DRY YOUR BEST

Managing nutrition around dry-off. New approaches.

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Nutrition during the dry period is critical for dairy cattle. The dry cow is at the late stage of pregnancy and needs to be prepared for the metabolic and immunological challenges of the forthcoming calving and lactation.

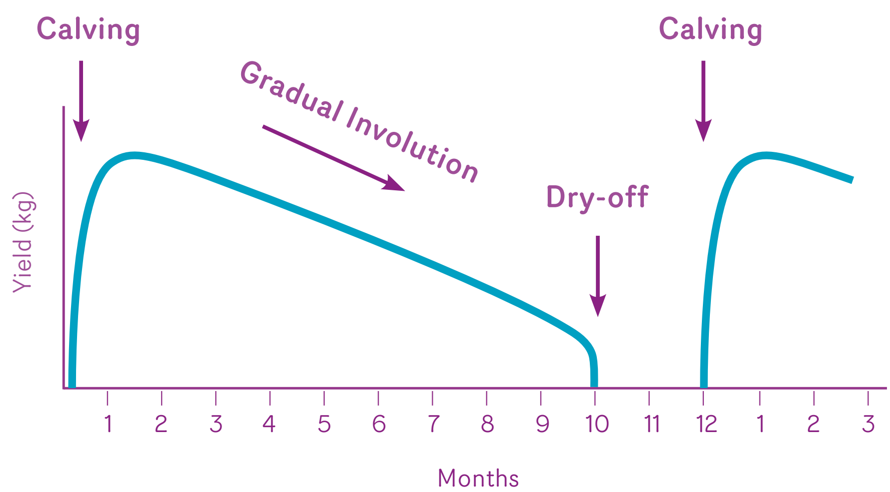
Key messages:

- Gradual dry-off aims to reduce milk production at the point of drying off by reducing the feed supply but this restriction impairs the immune system and therefore increases the risk of mastitis.
- During the dry period low energy rations are sufficient to meet the energy requirements of dry cows.
- There is no need to provide specific diets to “adapt” rumen papillae before calving but feeding special diets to minimize the incidence of hypocalcemia and udder oedema are interesting.
- A better nutritional management at dry-off and during the dry period can be proposed by using an abrupt dry-off and offering a single ration throughout the whole dry period.

Introduction

A cow's lactation is dependent on the number of mammary cells and their secretory capacity (Capuco *et al.*, 2003). The dry period is the time that these cell capabilities are set and therefore anything that can enhance mammary growth may improve the cow's performance in the next lactation. The nutrition of the dry cow has been typically divided into two parts: far-off and close up. However, there are differences of opinion regarding nutrition during pregnancy. Some current nutritional models assume that nutritional requirements for pregnancy are only relevant for the last 3 months of gestation and neglect any potential long-term effect of maternal nutrition on the offspring. This conflicts other evidence suggesting that nutrient supply and hormonal signals at specific windows during development (both pre- and early postnatal) may exert permanent changes in the metabolism of the offspring. Futhermore, current nutritional models do not consider the interaction between nutrient metabolic status and immune function. This is important especially during the dry-off, when copious amounts of milk can be accumulated in the udder and an active and effective immune system is mandatory. This article reviews the nutrition around dry-off and the reasons why the nutrition of the dry cow has been typically split in two, and proposes to feed dry cows a single ration throughout the dry period and avoid reducing nutrient supply preceding dry-off.

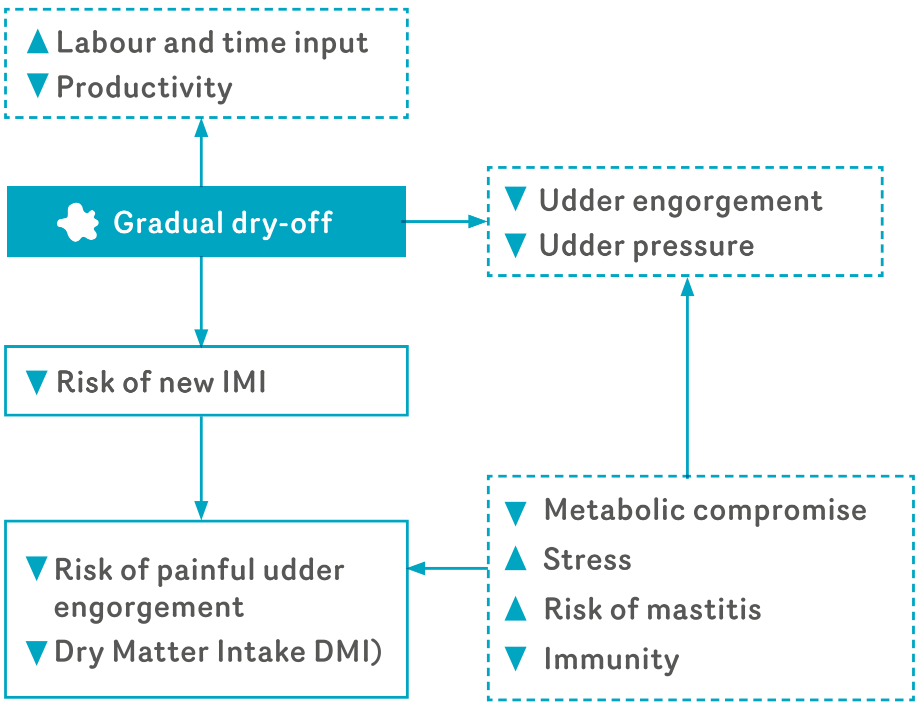
Typical lactation curve of multiparous cows



