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INSIGHTS INTO CALF FEEDING FOR OPTIMAL FUTURE PRODUCTIVITY

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The goal of a calf heifer rearing programme is to obtain optimal future productivity and sustainability of the dairy farm. Thereby it is essential to not only consider cost and ease of calf management and feeding programmes, but also health and durability of the heifers. As dairy herd health advisors, we need to focus more of our attention on preventing disease than to provide cures, as diseases leave permanent reduction in health, productivity, and durability of the animals. The nutrition and management of the young calves is many times lacking even on the best of dairies and needs special attention. Since the beginning of this millennium, increasing research has been made to evaluate the impact of heifer rearing on future productivity. Our improved ability to statistically analyse and evaluate chronic effects and long-term productivity effects has led to revised recommendations as regards colostrum administration, feeding programmes, preventive health programmes and welfare systems. In this paper, I want to reflect some on the current calf management systems, review some of the scientific research, and reflect on the ultimate solutions for a sustainable dairy production.

There are numerous studies indicating that the early life nutrition is critical for future health and productivity. There is limited evidence that cheaper calf feeding systems are cost-efficient, as sub-optimal body development and diseases have long-term financial consequences. When industrial calf feeding programs, with limited quantities of milk or milk replacer (MR) and early weaning were developed in the previous century, there were lacking studies and statistical abilities to evaluate long term consequences of early life management systems.

A healthy gut is crucial for a healthy calf. Elimination of pathogens (viruses, bacteria, and parasites) has been a traditional veterinary focus. However, the support and promotion of the gut microbiota and gut health may be a better strategy to underpin calf health. Microbial colonisation of the intestine during early life occurs through vaginal mucosa contact, colostrum, transition milk, whole milk/milk replacer and starter feeds, which all contribute to developing a well-functioning gut and immune system (Amin and Seifert, 2021).

The feeding of high-quality colostrum (high immunoglobulin concentration) hygienically harvested and fed to the calf within hours of birth is essential for optimal passive transfer of immunity. The higher that the passive transfer of maternal immunoglobulins to the calf can be, the lower the risk of diseases especially in the high-risk period in the second week of life (Diagram 1). At least 4 litres within 4 hours of birth can contribute to reduced calfhood diseases, higher milk yield in the first two lactations, earlier conception and increased longevity in the herd (Faber et al., 2005). Colostrum seeds the gut microbiota and various components in the colostrum contribute to healthy intestinal lining development (McGrath *et al*., 2016). This most important meal of the calf often fails, and I recommend verifying colostrum programmes described by the farm by evaluating serum total proteins in calves (Lombard et al., 2020). Colostrum pasteurization should not be used as a quick fix hygiene solution, since it does not only eliminate pathogens and reduce microbial counts but also destroy maternal white blood cells and colostral microbiota that may improve immunity against disease. Thus, clean raw colostrum is recommended when possible, and frozen good quality colostrum should always be present on the dairy as a back-up.

