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THE COLOSTRUM COUNSEL

The critical role that thermogenesis plays during the first hours of a calf's life.

Newborn calves are extremely susceptible to environmental conditions. Both heat and cold stress play a major factor in a calf's ability to survive the first days of life, and their comfort range is much more narrow than we would think. Mother nature can deliver the weather, but we can deliver colostrum that will give calves a fighting chance.

We know the significant impacts of failure of passive transfer from low IgG consumption after birth, but did you know colostral fat can also impact the overall health and performance of newborn calves?

Neonatal animals in terms of both calves and small ruminants are sensitive to cold temperatures. **Many may think of cold stress happening at temperatures below freezing; however, it does not take much in terms of cool ambient air to induce cold stress to a neonate.** The thermoneutral zone is one way to describe this phenomenon. It is a range of temperatures where an animal will not require additional energy, metabolism or physiological defense mechanisms to maintain its body temperature. The ambient temperature below what is considered the lower critical temperature (LCT) would thereby induce an animal to increase metabolic heat production to defend its body temperature. When the temperature goes above the upper critical temperature (UCT), the animal must also expend energy to maintain body temperature and prevent over-heating. And the physiologic mechanisms to do so require energy.

Thermalneutral Zone

Despite variances in environmental conditions, the thermoneutral zone of most calves is between 13.4°C/56°F and 25°C/77°F.

This means, if the temperature goes below 13.4°C/56°F, it induces cold stress and requires the calf to defend its body temp in ways we will discuss. The same goes for the upper range inducing heat stress above 25°C/77°F.

Table 1. Effect of age of calf on lower critical temperature

Age (d)	Critical Temperature (degrees C)
1	13.4
5	12.2
10	10.8
15	9.5
20	8.4
25	7.3
30	6.4

Source: Adapted from Davis and Drackley (1998).

Let's say for example, it is a cold winter night and a cow calves. The temperature is 10 degrees C/50 degrees F.

What then is required for this animal to defend its body temperature given it is literally coming into this world below its thermal-neutral zone?

In other words, how is this neonate going to produce enough heat to maintain its bodily functions? The answer lies in two important physiologic responses.

One is through shivering thermogenesis, and the other is through non-shivering thermogenesis involving brown adipose tissue metabolism (also called Brown fat). Studies proving this phenomenon stem all the way back to the 80's where Vermorel et al (1983) placed newborn calves in a 37 degree C water bath and found shivering began at 32 degrees C. Shivering worsened as they cooled the water; in fact, heat production increased by as much as 100%. So, with the calf just born, it is likely shivering is going to take place visually.

> "...colostrum provides the proverbial jet fuel for the potent heat producing brown fat"

Research in neonatal lambs has shown that approximately 60% of the thermogenic response is due to shivering and the other 40% due to brown fat metabolism (Carstens 1994). **This fresh calf just born will therein shiver most certainly and then it will also tap into the most potent heat producing organ in its body: brown fat!** Interestingly, the brown fat this calf likely has will only constitute 1-2% of its body weight at birth and yet still contribute 40% of its thermogenic capability. **(Fun fact: Believe it or not, brown fat, even though 1-2% of the body weight is an actual organ).**

What can we do to trigger heat production?

So with this calf now having two mechanisms to defend its body temperature through shivering or brown fat metabolism, it should be okay right? We can just in sense walk away and go to bed? Well, one might want to make sure the calf at least stands up. **A study conducted by Vermorel et al, found heat production in newborn calves to increase by 100% when calves stood for 10 minutes and by another 40% when they stood for 30 or more minutes. Activity as simple as standing increases muscle movement and indeed triggers heat production.**

Is there anything we can give the calf to warm them up?

There is one more thing we need to consider which may be most important. Colostrum! While there are antibodies and hundreds of bioactive factors in colostrum to provide immunity and tissue growth, colostral fat is an important player in cold stress. Colostral fat has a unique fatty acid profile and serves as a substrate for the brown fat cells. In a sense, **it provides the proverbial jet fuel for the potent heat producing brown fat.** The brown fat cells take in the fatty acids from colostrum and then it sparks combustion to where the cell literally produces heat. Interestingly, there are other bioactive factors in colostrum which recruit more brown fat cells to mature into functional heat producing machines. These include growth factors in the colostrum which have been documented in research to proliferate more brown fat cells, namely, fibroblast growth factor (FGF), insulin-like growth factor (IGF), Epidermal growth factor (EGF) and platelet derived growth factor (PDGF).

