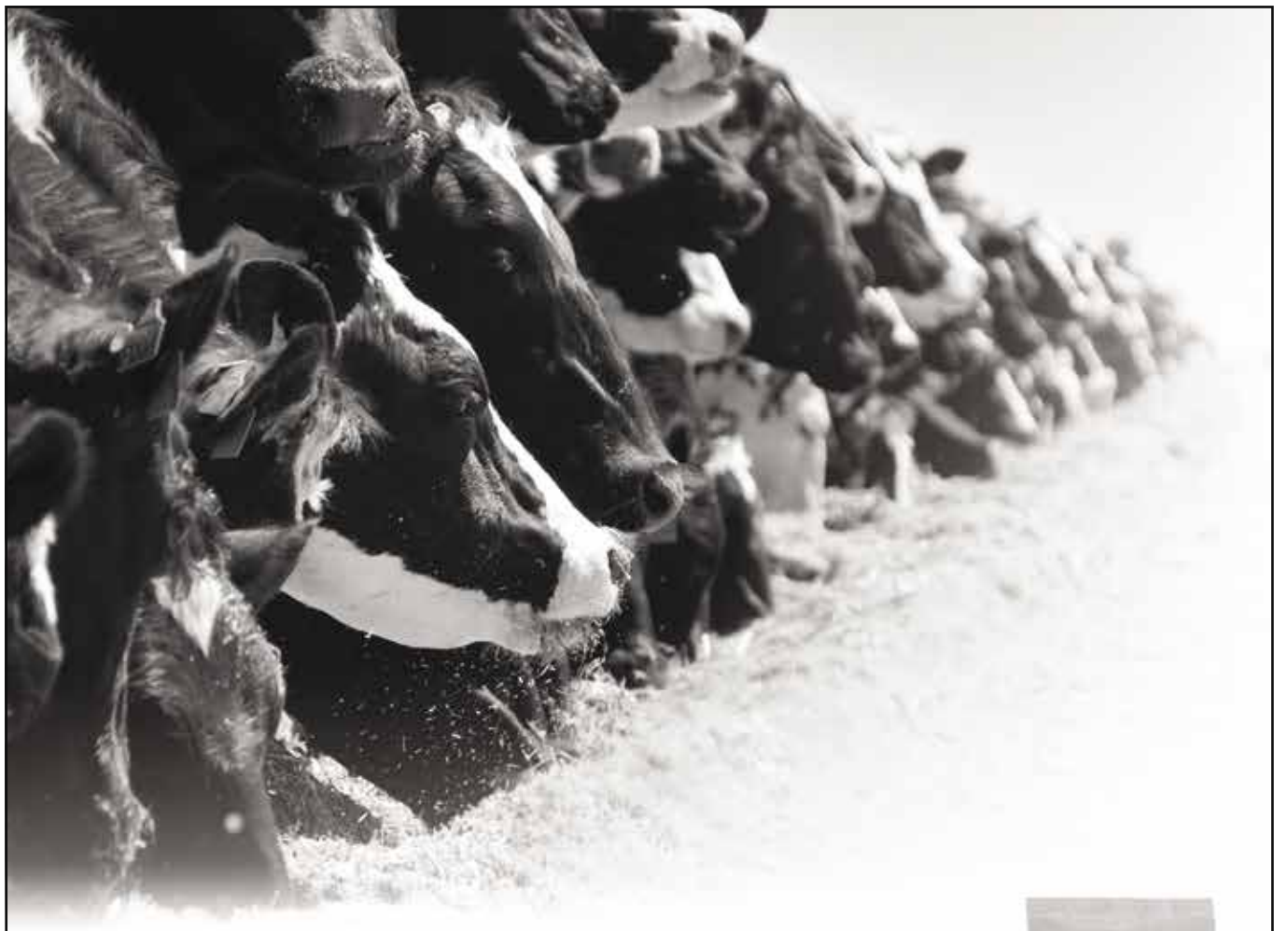
Bioactive additives help alleviate heat stress

Constantin Sebastien for *Progressive Dairy*

AT A GLANCE

Standardized and encapsulated bioactives enhance heat stress resistance by optimizing rumen functions and increasing water and feed intake.

In the coming years, heat waves may occur more frequently and last longer. Beyond reducing the quality and quantity of forage, high temperatures and humidity also affect productivity and reproductive performance of livestock. The management of heat stress is already a major challenge in animal production and, given the growing demand for food in the world, it will become an even larger strategic challenge in the future.



How to define heat stress

Like poultry or other mammals, ruminants are homeothermic animals. They are designed to maintain an ideal and stable internal temperature by regulating their various metabolic processes. Generally, their internal body temperature is higher than their surrounding environment, and thermoregulation results from endothermic mechanisms that produce heat. Nevertheless, when an organism absorbs or produces more heat than it can dissipate, thermoregulation fails, and the animal is unable to maintain its thermal balance. Heat stress occurs.

