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Popular Article

Physiological Adaptation of Small Ruminants to Environmental Heat Stress

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Abstract

Sheep and goats are essential components of sustainable production systems. However, heat stress can impede animal reproduction and overall productivity. Environmental conditions, such as high ambient temperature and relative humidity, often cause heat stress in these animals. Goats and sheep employ behavioral, morphological, physiological, and genetic mechanisms to adapt to harsh weather conditions. These adaptations are crucial for their survival and performance in various climates.

1. Introduction

Small ruminants, such as sheep and goats, are essential to rural communities' ability to build environmentally sound and sustainable production systems, especially in areas with intense heat stress. In many parts of the world, heat stress is one of the many distracting variables that impedes animal reproduction and output. It causes impairments in the animal's natural immunity, growth, production, reproduction, quantity, and quality of milk, as well as increasing susceptibility to various diseases. Environmental conditions (high ambient temperature, relative humidity, high sun radiation, low wind speed, and precipitation) can cause heat stress in ruminant animals.

The primary direct influences on the potential for production of ruminant animals are air temperature and relative humidity. Sheep and goats, however, are better at adjusting to heat stress in harsh environments than other ruminant animals. They are the most widely distributed and adaptable livestock species, living in both the extreme lowlands of a thermally stressed environment and the high mountains of hypoxia. Goats and sheep use behavioural, morphological, physiological, and mostly genetic mechanisms to adapt to harsh weather.

2. Morphological Adaptation

2.1 Body Size and Shape

The most important morphological traits affecting tiny ruminants' ability to regulate their body temperature in highly hot conditions are their size and shape. Animals have enormous, tiny, or dwarf bodies by nature, which aids in regulating their body temperature and water loss in excessively hot conditions. creatures with larger bodies produce heat more slowly and have a lower metabolic rate than smaller creatures. More heat is released by taller animals than by shorter, squat ones. The Bighorn sheep are a well-adapted species that thrives in hot, arid climates. They feature a compact muzzle, thin, pointed, short ears, a short tail, curled back horns over the ear, and deer-like fur.

2.2 Coat and Skin Color

Animals with light coat colouring absorb less heat than those with darker coats. For example, West African dwarf goats have smooth, short, and straight hair, which helps them adapt in hot, humid environments.

The coat colour has a significant morphological influence on the evolved adaptability. More heat is absorbed by animals with lighter coats than by those with darker coats. Animal coat and skin colour are significant characteristics with biological, monetary, and social implications. Sheep and goats that have evolved in tropical and desert regions have different coat and skin colour features than those that have evolved in temperate climes. For example, the Awassi sheep's open, loose fleece of wool and hair promotes convectional heat loss. Since coat colour can be rapidly and easily recognised, it is the easiest trait to check for when identifying the breed of sheep and goat population.

The ability to measure radiant heat load and the amount of solar radiation absorbed and reflected from the sheep and goat's body is a crucial characteristic. Animals with lighter coat colours retain heat more efficiently than those with darker coat colours. For instance, the straight, short, and smooth hair of West African dwarf goats aids in their adaptation to hot, humid climates.

2.3 Fat Storage

The majority of the time, fat rump and tails are thought to be an animal's adaptive reaction to harsh surroundings and serve as a vital energy store for the animal during migration and the winter months. Fat-tailed breeds make for about 25% of all sheep worldwide. Breeds that can accumulate and mobilise body fat in internal fat depots, like the Mexican Pelibuey sheep, are the most widely used maternal breeds in tropical climates. In addition, the barbarian Tunisian sheep is a breed of sheep with fat tails that may store and release body reserves from

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the body's overall fat and protein as well as the tail (fat).

3. Behavioral Adaptation

When an animal is under heat stress, their behaviour can reveal information on when and how to cool them [15]. Ruminants, for example, are active throughout the day and sleep at night. They use hair loss, shedding, water restriction, and feed intake to their advantage in order to dissipate body heat and protect themselves from harsh weather conditions.

Animals will consume less feed when they are exposed to high temperatures [33]. Since ruminants produce a significant amount of heat when feeding, reducing feed intake is a strategy for adapting to reduce heat production in a warm climate [33]. Compared to cows and sheep, goats are more resilient to heat stress. In warm weather, they exhibit dynamic eating behaviour.

4. Physiological Mechanisms

Numerous physiological adaption mechanisms found in animals aid in lowering heat load . Animals' bodies may become so hot that their health is threatened if the physiological system is unable to lessen the effects of heat load. Given that body temperature is the end result of all activities in the body that include heat gain and loss, it is a useful indicator of an animal's ability to withstand heat. Rectal temperature (RT), respiration rate (RR), and heart rate (HR) change are the primary indicators of the physiological adaptation mechanism in small ruminants.

Despite significant variations in several body score components during the day, rectal temperature is a reliable indicator of body temperature. Sheep and goats employ respiratory rate as their primary thermoregulation mechanism to assist them maintain body temperature in heat-stressed settings.

Additionally, panting is another physiological measure that is understood to be sheep's significant increase in respiratory rate in response to elevated environmental heat.It is crucial to talk about how complexity and a range of physiological alterations brought on by the heat stress response can vary from animal to animal and from person to person. The respiration rate, pulse rate, and rectal temperature of rats exposed to high ambient temperatures of around 40, 42, and 44 °C increase.

According to their physiological makeup, sheep and goats adapt to heat stress by increasing their rate of respiration, sweating more, changing their endocrine function, and lowering their metabolic rate.

5. Conclusions

The adaption strategies of tiny ruminants in situations under heat stress are highlighted in this review. When animals are unable to release enough heat to maintain body temperature equilibrium, heat stress sets in. Heat stress in animals is primarily caused by three environmental factors: high temperature, high humidity, and radiant energy. Sheep and goats, for example, use a combination of behavioural, morphological, physiological, and genetic basis to adjust to heat-stressed climatic conditions. The review also discusses particular genes and potential genes that are important in preventing heat stress. Nevertheless, thorough research is needed to determine how small ruminants adapt to the local harsh climatic conditions.

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