Therefore, whether a calf is beef or dairy and the temperature is below the lower critical temperature (ie.. 13.4 degrees C/56 degrees F), **it is vitally important this calf receives colostrum.** This will do three things:

1. It will supply an abundance of energy to get the calf to stand up (and remember heat production increases with activity)

2. It will provide the unique colostral fat to jump start the brown fat cells to produce heat

3. The plethora of growth factors in the colostrum will recruit more brown fat cells (in a sense make more heat machines).

Can a colostrum replacer can be used as a tool in a beef or dairy calf to play a role in thermogenesis?

Are colostrum replacers the same as the maternal colostrum produced by the beef or dairy cow? This is where things can get dicey. Unfortunately, not all colostrum replacers are created equal. Many colostrum replacers are made from blood serum, whey, whey protein concentrate, and do not have only colostral fat as the main energy source. Fat sources can include but are not limited to animal fat, vegetable oil, coconut oil, dairy and palm fat to name a few. These fats do not have the same or unique fatty acid profile as colostral fat. Fat is therefore also not created equal, and this has shown to have ramifications in terms of brown fat stimulation. Researchers have shown for example polyunsaturated fats (i.e... omega 3 and 6 fatty acids... fish oil) vs saturated fats (tallow, animal fat, butter, etc.) have shown to have both recruiting and stimulation effects on brown fat. (in terms of contributing key cell components (UCP1 protein content) which spark heat production in brown fat cells). In fact, research by Wilms et al (2022) shows colostral fat to be higher in polyunsaturated fatty acids compared to whole milk. The polyunsaturated fat called omega-3 fatty acid was 45% higher in colostrum compared to whole milk (fun fact: Eicosapentaenoic acid (EPA), a type of omega three fatty acid, was 73% higher in colostrum vs whole milk and it produces signaling molecules to reduce inflammation in the body). It is likely there is a physiological reason for this, and it raises doubt amongst many of the fat sources used in synthetically derived colostrum replacers on the market.

What should we look for in a colostrum replacer?

If a colostrum replacer is used, be sure to check it is made from whole bovine colostrum and colostral fat… not a different fat source!

To further prove the point of the importance of colostral fat in colostrum replacers, research was performed looking at colostrum replacer with low fat levels. It is important if a colostrum replacer is utilized it not only contains colostral fat (derived from pure bovine colostrum) but also enough fat.

The study compared colostrum replacer with 22% fat vs defatted colostrum at 5.7 % fat. Both replacers had the same amount of IgG/antibody with the only difference being the fat content. The study was designed such to not stimulate shivering and attempt to stimulate only brown fat metabolism (Min temp 13.4 Degrees C and average temp of 21.4 degrees C).

The results were astounding! Calves fed the defatted colostrum replacer had a 50% increase in respiratory disease in the first 90 days of life and a 6% increase in mortality. They also had lower rectal temperatures and spent less time standing and more time in a lying position. Interestingly, the calves fed defatted colostrum had lower weight gain in the first 4 months of life. **The calves fed the full fat colostrum gained 6.6 kg/14.6 lbs more at 90 days of age and 10 kg/22 lbs more at 127 days of age.** This equates to a difference in average daily gain of 0.07 kg/d (.154 lbs/d) in the first 90 days and 0.1 kg/d (.22 lbs/d) at 127 days of age. The impact on weight gain was immense and economically it means one can spend money on colostrum replacer with full fat and whole colostral fat.

In a conservative approach, lets say it costs $1.50 per head per day to feed out to 127 days old and the target weight is 129 kg/284 lbs.

If a calf is born at 40 kg/88lbs and gains .71 kg/d (1.56 lbs/d) it would take (129kg/284lbs-40 kg/88lbs = 89 kg/196 lbs of total weight gain) (89 kg/196 lbs total weight gain/.71 kg/d (1.56lbs/d) = 125 days to hit 129 kg/284 lbs. Now lets say in that 127 day period the calf gains .81kg/d (1.79 lbs/d).

The math would be as follows: (129kg/284lbs-40 kg/88lbs = 89 kg/196 lbs of total weight gain (89 kg/196 lbs total weight gain/.81 kg/d (1.79lbs/d) = 109 days to hit 129 kg/284 lbs. The difference then is 125d-109d = 16 days. In other words if a calf gains 0.07kg/d (.154 lbs/d) more, it will hit the target of 129 kg/284 lbs, 16 days sooner. *If it costs $1.50 per day to feed the calf it would equate to $24.00 more in savings in terms of decreased days on feed.* Can you afford to spend $24.00 more on a full fat colostrum replacer with pure colostral fat?

By now it should be evident how important brown fat is to the newborn and the role colostrum plays in thermoregulation. It does not mean a colostrum replacer can't be used but it is important to be sure it is made from whole bovine colostrum and is not defatted or made with other fat sources.

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