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Review Article

The Impact of Heat Stress on Sheep and Goats and Strategies for Mitigation

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Abstract

Heat stress presents a major hurdle for sheep and goat farming, especially in areas facing higher temperatures due to climate change. This article examines the effects of heat stress on sheep and goats in terms of physiology, behaviour, and productivity, which includes changes in thermoregulation, hormonal disruptions, and declines in milk yield, growth rates, and reproductive capabilities. It also considers epigenetic factors and adaptive behavioural modifications. Important mitigation techniques, such as providing shade, nutritional enhancements, selective breeding, and novel cooling methods, are discussed as vital steps to combat heat stress and promote sustainable livestock farming. Future studies should focus on genetic and technological innovations to boost heat resilience and enhance overall productivity in sheep and goats.

Keywords: Heat stress, sheep, goats, climate change, livestock mitigation strategies

Introduction

Sheep and goats play a crucial role in livestock farming worldwide and face various environmental challenges. One of the most significant of these challenges is heat stress, particularly in areas that experience high temperatures. Climate change has intensified this issue, making it a pressing concern for both farmers and researchers. Heat stress impacts the physiological and behavioural well-being of sheep and goats and results in considerable economic losses due to decreased productivity and increased vulnerability to diseases.

Unlike humans, who can effectively sweat to cool down, sheep and goats depend mainly on panting and finding cooler spaces. However, these methods are often inadequate during extreme heat, leading

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to serious health and productivity problems. It is vital to understand how heat stress affects these animals and to adopt effective strategies to alleviate its impact for sustainable livestock production.

What is Heat Stress?

Heat stress occurs when an animal's ability to dissipate heat is exceeded by its heat load, resulting in physiological and metabolic disruptions. The comfort zone for these animals is typically assessed using the Temperature-Humidity Index (THI), where values exceeding 72 signify potential heat stress (Marai et al., 2007).

Physiological Effects of Heat Stress

1. Thermoregulatory Changes: To counteract heat, sheep and goats experience an increase in both respiration and heart rates. Research indicates that under heat stress, respiration rates in goats can escalate from 30–45 breaths per minute to over 100 (Sejian et al., 2013).
2. Hormonal Alterations: Heat stress triggers the release of cortisol, a hormone related to stress, which dampens the immune system. Furthermore, it disrupts thyroid hormones, resulting in decreased metabolic efficiency (Nardone et al., 2010).
3. Electrolyte Imbalances: Extended panting can cause a significant loss of carbon dioxide, leading to respiratory alkalosis and altered blood pH levels.
4. Health Risks: Higher temperatures may result in dehydration, reduced appetite, and increased susceptibility to diseases in both sheep and goats (Čukić et al., 2024).

Impact On Productivity

1. Milk Production: Heat stress can decrease both the quantity and quality of milk produced. For example, a study conducted on dairy goats found a 20% drop in milk yield during peak summer months (Bionda et al., 2024).
2. Growth and Weight Gain: Heat stress impairs growth rates and modifies metabolic functions in sheep, leading to lower carcass quality and less meat production (Zhang et al., 2023). Although goats show some resistance, their reproductive outcomes suffer under elevated temperatures (Danso et al., 2024).
3. Reproductive Performance: Increased temperatures can disrupt estrous cycles, reduce conception rates, and negatively affect embryonic development. Heat-stressed ewes, for instance, demonstrate delayed ovulation and reduced pregnancy rates (Hansen, 2009).

Epigenetic Implications: Intergenerational Effects: Maternal heat stress may lead to epigenetic alterations that impact the health and productivity of offspring, potentially persisting over several generations (Laporta et al., 2024). This emphasizes the long-term effects of heat exposure on livestock.

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Behavioral Adjustments

Under conditions of heat stress, sheep and goats often show changes in behavior such as seeking out shade, lowering their activity levels, and increasing their water consumption. While these behaviors are adaptive, they do not completely alleviate the negative effects. Heat stress can also decrease the number of rumination cycles per hour and the amount of boli produced during rumination, with notable interruptions in respiration occurring during rumination contractions. The stopping of panting during rumination hampers a primary method of heat loss, and in extreme cases of heat stress, rumination may come to a halt altogether, worsening the issue of inanition. Goats affected by heat tend to have increased periods of standing and lying down, while the frequency of urination and defecation drops significantly when heat stressed (Alam et al., 2011).

Methods to Mitigate Heat Stress

1. Providing Shade and Cooling Solutions: The installation of shade structures like trees, sheds, or artificial shelters, along with cooling equipment such as fans and misting systems, can greatly reduce the heat burden on animals. Research indicates that goats with access to shaded areas show improved feed intake and productivity.
2. Nutritional Support: Incorporating electrolytes and antioxidants, including vitamin E, selenium, and ascorbic acid, into their diets can aid animals in fighting oxidative stress induced by heat. High-energy feeds that are more easily digestible can help offset the decrease in intake during periods of heat stress.
3. Management Techniques: Successful strategies involve providing shade, ensuring a sufficient water supply, and enhancing barn ventilation to lessen the effects of heat stress (Čukić et al., 2024). Furthermore, choosing breeds with higher heat tolerance can boost resilience (Bionda et al., 2024).
4. Hydration Strategies: Ensuring constant access to clean, cool water is essential. Adding electrolytes to water can help maintain hydration levels and electrolyte balance.
5. Selective Breeding Practices: Breeding for traits that promote heat tolerance, such as short hair in goats or the fat-tailed characteristics of sheep which allow for better energy storage for thermoregulation, can enhance resistance to high temperatures.
6. Grazing Management Adjustments: Changing grazing times to cooler parts of the day, like early morning or late evening, can reduce heat exposure during the hottest hours.
7. Housing Improvements: Adequate ventilation and reflective roofing materials can help keep indoor temperatures lower. Using flooring materials that absorb less heat, such as sand or concrete, also contributes positively.

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8. Innovative Cooling Solutions: New technologies like evaporative cooling pads, solar-powered fans, and wearable cooling devices for livestock are emerging as effective solutions for reducing heat stress.

Conclusion

Heat stress significantly affects the health and productivity of sheep and goats, posing a major challenge for sustainable livestock farming. Mitigation strategies like shade, proper hydration, nutritional support, and selective breeding are essential to minimize its impact. Embracing innovative technologies and focusing on genetic improvements will be crucial for enhancing heat resilience and ensuring the welfare and productivity of these animals in a changing climate.

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