Constantin Sebastien
Bioactives Product Manager
Pancosma
sebastien.constantin@pancosma.ch

The temperature-humidity index (THI) is a combined value of air temperature (AT (°F)) and humidity (RH). It is usually used to measure heat stress levels. Several formulas exist to calculate THI. As an example: THI = AT - [0.55 - (0.55 x RH) x (AT-58)]. Modern breeders are used to monitoring their THI levels and implementing different actions according to these levels.

A matter of homeostasis: Consequences of metabolic adaptation

In conditions that may induce heat stress, animals change their behaviors to regulate their temperature.

• Usually, increasing water intake and panting help to cool animals by increasing water evaporation. However, the respiratory rate increase also causes blood alkalosis. In order to reduce their blood pH level, animals excrete bicarbonate in their urine. This loss of bicarbonate will eventually lead to rumen acidosis (see **Figure 1**).

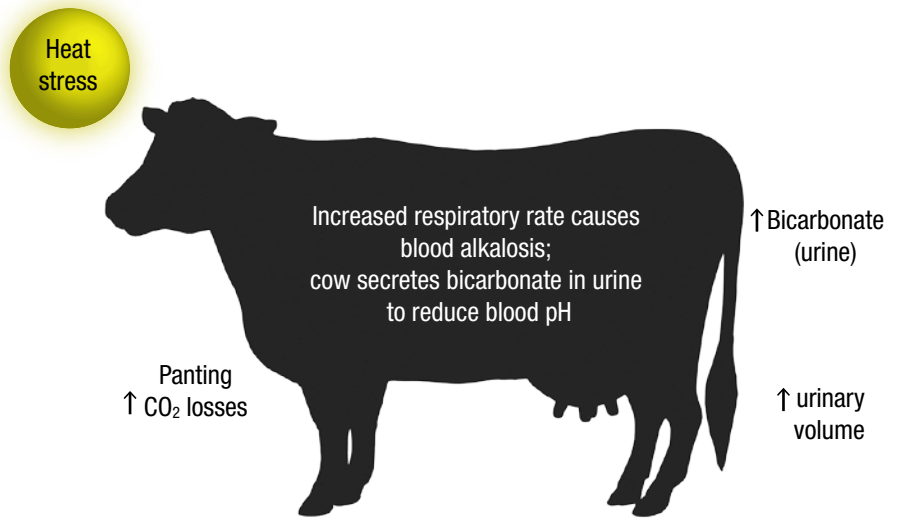
• Animals reduce feed intake in order to decrease heat production generated by digestion. This may cause a negative energy balance.

• Animals increase blood flow to the skin to dissipate heat. This leads to less blood flow to the gut, thus decreasing digestion efficiency.

• Standing increases the effective surface area of the skin able to dissipate heat but can engender problems such as lameness.

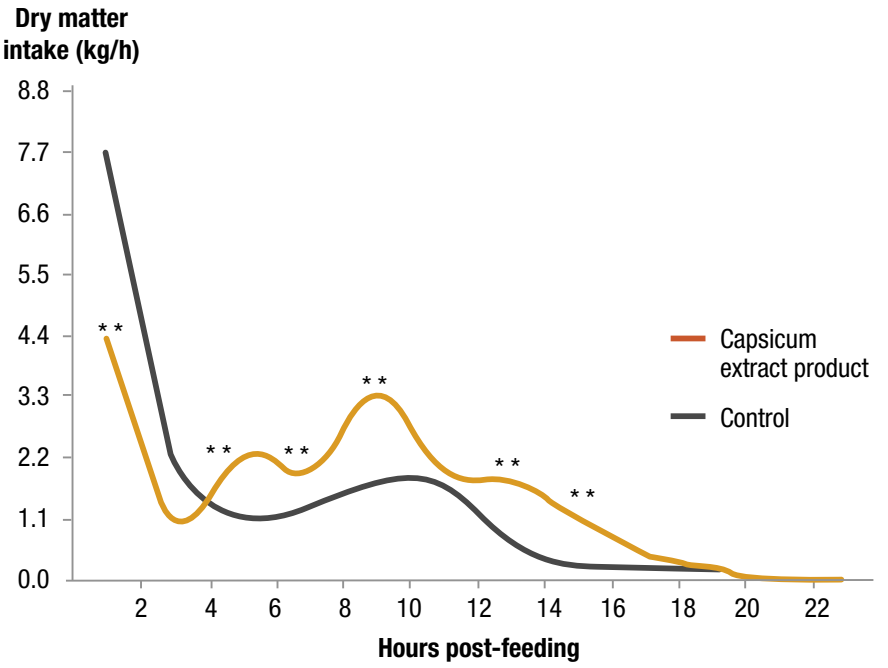
From a performance point of view, all these natural metabolic adaptations cause a reduction in the production of meat or milk, increased sensitivity to metabolic diseases (acidosis, ketosis) and affect reproductive performance. High-yield dairy cows start to decrease production from THI 68.0, a value that can be attained at just 71.6°F if the relative humidity reached 45 percent. From a mean daily THI of 73.2, sustenance intake can decrease by 5 pounds per day and,

