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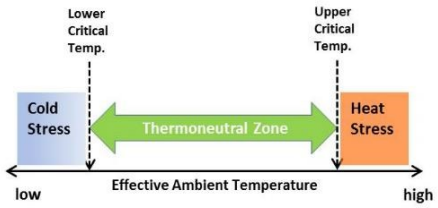
Calf Note #251 – Calves lose water in the heat

Introduction

Calves use energy to maintain their body temperature when it falls outside the "thermoneutral zone". Figure 1, from the NRC publication of nutrient requirements of domestic animals, shows the idea of this zone in animals. The "effective ambient temperature" is the temperature the calf actually feels, not necessarily the temperature on a thermometer.

Figure 1. Schematic of Relationships of Temperature and Thermal Zones[1]



[1]Adapted from: NRC, 1981, Effect of Environment on Nutrient Requirements of Domestic Animals

When exposed to heat stress, calves will lose heat by employing a number of behavioral and metabolic strategies, including changing posture, reducing feed intake, redistribution of blood flow, and, of course, sweating. Contrary to several "urban myths" in social media, cattle do sweat. It accounts for about 80% of heat loss.

Cattle rely on apocrine glands as the primary sweat glands to produce sweat and provide for thermal cooling (Hamazaoui et al., 2017). A schematic diagram of these glands is in Figure 2.

The Research

I was interested to understand the relative loss of water in calves during heat stress, and found a very interesting paper by Gebremedhin et al. from 1981. In this study, calves were housed in a respiratory chamber where the researchers could measure heat produced by the calf and losses of water from the animals' breath and sweat. They maintained temperatures between 0°C and 36°C to measure effects of both heat and cold. I should note that relative humidity in the chambers was maintained at a constant 50%.

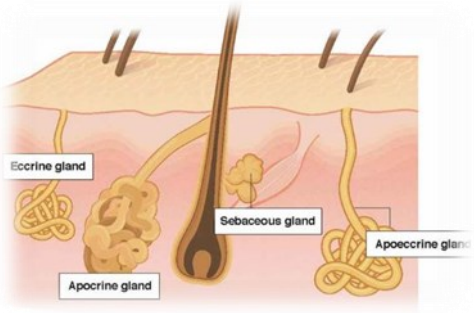


Figure 2. Schematic diagram of the sweat glands in cattle.

The results are shown in Figure 3 for water loss in respiration (and panting during heat stress) and losses from sweat in Figure 4. There was no effect of age on water losses or heat produced by the calf when expressed as a unit of BW. However, calves were drinking only milk, so no rumen development (which contributes to heat production) occurred during the trial

In Figure 3, we see that respiratory losses of water were low – about 0.3 grams per hour per kilo of calf BW. From 19°C, water losses increased to a maximum at 36° of about 0.9 grams per hour per kg. I took the liberty of interpolating the data and conducting a regression equation of the values from 17° to 36°. The equation was Y = -0.256 + 0.034 × Temperature. I think used this equation to calculate the amount of water lost for various BW and temperatures, as in Figure 5. We see that a 50 kg calf loses about 1 kilo (liter) of water per day at 20°C in

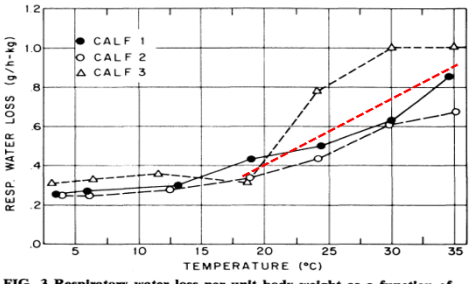


FIG. 3 Respiratory water loss per unit body weight as a function of chamber temperature.

RE (19-35°) = -0.256 + 0.031 x Temp

respiration, but loses about 40% more at 30° (1.4 kilos). The loss of respiratory water in hot environments is significant.

A similar situation occurred for water lost in sweat, as seen in Figure 4. Until calves reached 19°C, there was very little water lost from sweat. Losses increased linearly with increasing temperature to 36°C, as we would expect. Calves were sweating more as the temperature increased, and lost more water in their sweat as a result. At 36°C, water loss approached 4.5 grams per hour per kilo of BW. Again, I regressed water loss on temperature to develop a regression equation: $Y = -4.559 + 0.254 \times \text{Temperature}$.

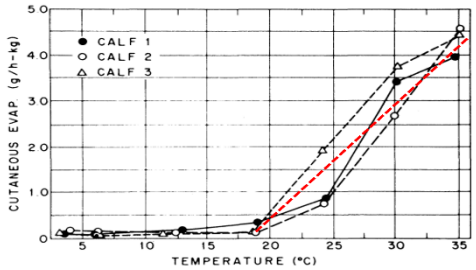


FIG. 4 Cutaneous water loss per unit body weight as a function of chamber temperature.

CE (19-35°) = -4.559 + 0.2540 x Temp

I did a similar calculation to estimate the amount of water lost in sweat for calves at various BW and temperatures as in Figure 6. You can see the losses due to sweat were much greater – and quite significant at hot temperatures. For example, a 60-kg calf would lose about 1.7 liters of water from panting at 30°C and another 4.4 liters from sweat, for a total loss of about 6 liters per day.

	Body weight, kg					
Temp, °C	45	50	55	60	65	70
20	0.9	1.1	1.2	1.3	1.4	1.5
25	1.1	1.2	1.4	1.5	1.6	1.7
30	1.3	1.4	1.6	1.7	1.9	2.0
35	1.4	1.6	1.8	1.9	2.1	2.3

Figure 5. Respiratory water lost (liters per day) in calves at various temperatures and body weights.

We can use the sum of both table to estimate how much water a calf might be expected to lose in hot conditions. Of course, we need to ensure that calves have access to free water to allow them the chance to replace that water. Many producers who raise calves in warm climates will offer calves additional dilute electrolytes as a means of providing both water and electrolytes – especially sodium – as this is a primary mineral lost in sweat.

Summary

Calves lose a lot of water in both respiratory losses and in sweat. Producers should be aware of these losses and take steps to replace lost water by providing free water and electrolytes in additional feedings when calves are exposed to heat stress. This interesting article provides a method to estimate these losses and a guideline for replacement.

	Body weight, kg					
Temp, °C	45	50	55	60	65	70
20	0.6	0.6	0.7	0.8	0.8	0.9
25	1.9	2.1	2.4	2.6	2.8	3.0
30	3.3	3.7	4.0	4.4	4.8	5.1
35	4.7	5.2	5.7	6.2	6.8	7.3

Figure 6. Water losses (liters per day) from sweat in calves at various temperatures and body weights.

References

Gebremedhin, K. G., C. O. Cramer, W. P. Porter. 1981. Predictions and Measurements of Heat Production and Food and Water Requirements of Holstein Calves in Different Environments. Trans. ASAE. 24:715-072. https://doi.org/10.13031/2013.34326.

Hamzaoui, S., C. A. Burger, J. L. Collier, and R. J. Collier. 2017. Technical note: Method for isolation of the bovine sweat gland and conditions for in vitro culture. J. Dairy Sci. 101:4638–4642. https://doi.org/10.3168/jds.2017-14056.

Written by Dr. Jim Quigley (21 July 2024)

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