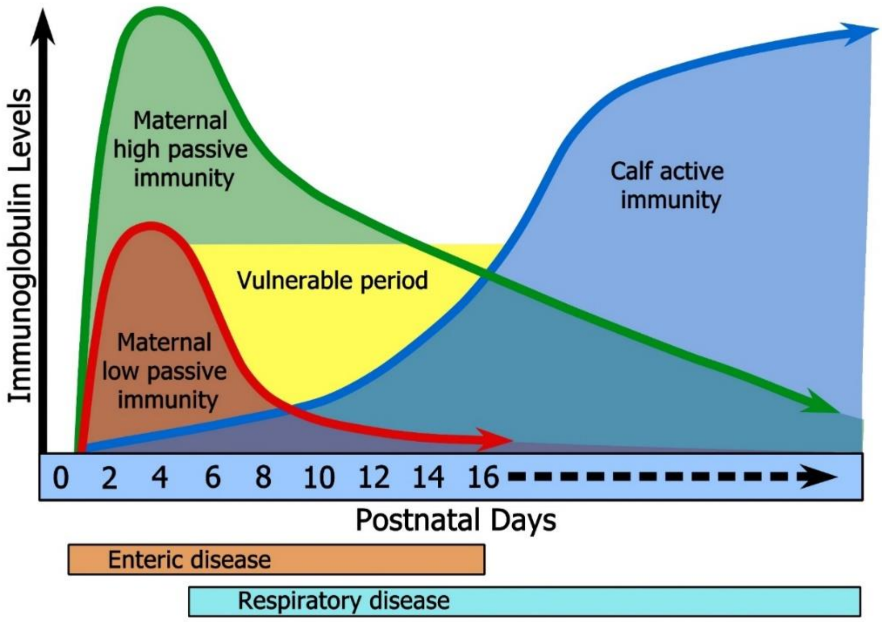

Diagram 1. This graphic representation of serum immunoglobulin levels in the neonatal calf shows how a high level of passive immunity provides better humoral immunity against diseases than a low level of passive immunity.

Transition milk, (the second milking and following milkings prior to that the dam's milk can be put into the bulk tank milk) is recommended to be targeted for calves in the first week of life. This milk has various gut active components and immunoglobulins that develop the gastrointestinal tract and improve immunity. Transition milk feeding to calves after the first colostrum feed has been shown to reduce the incidence of respiratory symptoms (Conneely *et al*., 2014) and improve preweaning weight gain (Kuhne et al., 2000). Colostrum supplementation of milk and milk replacers has also been shown to reduce diarrhoea in calves, improve daily weight gain and boost local gut and humoral immunity (Berge et al., 2009; Parreno et al., 2010; Kargar et al., 2020; Zwierzchowski et al., 2020). Thus, it is clear that the colostrum and transition milk produced by the dam needs to be harvested and used exclusively for the neonatal calves in a targeted feeding system.

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An ideal calf rearing scheme allows the calves *ad libitum* consumption of fresh whole milk or pasteurized waste milk in many meals. Milk has been created by the cow for one sole reason; to grow a calf, and mother nature intended weaning to be at around 10 months of life. This indicates that milk is a long-term solution for the young calf development. Our industrial early weaning programmes creates a physiological stress on the calves, and we need to do our uttermost to reduce this stress.

As regards the choice of milk replacer of whole milk, the claim that a product created with highly processed and heat-treated milk proteins, vegetable proteins, vegetable fats and other additives outperform and is better for the calf than fresh milk is questionable. That is like telling a mother that her baby will grow better and be healthier if she is fed powdered infant formula rather than breast milk. When a dairy does not want to use milk, a high-quality milk replacer (MR), derived from high quality milk protein sources may provide good results, but the choice needs to be made carefully. High skim milk concentrations may not be as important as a high quality whey protein concentrations, and this is important to note, as skim milk powders are more expensive than whey protein products (Terosky et al., 1997).

Higher preweaning weight gain has been associated with higher first lactation milk production (for every additional 100 g daily weight gain, 150 Kg more milk in first lactation) (Soberon and Van Amburgh, 2013; Gelsinger et al., 2016). This is due to that udder development is inhibited in restrictive feeding programmes. Studies have shown that calves on enhanced nutrition had 6 times greater mammary parenchymal mass at weaning compared to restricted nutrition calves (Soberon and Van Amburgh, 2017) and 32-47% increase in mammary DNA in heifers fed 900 grams versus 440 grams MR/day (Brown et al., 2005). There is evidence that a higher level of milk feeding preweaning will benefit the calf also post-weaning (Rosadiuk et al., 2020). Enhanced pre-weaning diet has been associated with better prepubertal follicle growth, better growth, and was shown to not correlated with performance post-weaning (Bruinje et al., 2019).

