Betaine may minimize effects of heat stress in broilers

By JANET REMUS

Combating the negative effects of heat stress can be one of the primary concerns for U.S. broiler poultry producers as temperatures soar during the summer months.

Strategies to minimize heat stress tend to concentrate on management practices such as providing adequate ventilation or introducing dietary electrolyte supplements. Betaine can be a useful tool as part of an overall strategy to minimize the damaging effects of heat stress by maintaining performance.

What is heat stress?

Heat stress occurs when birds have difficulty in balancing body heat loss and body heat production. At high environmental temperatures, birds rely on a range of mechanisms to regulate their body temperature within a comfort zone described as the "thermoneutral zone." The normal body temperature of a broiler is 106°F. When the environmental temperature exceeds 95°F, the broiler is likely to experience heat stress.

In an effort to maintain body temperature, birds first rely on losing heat from blood vessels near the surface of the skin in a process called "non-evaporative cooling." This process also consists of behavioral mechanisms to adjust body temperature, such as resting in a cool, shady area on a hot day. However, this non-evaporative cooling is only effective when the ambient temperature is lower than the bird's body temperature.

As the ambient temperature increases beyond the bird's thermoneutral zone, the "upper critical temperature" (UCT) of the bird is reached, and non-evaporative cooling becomes ineffective at regulating body temperature. This is due to the reduced difference in temperature between the bird and its environment, which slows heat loss from the bird.

At these higher temperatures, the bird becomes reliant on panting (evaporative cooling) as the mechanism for controlling body temperature. Panting is an effective but energy-expensive way for the bird to control body temperature and typically results in lower feed intake and growth as well as reduced feed efficiency.

The bird will increase water intake to try to offset water loss, but the situation is complicated by the fact that the body's ability to retain the water is reduced as the evaporative cooling process escalates. When environmental temperatures are higher than the thermoneutral zone, birds increase panting up to 10 times, from a normal rate of 25 breaths per minute to 250 breaths per minute (Nillpour, 2000.)

This usually leads to an excessive loss of carbon dioxide, resulting in raised blood plasma bicarbonate levels and increased blood pH. The bird attempts to correct blood pH by excreting bicarbonates via the urine. Bicarbonates are negatively charged ions that must be coupled with positively charged ions, such as potassium, to be excreted in urine.

However, as potassium is important in maintaining intracellular water balance, a loss of potassium ions via the urine reduces the bird's ability to maintain this water balance.

Consequently, while birds do compensate for water losses associated with panting by consuming more water, its retention in body cells is limited by the simultaneous loss of electrolytes such as potassium in the urine (Belay et al., 1992).

A number of safeguards against heat stress can be incorporated into poultry housing as well as into the bird's water and feed management. For instance, many poultry houses in hot climates are now fitted with innovative ventilation and cooling systems to improve temperature control.

Unfortunately, the wind-chill benefit of tunnel ventilation systems begins to decline as air...
temperature reaches 95-105°F (Donald, 2000).

Similarly, the effectiveness of evaporative cooling systems is progressively reduced as relative humidity increases above 70%.

Birds lose heat by evaporation of moisture during panting and, therefore, require greater amounts of drinking water, which may also be cooled to help reduce heat stress. Withdrawing feed until the cooler evening hours can also help birds disperse the body heat generated by the digestion process. Other nutritional practices used by the industry include increasing the relative humidity above 70%.

The birds were either exposed to a constant temperature of 75°F, i.e., thermoneutral temperature (no stress), or exposed to "heat stress," i.e., 12 hours at 75°F, three hours cycling from 75 to 99°F, six hours at 99°F and three hours cycling down from 99 to 75°F. In the same study, birds fed betaine were also shown to be more effective in controlling their body temperature.

In a second trial, broilers were subjected to high cycling environmental temperatures (12 hours at 75°F, three hours cycling from 75 to 99°F, six hours at 99°F and three hours cycling from 99 to 75°F). Betaine improved survival, bodyweight and feed:gain at 48 days of age (Table).

In a further study at the University of Tennessee, broilers were subjected to heat stress (10 hours at 77°F, three hours cycling from 77 to 95°F, eight hours at 95°F and three hours cycling from 95 to 77°F) and fed diets with or without betaine from 21 to 49 days of age. Betaine significantly improved feed conversion 6.3% at 49 days of age (Figure 2).

By increasing the bird's tolerance to high temperatures, betaine can be a useful tool as part of an overall strategy to minimize the damaging effects of heat stress by maintaining performance.