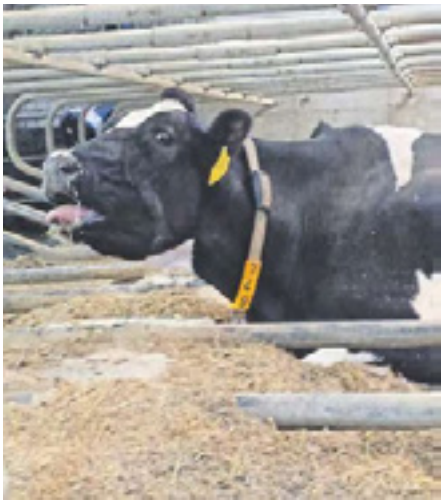
When is it too hot for cows?

The hot season of the year is a challenging time for dairy cow metabolism. Rumen-stable fats and sugar support the metabolism in critical phases.



Heat stress in cows is not a topic that can be put on the back burner. It can start as low as 24°C, especially at high humidity. (*pic.: Gundula Hoffmann*)

Hot climate conditions influence the performance and fertility of lactating cows, and thus strongly affect their economy. Each domestic animal has a thermoneutral zone. In this temperature range the animal can maintain a constant body temperature without adaptive reactions, and all metabolic processes run normally. If the ambient temperature moves above or below this range the body starts to react. Cold leads to shivering to generate heat, while if the upper critical temperature is exceeded animals release heat through sweating.

Temperature regulation

The thermoneutral zone for cows is between 4°C and 16°C, subject to varying circumstances. Cows cope better with lower temperatures, while heat stresses them. Lactating cows have a very active metabolism and produce heat as a by-product of digestion and lactation. If the ambient climatic conditions worsen, they react immediately by regulating their body temperature. The THI (Temperature Humidity Index) is a measure of the stress level of cows based on temperature and humidity. At 24°C and 70% relative humidity, cows begin to suffer from heat stress. They reach the limit of their ability to thermoregulate, resulting in sickness and impaired performance. Different climate zones as well as individual husbandry conditions have an influence on when lactating cows start to experience heat stress.

(Fig.) Glucose, the main energy source

Fluid bed treatment surrounds glucose with a fatty coating, making it rumen-stable and thus available to the cow in the small intestine. This technical process ensures the stability of the nutrient for an extended period. *(Source: Berg + Schmidt)*

Effects of heat

It is important to be attentive to the first signs of heat stress. Heat is released by the evaporation of sweat and saliva through higher breathing frequency. Saliva is an important buffer substance for the rumen. If it is lost through dribbling, there is a higher risk of rumen acidosis. Higher breathing frequency also brings with it the risk of exhaling too much carbon dioxide, thereby raising the blood pH and causing metabolic disorders. The increased release of body fluids also leads to the loss of important minerals. Furthermore, heat stress leads to selective or reduced dry matter intake. Animals eat less feed, in order to reduce heat production from fermentation. This means lower nutrient intake and chewing activity. As a consequence, less energy and active ingredients are available to the animals, causing lower milk performance, body condition and fertility. Meanwhile, reduced chewing is associated with reduced saliva production, increasing the risk of rumen acidosis. When cows are selective about their diet, i.e. take in less forage and more concentrate feed, there is also a higher risk of rumen acidosis. The acids from concentrate feed fermentation cannot be adequately neutralized by the saliva. Another way cows adapt to heat is by increasing blood circulation in the skin in order to emit more body heat. This reduces blood flow in the internal organs, resulting in reduced removal of the volatile fatty acids produced by fermentation, so that they enrich in the rumen and drop the pH-level. In addition, endotoxins from lipopolysaccharides released by the degradation of bacteria in the rumen cause inflammation since heat stress causes the rumen wall to become more permeable. Thus, heat stress can cause inflammation in the rumen. A cow suffering from heat stress will try to release heat by raising the skin temperature. Studies have shown that an increase in body temperature of just 0.5°C leads to longer standing times and shorter lying times, since lying down means higher heat production. While standing, more skin is exposed to the air, which can release more heat with airflow. However, less time spent lying down negatively affects chewing the cud which in turn may lead to metabolic issues. Furthermore, the animals are less moving, meaning fewer visits to the feeding table as well as reduced breeding behaviour. Reduced success of first insemination and higher embryo mortality

and miscarriage rates are thus further consequences of heat stress. Long-term effects include lower birth weight of calves and metabolic problems in calving. In addition to the health aspects, the various adaptations to heat cause decreased milk yield and milk solids accompanied by higher cell numbers in the milk. Heat stress can reduce feed intake by up to 25% and thus cause milk yield reduction by up to 40%. Heat stress and its effects on the metabolism can result in inflammation and thus severely stress the immune system. Such an inflammation can account for 10-30% of the daily energy and protein needs. The immune system uses glucose that must be saved elsewhere within the metabolism. This means that less glucose is available for synthesizing lactose, thus reducing the milk performance.

