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HEAT STRESS: CAN ANIMALS BE STRESSED AND STILL BE HEALTHY?

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Abstract: In this era of rapid climate change, heat stress has emerged as a major problem for sheep farming. The quantity and quality of sheep production, as well as the welfare, are all shown to be negatively impacted by heat stress. Reduced cellular immune function in sheep exposed to high temperatures increases susceptibility to various diseases, although the underlying mechanisms are unclear. The imbalance between oxidants and antioxidants, known as oxidative stress, negatively impacts animal health due to heat stress-induced impairments in immune responses, increased production of reactive oxygen species, and/or a lack of antioxidants. Heat stress in livestock has negative effects on both the cell-mediated and humoral immune responses. However, the negative effects of heat stress on immune response in sheep can vary by breed. This review discusses how heat stress affects sheep's immunity. An overview of some molecular markers related to immunity, such as interleukin (ILs), Toll-like receptors (TLRs), and also the heat stress protein (HSPs) in sheep, is also discussed. Finally, recent research on the effects of antioxidant supplementation and other promising nutritional strategies for reducing heat stress and improving animal health is presented.

Introduction

Heat stress (HS) is one of the main problems faced by livestock amid the recent increasing intensity of global climate change. During the HS conditions, the livestock's body temperature rises, and they are unable to dissipate enough heat to maintain thermal equilibrium, leading to decreased productivity, reduced reproductive performance, weakened immunity, and increased mortality in some cases, as illustrated in Figure 1.
In terms of animal health, the increased risk of disease occurs due to weakened immunity, as during HS, the animal elicits several thermoregulatory activities, including behavioral, physiological, neuroendocrine, and cellular responses to maintain homeostasis and survival, during these, immune responses in the animal tend to be suppressed (Figure 2). HS can be mitigated by using exogenous antioxidants and salt supplementation in the diet, as presented in Table 1.