A high daily milk/MR volume is recommended the first 5-6 weeks of life (7—10 litres per day depending on type of milk, MR, MR concentration, and environmental conditions) (Table1). The amino acid composition of milk proteins is perfectly adapted to the calf's needs, and the calf's digestive system has been created to assimilate this diet efficiently. Calves do not consume much grain the first month of life, and the feed efficiency through grain consumption is much inferior to feed efficiency from milk consumption. There are recent studies indicating that calves that are limit-fed (6 litres or less per day) are suffering from hunger (Rosenberger et al., 2017). Automatic feeding systems can facilitate daily calf feedings and allow the calf to feed multiple times per day. Studies have indicated that in *ad-lib* systems calf can nearly double their milk replacer intake with no negative health effects, while maintaining similar grain intake levels as limit fed (six litres) calves (Schaff et al., 2016; Schaff et al., 2018). However, calves can easily ingest high quantities of milk or MR in one meal (up to 7 litres) without the milk overflowing into the rumen or discomfort (Ellingsen et al., 2016). I recommend that calves are group housed from the second month of life, and thereby multi-feeders or automatic milk feeders can be used that assure that all calves in the group get their appropriate share of milk. There are also studies indicating that pair-housing of preweaned calves will encourage starter grain intake, improve social skills and welfare and facilitate weaning procedures (Costa et al., 2015). After 6 weeks of age, I recommend a gradual reduction in milk feed until weaning, to encourage calf starter intake. Studies have shown that a 10-day reduction of 10% reduction per day in milk feed prior to weaning enhance transition and improved performance after weaning (Steele et al., 2017).

Table 1. My recommended feeding schedule for dairy calves with the aim to wean the calves at 8-12 weeks of age.

Week	**Liters of milk – milk replacer/day**
1	6-7
2-5	8-10
6	6-7
7	5-6
8-12	4-5
Weaning week	2-3

For an enhanced rumen development to allow early transition to roughage, a good starter grain is essential, as rumen development is enhanced by the consumption of starter grain. It has been shown that reduced grain intake preweaning is linked to reduced growth (Tautenhahn et al., 2020). If the starter grain is not palatable and the calf does not eat it enough, then this will delay the rumen development. The calf should be offered starter grain in the first week of life. Ensure that the grain is fresh and change it every day or at least every other day to encourage the calf to taste it, (fresh grain has a stronger smell). Starter grain is optimally including whole grains, protein rich pellets and no fine ground grains. Fine-ground and all-pelleted starter grain may be rapidly fermented in the rumen, contain insufficient structure for rumen papillae development and lead to ruminal acidosis. Limited hay should be available in the preweaning period to optimize the starter grain intake. In the second month of life, hay can be fed separate from the grain in increasing quantities. There has been much research into strategies for calf starter grain and roughage feeding to young calves and it can be complicated for the dairy producer to understand the best grain versus roughage feeding strategy (Khan et al., 2016; Imani et al., 2017).

Water should be available ad-lib from the first day of life and is important for the rumen development and grain intake, as the water enters the rumen, whereas the milk or

MR enters the abomasum. Water should be provided in a bucket to optimize water intake and prepare the calves for future watering systems (Hepola et al., 2008).

Early weaning was created as an industrial solution to sell more milk and reduce time spent feeding calves. Calves will benefit and continue to have optimal proteins for development with a longer milk feed period. Through starter concentrate feeding to young calves, we have found a way to speed up the maturation of the ruminal functioning of the calf, and this has allowed us to wean the calves earlier and earlier. However, in early weaning programmes (≤ 8 weeks), the calves are stressed by the early diet change, to which the digestive tract is not properly prepared. Weaning the calf at 3 months of age will prevent many calves to go through difficult feed transitions in a critical period of organ development. Thus, either the weaning is individual where it is verified that the calf can eat at least 1-1.5 Kg grain per day prior to weaning, or an extended milk feeding to all calves is recommended to at least 12 weeks of age to allow all calves to mature at their own pace.

After weaning the hay and starter grain should be continued for at least another month to reduce stress of weaning is impacted by dietary change. One month after weaning the calf can be fed a grower grain (approx. 15% protein) with hay, and gradually increasing quantities of haylage or silage can be fed. Heifers usually do not need a high energy roughage source. However, it should be of high nutritional quality roughage and free from mould growth that can contribute to mycotoxins in the feed. The weaning, which is indeed stressful, is many times combined with changes in housing or transitioning from individual housing to group housing, and this social stress combined with feed change stress is many times enough to reduce growth and lead to increasing levels of disease.

Many of these health and productivity challenges in the lactating herd can be traced back to sub-optimal heifer rearing which leads to high treatment costs, reduced milk production and early culling. Setting the focus on the calves is setting the focus on the future of the dairy herd, and I recommend a calf health and disease preventive strategy for every single dairy.

Footnote: If you want to read further, I recommend that you order my book 'The Healthy Dairy Calf'. Contact me at cat@bergevetconsulting.com or +32499703112.

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