FIGURE 1 Heat stress effect on rumen pH



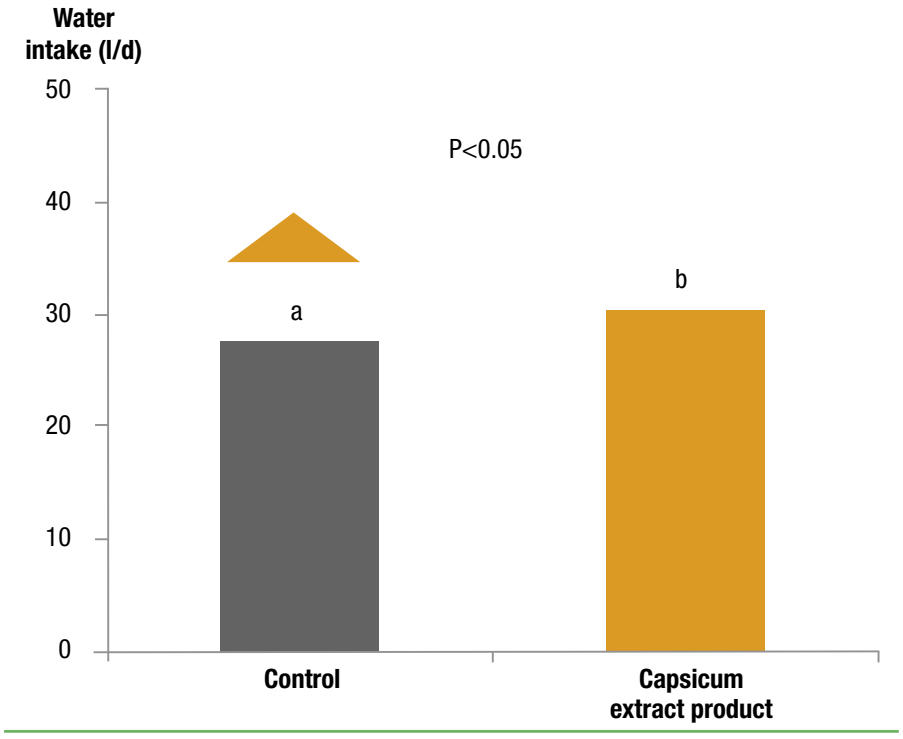
Source: Schneider et al., 1988

FIGURE 2 Effect of capsicum extract on feeding pattern



Source: Rodriguez-Prado et al., 2008

FIGURE 3 Effect of capsicum extract on water intake



Source: Rodriguez-Prado et al., 2008

Bioactives represent a promising natural strategy to alleviate heat stress and support animal metabolism during these challenging times.

consequently, milk production can decrease by 4.4 pounds.

How do standardized and encapsulated bioactives enhance resistance against heat stress?

Optimized rumen functions

Encapsulated bioactives, which contain active substances such as capsicum oleoresin, cinnamaldehyde and eugenol, optimize the profile of volatile fatty acids produced in the rumen. The supplementation of eugenol and cinnamaldehyde exerts an inhibitory effect on methanogenic micro-organisms. This results in a lower molar proportion of acetate and a higher proportion of propionate and butyrate. By increasing propionate, a glucose precursor in gluconeogenesis, more energy is provided to the animal, and this limits the impact of decreased dry matter intake (DMI).

Better feeding behavior

When feeding encapsulated capsicum oleoresin, published in-vivo studies in heifers and in beef showed a modification of feeding frequency and an increase in water consumption (see **Figures 2 and 3**). It is commonly accepted that the pungency of capsicum could be one of the possible causes of this behavior. Nevertheless, a scientific paper, conducted on rats, demonstrated that a perivagal application of capsaicin (active ingredient of capsicum oleoresin) also stimulates water and food intake. Long-term satiety depends on metabolic factors, but short-term satiety is related to neural mechanisms. In this study, capsicum influenced satiation and water intake by affecting vagal neurons that express vanilloid receptors. Beyond the aspect of palatability, capsicum has a large action spectrum, and its mode of action is probably multifactorial.

Rumen acidosis is the primary metabolic disorder which occurs during heat stress and is widely driven by feeding behavior. When the number of meals increases, salivation secretion and rumen movements are augmented and, together, these contribute to limiting the ruminal pH variability. Thus, pH drop is slowed down, and this limits the risk of acidosis during heat stress periods. Maximizing water intake enhances the cooling effect and helps maintain body temperature and buffer the capacity of the rumen.

Moreover, in ruminants, the digestion process generates a large amount of heat due to ruminal fermentations. Regulation of the feeding patterns limits the peak heat, which occurs after a big meal eaten over a short period and extends the digestion process over the course of the whole day. This improved distribution of heat production also helps animals cope with heat stress.

Conclusion

Today, the negative effect of heat stress on ruminants is well-known and well documented. Animals adapt their behavior, but this induces physiological changes and causes metabolic disorders. Bioactives represent a promising natural strategy to alleviate heat stress and support animal metabolism during these challenging times.