Dairy Research Summary

DRECA
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Understanding gut microbial colonization in newborn calves

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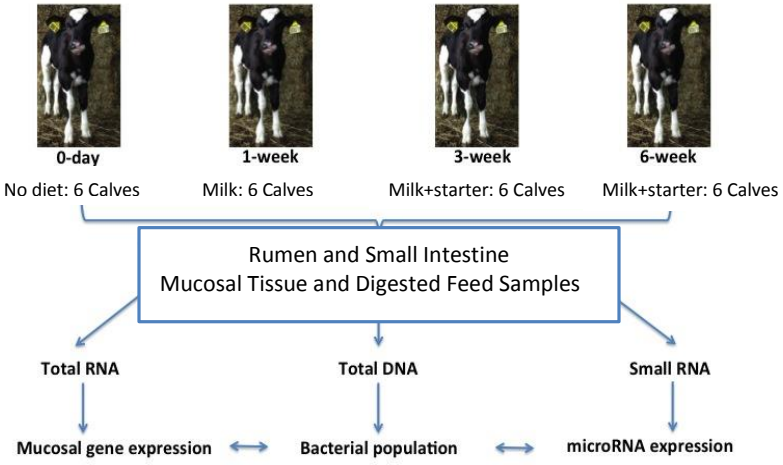
Why is this important?

Diarrhea in the newborn calf is the major cause of death in pre-weaned calves, accounting for more than 50% of calf deaths in the North American dairy industry. In most cases, diarrhea is related to the make-up of the microbial population in the calf's gut (the gut microbiome). Research studies carried out in humans and mice showed that gut microbes are very important for the development of the host immune system (i.e., the ability to fight disease) and overall health. While in the uterus the gut is sterile (i.e., contains no microbes), however during and after birth, many different microbial species colonize the gut. This is an important process, as microbes that are specific to the animal species are crucial for the development and maturation of the gut-associated immune system. The mucosal immune system protects the mucous membrane, which is the inner-most lining to many areas of the body including the digestive tract. This is the barrier to many pathogens that try to invade the body through the digestive system. We know very little about the interaction between gut microbes and the mucosal immune system in the newborn calf.

It is important to understand microbial colonization in the calf gut immediately after birth by identifying what microbes are there and what they are doing. It is also important to determine how early colonization influences the relationship between gut microbes and the animal's immune system. This knowledge may help to identify calf management practices that lead to improved calf health.

What did we do?



Samples were collected from groups of 6 male Holstein calves on days 0, 7, 21 and 42 days after birth. In their respective groups, calves were fed nothing, whole milk or whole milk plus *ad lib*. starter. Tissue and digesta were collected at various locations along the gut

Total DNA extracted from both tissue and digesta samples were used to determine total bacterial number. The number of *Bifidobacterium* and *Lactobacillus* species was determined by estimating 16S rRNA gene copies (i.e increased gene copies = increased bacterial numbers). Both *Bifidobacterium* and *Lactobacillus* are beneficial bacteria that contribute to gut health and immunity. Total RNA extracted from intestinal tissue samples were used to determine microRNA (miRNA) expression, which are small, non-coding RNA molecules. A possible relationship between miRNA expression and microbial colonization in the digestive tract was explored.

What did we find?

- Gut bacteria reached 100 million 16S rRNA gene copies/g of samples soon after birth, which eventually increased 100-times in older calves (1 – 6-weeks)
- We have found that there is a stable and diverse *Bifidobacterium* population in the calf gut with highest density and diversity of species at 3 weeks
- The increase in *Lactobacillus* and *Bifidobacterium* density was linked to an increase in gut barrier function and inflammatory responses in 1 and 3-week calves. This suggests that colonization by these bacteria prevents unwanted substances or microbes from invading the intestinal tissue and improves calf health by decreasing calf susceptibility to infections.
- Expression of 2 miRNA fractions showed a strong relationship with both *Lactobacillus* and *Bifidobacterium* species density at 3 weeks. Expression of these miRNAs may also be linked to the development of the immune system during the newborn period.

What does this mean?

- Gut microbiome changes may influence the development of mucosal immune responses and barrier function (preventing leakage), immediately post-partum for dairy calves, 1 – 3 weeks, through mucosal gene expression
- Microbe-microRNA interaction is another possible mechanism that aids the development of the calf immune system during early life
- This research may lead to future studies to understand the possible use of *Lactobacillus* and *Bifidobacterium* species as probiotics in calf feeding to improve healthy gut microbial colonization and decrease newborn diarrhea

Summary Points

- Colonization of the calf gut with microbes starts during the birthing process
- Changes in the density of beneficial bacteria (*Lactobacillus* and *Bifidobacterium*) are associated with mucosal genes and miRNA expression
- Gut bacterial interactions with the calf aids in immune system development and calf immune responses

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