Nutritional Strategies for Managing the Heat-Stressed Dairy Cow

Joe W. West
Animal and Dairy Science Department, University of Georgia, Coastal Plain Station, Tifton 31973-0748

ABSTRACT: Heat stress results from the animal's inability to dissipate sufficient heat to maintain homeothermy. Environmental factors, including ambient temperature, radiant energy, relative humidity, and metabolic heat associated with maintenance and productive processes, contribute to heat stress. The focus of this article is to identify environmental and metabolic factors that contribute to excessive heat load, describe how disruption of homeothermy alters physiologic systems of the cow, and discuss nutritional modifications that help to maintain homeostasis or prevent nutrient deficiencies that result from heat stress. Changes in diet are needed during hot weather to maintain nutrient intake, increase dietary nutrient density, or to reestablish homeostasis. Formulation for adequate nutrient intake is challenging because of the competition between nutrient density and other needs for the cow, including energy density and adequate dietary fiber. Lower DMI during hot weather reduces nutrients available for absorption, and absorbed nutrients are used less efficiently. An excess of degradable dietary protein is undesirable because of energy costs to metabolize and excrete excess N as urea. Optimizing ruminally undegraded protein improves milk yield in hot climates. Mineral losses via sweating (primarily K) and changes in blood acid-base chemistry resulting from hyperventilation reduce blood bicarbonate and blood buffering capacity and increase urinary excretion of electrolytes. Theoretical heat production favors feed ingredients with a lower heat increment, such as concentrates and fats, whereas forages have a greater heat increment. Improved dietary energy density and the lower heat increment associated with the inclusion of dietary fat must be coupled with limitations to fat feeding to avoid ruminal and metabolic disorders. Numerous nutritional modifications are used for hot weather feeding; however, many need further investigation to achieve specific recommendations.

Key Words: Dairy, Heat Stress, Intake, Metabolism, Milk

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Introduction

High ambient temperature, relative humidity, and radiant energy compromise the ability of the lactating dairy cow to dissipate heat, resulting in heat stress. These environmental factors, coupled with metabolic heat, create difficulties in maintaining thermal balance. This results in elevated body temperature, which in turn initiates compensatory and adaptive mechanisms to reestablish homeothermy and homeostasis. Stott (1981) stated that these readjustments to maintain homeostasis are referred to as adaptations and may be favorable or unfavorable to the economic interests of humans, and that, nevertheless, they are essential for survival of the animal.

The impact of heat stress on livestock is broad in geographic terms. Dairy cattle across the southern United States and in many subtropical and tropical regions are subject to high ambient temperatures and(or) high relative humidity for extended periods. In the southeastern United States, high ambient temperature and relative humidity exceeding the temperature-humidity index (THI) associated with heat stress, persist for 4 to 6 mo of each year.

In an excellent review, Beede and Collier (1986) identify three management strategies that minimize the effects of thermal stress: 1) physical modification of the environment, 2) genetic development of heat-tolerant breeds, and 3) improved nutritional manage-