Discussions

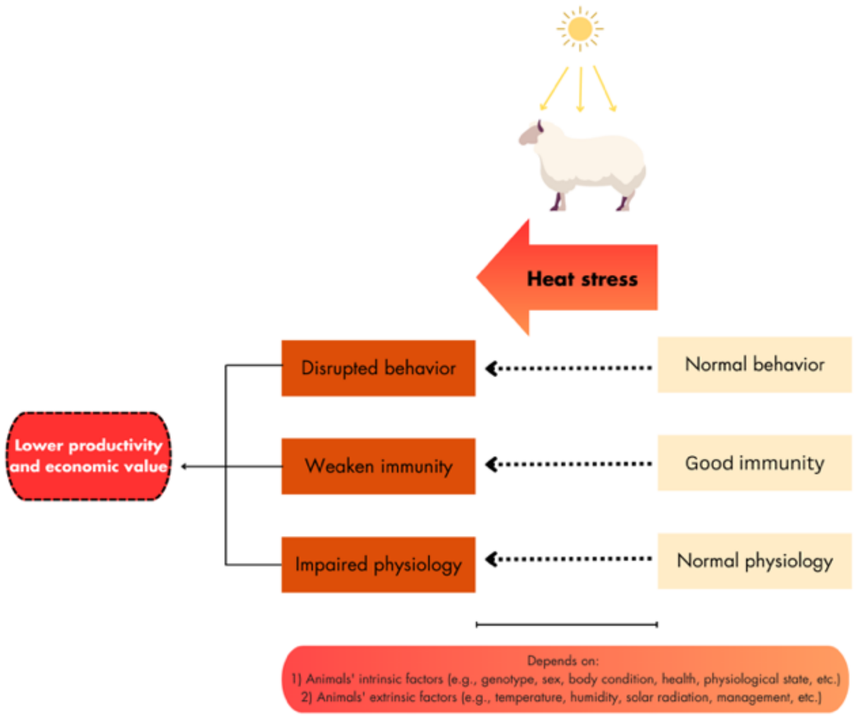

Figure 1. Heat stress deleterious impact to livestock through various ways

Table 1. Nutritional intervention in sheep that successfully reduce heat stress

Breed	Supplementation (per kg feed)	Ref.
Malpura ewes	20 gr mineral and antioxidant mixture (164.0 mg zinc sulphate, 0.95 mg cobalt sulphate, 1.2 g chromium acetate, 0.1 mg selenium chloride and 40.0 mg vitamin E)	[1]
Merino × Poll Dorset crossbred ewes	100 IU vitamin E and 1.20 mg Selenium	[2]
Katahdin × Dorper ewe lambs	250 mg free ferulic acid	[3]
Crossbred lambs ((Merino × Border Leicester) × Dorset)	228 mg vitamin E and 1.16 mg Selenium	[4]
Katahdin × Pelilbuey and Dorper × Pelibuey crossbred ewes	10 mg of zilpaterol hydrochloride	[5]
Australian Merino rams	0.8 mg Selenium and 150 mg vitamin E	[6]
Barki rams	4% Sargassum latifolium algae (contain β-carotene, fucoxanthin, and tocopherol)	[7]
Merino x Poll crossbred sheep	0.4 and 0.8 µg nano chromium picolinate	[8]
Chios cross-bred ewes	0.515 g cornus extract with oregano and thyme essential oils	[9]
Afshari × Chaal lambs	2% phytogenic-rich herbal mixture (cinnamon, turmeric, rosemary, and clove buds)	[10]
Ujumqin lambs	5-10 g chestnut tannins	[11]
Iraqi ewes	40 mg vitamin C	[12]

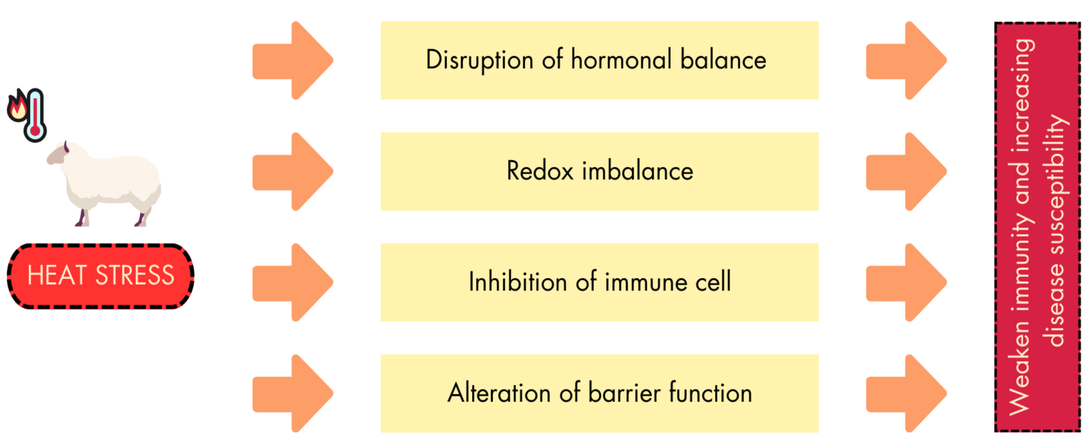

Figure 2. Heat stress weaken immunity and increases disease susceptibility

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Conclusions: The answer to the title of the review is definitely a '**no**', **animals that have been exposed to extreme temperatures cannot maintain their health indefinitely.** Heat stress compromises immunity in a complex way, including disruption of hormonal and redox balance, inhibition of immune cells, and alteration of barrier function. Immunological indicators such as interleukins (ILs), toll-like receptors (TLRs), and heat shock proteins (HSPs) can be used to assess the heat stress and thermotolerance ability of an animal. Nutritional interventions in the form of feed supplementation are an immediate solution for mitigating the effects of heat stress in addition to practical management and environmental interventions such as improving housing and ventilation.

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