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Tech Bulletin

Thermogenesis 201: Nothing Beats a Little Heat

by Clint Peck

Last winter in our first lesson on the subject of thermogenesis we learned that just about anywhere you raise cows and calves there will be times when nothing beats a little heat. And while sunshine, heat lamps and hot boxes can help warm calves from the outside, it's the heat produced inside the calf that can be critical to its survival and future performance. Diet energy is necessary for heat production and beef producers who feed adequate energy can improve the cow's ability to product heat. In turn, this increased "thermogenesis" — or heat production capability — carries over to her newborn calf.

This year in Thermogenesis 201 we will further explore the complex relationships between a cow's diet and the thermal physiology of both the cow and calf. These relationships are being examined by Bob Bellows, reproductive physiologist, USDA-ARS Livestock and Range Research Center, Miles City, Mont.

Bellow's research shows that cows fed high fat diets produced calves with higher body temperature, when challenged with a constant cold exposure, than cows fed low fat diets. "We believe this could have an effect on calf survival," explained Bellows. He emphasized he doesn't have any data on this thermogenic effect on calf survival, but hypothesizes that calves born with the ability to maintain a higher core temperature are better able to withstand the rigors of birth.

Bellows cites experiments with beef cattle in Wyoming

where pregnant cows were fed 50 to 65 % of recommended levels of energy. Only 90% of the calves survived from these "low-energy" dams, while 100% of calves were alive from cows fed adequate levels of energy. The data gets even more interesting when we look at calf survival after birth. At weaning only 71% of the calves survived from the low-energy dams. This is compared to a 100% live-calf rate from the cows fed adequate energy.

The majority of this death loss was due to scours, which indicates that the immune system is effected by low-energy intake, according to Bellow. The relationship between energy and protein in the diet of a pregnant cow cannot be overlooked. In research on weak-calf syndrome, the incidence of weak and dead calves increased as crude protein in the diets decreased.

"There is no question inadequate protein intake during gestation can potentially result in calves which are more susceptible to cold stress", says Bellows. "Cold stress and low crude protein diets can interact to markedly increase the incidence of weak calves." To maintain normal body temperature, the newborn calf must product enough heat to balance evaporative and non-evaporative heat losses. "The transition from the warm uterine environment to the often-times hostile external environment brings about many physiological changes necessary to maintain normal body temperature," explains Bellows.

Heat production is dependent about 50% on shivering thermogenesis in muscle tissue, and 50% on non-shivering thermogenesis in the brown adipose tissue – a specialized organ located principally around the kidneys in newborn calves. Whenever feed is digested and metabolized, heat is produced as a by-product. The fuels for heat production, or thermogenesis, are carbohydrates, glucose, fats, lipids and fatty acids. "Brown fat" is specifically used to produce heat in the body. Bellows would like to further explore the relationship between brown fat deposition, its metabolism and the type of fat in the diet — and whether this is something related specifically to energy metabolism through glucose. By including supplemental safflower-based fat in cow rations during the last 53 days of gestation, the Fort Keogh researchers were able to improve the cold tolerance and increase plasma glucose concentrations in newborn calves.

And while Bellows still has not pinpointed whether linoleic acid is the key fat in the thermogenic effect, it appears there is a boost in reproduction with the addition of fat to the diet. Bellows has seen higher pregnant rates from cows fed both the high oleic and linoleic safflower. "Pregnancy rates were greater in the dams that received

Bellows. “Its important to note that even rations which might otherwise be considered “Good” diets for gestation cows appears to be low in fat.”

Positive response to fat supplementation may be dependent on the lipid involved. This factor and possibly the specific fatty acids composition of the cow’s diet may be important for both the cow and the calf. “If you look only at the energy and protein content of the diet, you may be overlooking an important component of the diet that can potentially affect the cold tolerance of the newborn calf and subsequent reproduction of the dam.” Says Bellows. “When rations are formulated we need to be concerned about dietary fat in addition to the other nutrients such as protein, energy, vitamins and minerals.”

What’s encouraging about the research into the use of fat supplements used to boost the thermogenic effect in calves is the carry-over effect on reproduction in the cow, adds Bellows. “We apparently have something you can feed during gestation that builds up a reserve that can show up in positive reproductive efficiency.

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