More water is needed during heat. Animals must have access to sufficient drinking troughs with high enough flow-through.
(*pic.: Fritz Fleege)*

Strategies against heat

The many effects of heat stress all have economic consequences and should be minimized by various means: optimizing water intake, stall climate and feed strategies. Fresh water in clean, functioning drinking troughs must be available and inspected daily. The barn also needs to be cooled using fans or a sprinkler system. The raw fibre content of the diet needs to be adjusted, and it may be necessary to reduce the content of easily soluble carbohydrates in the rumen. The feed should be repeatedly replenished on the feeding table during the day. Espacially during the cooler night the cows should be offered good, high-quality feed. Rumen-stable feeds that do not ferment in the rumen, and thus do not generate heat from fermentation, are ideal in such situations. After calving, cows have a negative energy balance due to insufficient energy intake combined with high energy needs. Heat stress worsens this negative energy balance by reducing dry matter intake. The energy density in the diet should therefore be adjusted, for example by adding rumen-stable fats or rumen-stable sugar.

Innovative use of sugar

Sugar in the form of glucose is the main form of energy for the metabolism. Some important organs like the brain and udder require energy in this form. The immune system also uses glucose. The difficulty in covering the cow‘s demand of glucose, is that much of the glucose in the diet is already metabolized by the microbes in the rumen and therfore no longer available to the cow. Thus, most of the cow’s glucose requirement are not covered by the diet, but by the glucose being produced in the liver in a process called gluconeogenesis. During the period around calving, the cow’s liver is very busy providing energy, producing sugar for milk production, making proteins for the immune system and removing toxins. Feeding sugar to the cow in a rumen-stable form can reduce the burden on the liver, since the glucose passes through the rumen unaltered and can be absorbed directly in the small intestine and thus immediately available for the metabolism and the immune system, without producing fermentation heat in the rumen (see fig.). The glucose is protected by encapsulation with rumen-stable fat using a special fluid bed technology. Unlike matrix technology, this permits a high concentration of the desired nutrient with a high level of protection at the same time. Targeted digestion and rumen stability are the result. The animal also benefits from the coating since the fat can also be used as energy. Especially for cows with reduced dry matter intake, this is an ideal way to boost energy density of the diet and compensate for high energy demand. This is important for fresh lactating cows who are also challenging negative energy balance and inflammation, which are fortified by heat stress.

Rumen-stable glucose – Energy where it's needed

SUMMARY: Dairy cows have a very active metabolism, which can cause problems for them in the summer. They suffer from heat stress starting at temperatures of 24°C and 70% humidity. This has many consequences, all of which affect the economics of dairy farming and should be minimized. In addition to cooling, sufficient fresh drinking water and plenty of air movement in the stall, supplementary feeding with rumen-stable (coated) nutrients is a way to reduce the heat burden on ruminants.

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Supplementary feeding with rumen-stable (coated) nutrients is one way to help the cow's metabolism cope with heat stress. Scientific studies have shown that the addition of microencapsulated glucose to dairy cows improves health and performance. It reduces the burden on the liver and supports the immune system, leading to high milk yield and fertility. But what are the physiological processes behind this? If a dairy cow cannot cover her energy demand through the feed intake – which is the case during the phase from calving to the eighth week of lactation – she will mobilize her body fat, taking non-esterified fatty acids (NEFA) from the adipose tissue to the liver, where they are broken down to provide energy. Exceeding the synthesis capacity of the liver, NEFA are instead converted into ketone bodies, which include acetone, acetoacetate, and ß-hydroxybutyric acid (BHBA). Excessive ketone body production leads to a metabolic disorder called ketosis or acetonemia. Alternatively, the liver re-esterifies the NEFA into triglycerides, which is likewise unhealthy as it can lead to a fatty liver. Studies have shown that the supplementation of sugar can reduce the plasma concentrations of NEFA and BHBA in cows. Thus, reduced plasma concentrations of NEFA and BHBA is an indicator of a low level of fat mobilization resulting from higher energy provision from feed and reduced burden on the liver metabolism