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Research Update

The critical first two weeks: Feeding to support the calf's immune system

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During the first two weeks after birth, a calf's health and future productivity is at high risk. Investing time and money to reduce the incidence of disease and improve survival at this time generates good payback. Feeding to support the calf's immune system, combined with good husbandry and environment, helps to optimize overall health, growth, and productivity.

The newborn calf possesses a functional immune system, but it is poorly developed. Antibodies such as immunoglobulins (IgG) do not cross the placenta in pregnancy. However, they are available to the calf through colostrum. In order to help protect from diseases early in life, the calf depends on receiving adequate amounts of high quality colostrum soon after birth.

Feeding good colostrum offers the first opportunity to support the calf's immune system. Practical advice includes the "Five Qs" – a memory aid for colostrum management.

The "Five Qs" of Colostrum Management

- **Q**uality: 50 g/L IgG
- **Q**uantity: 10% body weight (roughly 4 L for a normal dairy calf)
- **Q**uickness: 1 to 2 hours after birth
- **SQ**ueaky clean: Low bacterial contamination (TCC [total coliform count] < 10,000 CFU/ml; TPC [total plate count] < 100,000 CFU/ml)
- **Q**uality of passive transfer: More than 80% of calves should have TP (total protein) ≥ 5.5 g/dl.

Source: S. Godden, 2013.

As the calf's immune system develops, it is important to keep the gut healthy. Roughly 70% of all immune cells are part of the gastrointestinal tract in the form of "gut associated lymphoid tissue" (GALT). GALT is the calf's first line of defense and a potential entry site for disease-causing antigens and infectious agents. Any disruption of GALT impacts the calf's immune system (Liebler-Tenorio and Pabst, 2006).

Disease susceptibility

Although the calf's gastrointestinal tract is developing rapidly, the acquisition of immunity requires time. During the first few weeks after birth, the calf remains susceptible to diseases. The most common cause of death in pre-weaned calves results from gastrointestinal pathogens, such as *Escherichia coli*, *Salmonella*, and *Clostridium* bacteria, *Cryptosporidia* protozoa, and *Rotavirus-Coronavirus* virus.

In 2007, a study of the U.S Department of Agriculture's National Animal Health Monitoring System (USDA NAHMS) reported an average 7.8% mortality rate in pre-weaned dairy heifers. Digestive problems accounted for 56.5% of the deaths. In a more recent U.S. survey of 105 calf ranches, mortality averaged 3.6% at operation level (average of total number of farms surveyed) and 5.4% at calf level (average of total number calves in the survey). In this survey, more than half of the deaths were attributed to diarrhea (Walker et al., 2012).

In other parts of the world, similar mortality rates occur. In Quebec, a study involving 115 farms reported a pre-weaned calf mortality of about 8% (Vasseur et al., 2012). In Europe, 60 farms in Austria and Germany showed a mortality rate of about 5% (Vasseur et al., 2012). Therefore, improvements in gut health to minimize susceptibility to disease are likely to help to minimize mortality in pre-weaned calves.

Gut health feeding strategies

Feeding strategies for the very young calf have been changing. In 2010, 7 to 10% of pre-weaned heifers affected by digestive problems were treated with antibiotics (USDA NAHMS Dairy Heifer Raiser Report, 2011). Today, "all-natural" feeding strategies have become important in helping to maintain calf health and productivity, including during the critical first two weeks after birth.

These feeding strategies have focused on decreasing the interaction of potential pathogens with cells in the gastrointestinal tract. Feed additive products used in these strategies have included hyperimmunized egg protein, probiotics, prebiotics, and microbial fermentation metabolites. Various studies have shown beneficial effects from supporting gastrointestinal health and growth in pre-weaned calves.

Hyperimmunized egg proteins are the product of eggs inoculated with specific pathogenic organisms in order to produce specific antibodies to those organisms. These proteins are then fed to the calf to help minimize gastrointestinal diseases. Probiotics or “direct-fed microbials” are live bacteria that are typically combinations of various species. They may include combinations of benign lactic acid-producing species that can propagate in the intestines to help prevent attachment and colonization by pathogenic bacteria. However, because these are live bacteria, some probiotic products require coating or other treatments in order survive and remain effective following storage, feed processing heat and pressure, and the pH of the gastrointestinal tract. Prebiotics are dietary components that are not digested by the calf, which promote growth of beneficial bacteria in the calf’s gastrointestinal tract.

The growth of beneficial bacteria helps maintain and possibly improve overall gut health and digestibility.

In 2011, Ballou conducted a study to determine the effects of supplementation of a blend of probiotics, prebiotics, and hyperimmunized egg proteins in Holstein calves during the three first weeks after birth. Results from this study showed an improvement in gastrointestinal health. Various other studies also have shown beneficial effects of these product in supporting gastrointestinal health, as well as growth in pre-weaned calves. However, results from studies on the benefits of probiotics and prebiotics on health of dairy calves remain ambiguous.

Some studies have shown a reduction in scouring and improvement in growth (Abe et al., 1995; Heinrichs et al., 2003), while other studies have shown no benefits to including either prebiotics or probiotics in milk for calves (Morrill et al., 1995; Hill et al., 2008). The lack of a clear effect in calves is likely due to many factors such as environment, age of the calf, rearing techniques, etc., which require additional investigation.

Fermentation products

Liquid feeding strategies have become popular to deliver some of these gut health products to the calf during the critical first two weeks of life when the calf does not eat much dry feed. Recent research sponsored by Diamond V used this approach to deliver a new nutritional health product called SmartCare® to newborn calves. This product is composed of unique bioactive metabolite compounds produced during fermentation of *Saccharomyces cerevisiae*. A study with this product in the milk replacer and Original XPC™ in the starter ration was conducted by Iowa State University with pre-weaned dairy calves inoculated with live *Salmonella* bacteria (Brewer et al., 2014).

A second study conducted by researchers at Texas Tech University and the USDA ARS validated the Iowa State results and provided additional data on calf starter intake, average daily gain, and feed efficiency when *Salmonella* challenged calves were fed these products compared to a placebo control group (Harris et al., 2015 [in press]).

Research-supported options and a higher plane of nutrition

When following a liquid feeding strategy to support calf health and productivity in the first two weeks after birth, there are many options. Not all probiotics, prebiotics, hyper-immunized egg proteins, or fermentation products perform alike. As a rule, those based on peer-reviewed controlled research are more likely to achieve predicted outcomes.

After the first two weeks, the calf's risk of gastrointestinal diseases decreases dramatically. Also, the calf's plane of nutrition, achieved during the first two weeks and for the remainder of the pre-weaning period, has effects on the calf's immune responses. These effects extend into the immediate post-weaning period (Ballou, 2012; Hanson, 2012). A recent meta-analysis suggests that higher planes of calf nutrition positively impact the long-term productivity of the heifer and cow (Soberon and Van Amburgh, 2013).

Developing new feeding strategies to support immune function in the newborn calf is an exciting area for research requiring more studies. These strategies can help optimize health and growth during the critical first two weeks and support long-term productivity in the heifer and cow.

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