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Factors affecting heat tolerance in dairy animals

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Introduction

Over the last century the dairy cattle populations from temperate climates were introduced to tropical areas and have developed phenotypic traits that support heat tolerance through either natural or induced evolutionary adaptation. Heat tolerance is defined as the ability of an animal to maintain production and reproduction levels under hot, humid conditions (Cheruiyot *et al*., 2022). Indigenous breeds of cattle are more heat tolerant than temperate breed of cattle**.** Reliable indices for measuring heat tolerance of the farm animals are respiration rate, rectal temperature and heart rate. A change in respiration rate is a good indicator for measuring heat tolerance. There are different types of indexes used for measuring heat tolerance which are Iberia heat tolerance test, Gaalaa's heat tolerance test, Benezra's coefficient of adaptability, Dairy search index. (Singh *et al*., 2013).

Heat tolerance of a farm animal depends on several factors. These factors can broadly be classified as:

1) Animal Factors
2) Environmental Factors
3) Management Factors

Physical responses: Respiration rate, heart rate and rectal temperature are

Animal factors

1. **Species & Breed of the animal**

   Some animals can tolerate heat well while others are more prone to heat stress. It is because of some animals' genetic makeup that differ from others, whether as a result of natural

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selection, artificial selection, or breed adaptation. For instance, the size of the animal's sweat glands or its coat. Zebu cattle have more heat tolerance capacity compared to crossbred cattle and exotic cattle. Due to thick black skin, less hair coat and lesser sweat glands (1/6th as compared to that of cattle) buffaloes are more prone to heat stress than zebu cattle.

2. **Morphological characteristics**

Light or white coat color may reflect solar radiation and help in improving an animal's capacity to withstand heat. Other traits that improve heat tolerance include small ears, a slender tail, and a sleek hair coat. Dewlap and hump on zebu cattle help in lowering heat load. Dewlap increases surface area for greater heat dissipation, and the hump serves as an energy storage organ during times of heat stress. Skin pigmentation may act as a barrier against UV rays. Using the powerful tool of genetic selection, we may be able to increase our animals' ability to withstand heat. Both traditional quantitative genetics and more recent "omics" technologies are extremely helpful in that and with current trends. Slick hair genes and other genetic modifications increase the Holstein Friesian breed's resistance to heat stress.

3. **Physiological adjustments**

Animals have a variety of mechanisms to combat the effects of heat stress. In order to improve evaporative cooling, the rate of breathing and skin sweating increase. Plasma thyroxine (T3 & T4) concentration drops in hot weather, slowing down metabolism and subsequently lowering body heat production. As the temperature rises, the concentration of haemoglobin and the number of red blood cells both increase, allowing the animal to have a greater supply of oxygen to combat stress. Additionally, a drop in insulin levels causes an increase in cortisol levels. Growth hormone (GH), prolactin (PRL), mineralocorticoids, and catecholamine are additional hormones that are involved.

4. **Body Condition Score**

In warm season, BCS of 3.5 on a 5-point scale increase the heat tolerance and increase reproductive performance and is desirable. The body should be smooth and a little bit rounded with bare bone prominence. More amount of fat causes more weight & hence more metabolism whereas less amount of stored fat in body will result in no backup for energy depletion and homeostasis maintenance.

5. **Parity & Stage of lactation**

Greater parity generally lowers the heat tolerance since the animal is less efficient in converting feed to milk and hence, the animal would have to increase the intake leading to rise in heat. At 3-5th lactation production is most and after 6-8 weeks the peak yield is attained and these are critical periods in case it subsides with warm temperature because energy demands are high but

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eating feed increases heat. During peak yield, the feed requirement would be maximum along with surge in fermentation and metabolism processes leading to more chances of heat stress.

6. **Production Level**

   Greater production level would require the animal to surge its metabolism which will increase the heat inside leading to decreased heat tolerance. Also, the animal would have problem with maintaining its diet that would further add up to the stress.

7. **Behavioral patterns**

   Wallowing habit in buffaloes is a learnt behaviour which can increase heat tolerance by aiding in evaporative heat loss and compensate for lesser sweat glands. There should be provision for wallowing pond so the buffalo can see and learn. Animals go the shady places to prevent heat stress. Frequent drinking of water provides more water to body for more evaporation. Mostly animals will appear standing during heat period because sitting causes accumulation of heat since exposed surface area is decreased.

Environmental Factors & Management Factors

Less humidity and greater wind velocity will increase the heat tolerance as they will help in better evaporative heat loss. Collier and Beede (1985) proposed that the main methods for minimizing adverse environmental effects on animal production and dairy profitability would be physical modification of the environment or genetic selection for more heat-tolerant cattle. Development of genetically heat tolerant dairy breeds through introducing heat adaptation gene from local breed to commercial breed or we can select local heat tolerant breed. Heat can be reduced by changing designs for animal facilities (such as shape, orientation, the thermo-physical characteristics of building materials, ventilation, and facility openings). Changing of Microclimate around animal increase heat tolerance. Changing feeding frequency can also be helpful. Night feeding can be preferred. Feeding high energy and low fibre diet cause less increment of heat and thus increase heat tolerance ability of the animal. Adding minerals like Fe, Zn, Se, and Cr, vitamins such as vitamin C, E, and A, B3, electrolytes and feed additives like yeast in the feed cause increased tolerance.

Conclusions

Characteristics of farm animals play an important role in determining heat tolerability of an animal. Genetic makeup is an important part and selection of animals well adapted for a certain region helps to have more heat tolerable animals. Behavior may enhance heat tolerance and is closely associated with physiological adjustments. Correct BCS around 3.5 is desirable on a 5-point scale basis. Parity, Stage of lactation & production capacity influence fermentation and metabolism inside body, adding heat inside the body making the animal less heat tolerable.

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