



Nutritional Armour against Heat Stress in Cattle

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Introduction

Global warming and climate change significantly rises the environmental temperature which causes intense heat waves. Heat waves along with high moisture leads to high Temperature Humidity Index (THI) resulting in heat stress. Heat stress has become a critical threat to animal welfare, veterinary health and productivity. Accumulation of more heat in the body than it can dissipate leads to heat stress, resulting in rise of core temperature and increased heart rate. Cattle lack efficient sweating mechanism as they have low surface to mass ratio and due to rumen fermentation massive amount of heat is produced making them more prone to heat stress. To overcome this, they start panting heavily leading to excessive loss of saliva which causes loss of vital minerals like sodium and potassium. Due to loss of significant amount of saliva, which acts as a natural buffer, lead to increase in acidity of their stomach. To reduce heat production, they reduce their feed intake but energy is being utilised which predisposes them for metabolic disorders like ketosis, fatty cow syndrome etc. Somatic cell count is higher in milk of heat-stressed cows indicating risk of mastitis. As more amount of energy is directed towards thermoregulation which heavily affects their productivity. Heat stress in dairy cattle may cause 25% to 40% decrease in milk production (Tao *et al.*, 2018) and decreased reproductive performance causing financial loss to the farmers. Fans and sprinklers are necessary for regulating the environmental temperature but they cool only the outside, to cool them from inside proper nutritional intervention is a must. By various measures heat stress can be countered for welfare of animals and profit of farmers. Nutrition plays an important role in preventing heat stress in animals. Various nutritional approaches for combating heat stress are discussed below:

1. Balancing electrolytes (DCAD management)

During the period of high risk of heat stress DCAD concentration of diet may be increased to overcome the loss of electrolytes. For this purpose, NaHCO_3 , KHCO_3 and K_2CO_3

may be used. It helps in increasing the feed intake and water intake, also maintains acid base balance (Wildman *et al.*, 2007). Ruminal acidosis associated with heat stress may also be prevented by this practice.

2. Fat supplementation

Providing fat in cattle diet during summers has a cooling effect as it produces less metabolic heat. It compensates for the reduced feed intake to sustain their basal metabolism and milk yield. Using free oils and unprotected lipid may cause disturbance in fibre digestion, to avoid this rumen protected fats (RPF) are used. RPFs are directly absorbed in the small intestine without disturbing rumen microflora and facilitate with necessary energy. Some cost effective RPFs are vegetable oil, calcium salts of fatty acids *etc.*

3. Rumen undegradable protein supplementation

Rumen degradable protein (RDP) produces significant amount of ammonia in rumen; liver utilises a large amount of energy for conversion of ammonia to urea. Hence rumen undegradable protein (RUDP) is preferred as it is directly available for utilisation in small intestine and reduce excess heat production. Total elimination of RDP from diet is not practical so it is given in optimum amount for normal functioning of rumen microflora. Methionine and lysine are the first limiting amino acids and they can be availed from enhanced quality RUDP (Conte *et al.*, 2018).

4. Provision of antioxidants and vitamins

Due to heat stress, there is disruption in cellular as well as physiological homeostasis which leads to enhanced production of reactive oxygen species (ROS) and when the production of ROS exceeds the capacity of antioxidants then oxidative stress occurs (Zhang *et al.*, 2025). To combat this, we can use antioxidants both enzymatic (superoxide dismutase, catalase, glutathione peroxidase) and non-enzymatic (Vitamin E, Vitamin C and carotenoids). They scavenge the ROS to prevent cellular damage and maintain its integrity. Niacin (Vitamin B3) also given as they act as vasodilator and facilitates the heat dissipation through skin surface of animals.

5. Addition of trace elements in diet

Zinc helps in maintaining the tight junction of intestine preventing “leaky gut syndrome” due to oxidative stress. It is also a component of superoxide dismutase. Selenium works synergistically with Vitamin E; it is a critical part of Glutathione peroxidase helps in converting ROS to water and protect the immune system. Chromium helps in regulating the levels of cortisol produced during heat stress. It helps in efficient utilization of glucose and provides energy without putting the animal in severe stress (Rezaei-Ahvanooei *et al.*, 2025).

6. Addition on of osmolytes and rumen supporting additives in feed:

Heat stress increases the risk of acidosis and poor digestion. At the same time body dehydration causes cell to lose water and use extra energy to maintain balance. To manage this, osmolytes and rumen supporting additives plays an important role. Osmolytes like betaine help cells retain water and reduce energy loss, keeping tissues healthy and improving overall metabolism. On the other hand, live yeast (*Saccharomyces cerevisiae*) supports rumen health by improving good bacteria, reducing excess acid, and stabilizing rumen conditions. Rumen modifiers such as buffers further help maintain proper pH and digestion.

Conclusion

Combating heat stress is not just about cooling the air around them but also strategic intervention in the animal's nutrition. These measures should be introduced before the animal is under severe stress and panting heavily. By this approach the animal can maintain its physiological functions and production levels with minimal stress.

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