased aggression, and reduced locomotion, are best analyzed using smart video surveillance systems and machine learning algorithms capable of real-time data processing and pattern recognition. Also, the integration of wearable sensors (e.g., temperature and heart rate monitors) represents a complementary tool to enhance the precision and reliability of behavioral data. This review offers a comprehensive study of current digital solutions aimed to enhance animal welfare through automated, continuous, and non-invasive stress monitoring in broiler flocks. It discusses the use of video cameras equipped with computer vision and behavioral pattern recognition algorithms, presenting real-time applications for identifying signs of social isolation, aggression, and abnormal movement patterns. Additionally, the review emphasizes the role of machine learning algorithms in training neural networks to analyze large datasets generated from video recordings and behavioral reports. Finally, the review examines the wearable sensors tools like temperature and heart rate monitors, emphasizing how they enhance visual observations by providing valuable information about internal physiological states. Each of these technologies is evaluated in terms of accuracy, feasibility, and implementation challenges in commercial poultry systems. The integration of such tools can significantly enhance our ability to monitor broiler welfare dynamically, paving the way for predictive management strategies and improved animal care.*

Introduction

The integration of accessible digital technologies allows real-time intervention, non-invasive monitoring of broilers, enhances data exchange, supports prompt decision-making, and optimizes large data management for accurate thermal stress control in poultry farming (*Brassó et al., 2025*).
This review explores digital tools—video surveillance, machine learning, and sensors—for detecting stress in broilers, emphasizing their accuracy, feasibility, and potential to enhance welfare through predictive management.



Conclusion

Research suggests that digital technologies can significantly improve early thermal stress detection and welfare outcomes, but their implementation in commercial broiler rearing systems requires addressing challenges related to adaptability, cost, and data management.

Digital Monitoring Technologies for Thermal Stress Assessment

❑ Video Surveillance and Computer Vision

- *Sound Analysis*: Microphone arrays and AI models identify stress-related vocalizations with over 96% accuracy (Neves et al., 2022)
- *Image Processing*: Optical flow techniques detect movement anomalies linked to lameness 10 days before clinical diagnosis (Yang et al., 2023)
- *Behavior Recognition*: Convolutional Neural Networks (CNNs) and models like YOLOv5 classify behaviors (feeding, drinking, resting) in real time, enabling proactive welfare management (Li et al., 2023)

❑ Machine Learning Algorithms

- *Training Neural Networks*: Advanced models like the Improved Feature Fusion SSD (IFSSD) detect health-related behavior with 99.7% mAP accuracy in high-res video (Xu et al., 2021)
- *Behavior Classification*: Unsupervised algorithms classify activity levels. Broilers under heat stress clustered more frequently in low-activity groups, closely linked to elevated temperatures (Ramesh et al., 2022)
- *Real-time Analysis*: Real-time local processing CNNs enable instant detection of distress behaviour and trigger automated interventions within seconds (Kim et al., 2023)

❑ Wearable Sensors

- *UWB & IMU Systems*: Ultra-Wideband (UWB) tracks birds with <20 cm precision, while using Inertial Measurement Unit (IMU) monitor physical activity, detect inactivity, or identify abnormal movements. IMU data showed broilers were inactive 76.22% of the time, confirming thermal stress-induced lethargy (Alameer et al., 2022)
- *Physiological Sensors*: Implantable or skin-mounted devices measure heart rate, body temperature, and respiration, key indicators of stress. Integrated monitoring detected early circadian heart rate changes linked to thermal discomfort (Marques et al., 2021)
- *Attachment Methods*: Sensor weight must remain <5% of body weight to preserve welfare. Retention techniques—like sutures (19.5 days) or fabric harnesses—are under evaluation (Wang et al., 2021).

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