Drying-off

With increasing milk production, drying off has become a challenging period for dairy cows. The dry period is important for optimal milk production in the subsequent lactation, especially the first 3 weeks. During this period the cow is highly susceptible to new intra-mammary infections (IMIs) (Eberhart, 1986).

Once mammary gland involution is completed, within 30 days after cessation of milking, the mammary gland becomes much more resistant to new IMI because of a low fluid volume in the udder and an unfavorable medium for bacterial growth (Breau and Oliver, 1986). A common drying-off practice among farmers (known as gradual dry-off), involves a drastic short-term reduction in feed supply in the days that precede the dry off. Although this method is effective for rapidly reducing milk yield (Bushe and Oliver, 1987), such a reduction in nutrient supply at drying off may lead to metabolic problems, especially among high-yielding cows.



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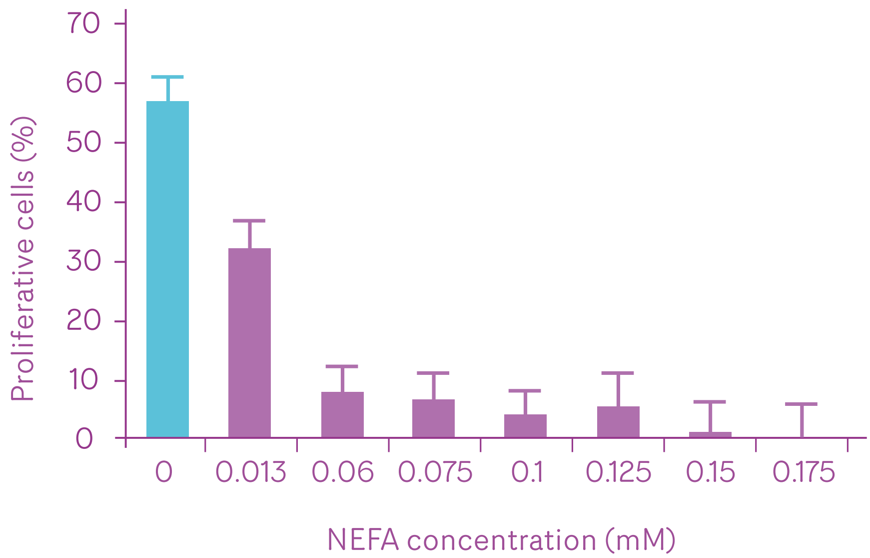
The reduction in nutrient supply has been consistently shown (Loisse *et al.*, 2009; Ollier *et al.*, 2014) to result in increased blood concentrations of non-esterified fatty acids (NEFA) as a result of fat mobilization.

Furthermore, cows fed dry hay for 5 days before drying-off have reduced peripheral blood mononuclear cell proliferation and IL-4 production (Ollier *et al*., 2014). This impaired immune function is likely to be a consequence of elevated NEFAs. Ster *et al*., (2012) clearly illustrated that the immune function is impaired in sera obtained from periparturient cows and that this inhibition is directly related to NEFA concentration in the serum.

Providing a balanced diet throughout the dry-off process is recommended to minimise impairments of the immune system and thus reduce the risk of incurring mastitis. Therefore, reducing feed supply even for a few days before drying-off is not recommended.

Impaired immune function is directly related to NEFA concentration in serum.



Dose effect of concentrations of NEFA (A) on concanavalin A - stimulated peripheral blood mononuclear cell (PBMC) proliferation. Data are presented as least squares means ± standard error of least squares means. Letters are different for significant differences (P < 0.001). Adapted from Ster *et al*., 2015.

Preparing for calving

Since the early 90's (and especially after the release of the National Research Council (NRC) model in 2001, which recommends energy densities around 1.60 Mcal of Net Energy lactation (NEl)/kg during this period) late pregnant cows have been fed high-energy rations in the immediate pre-calving period to:

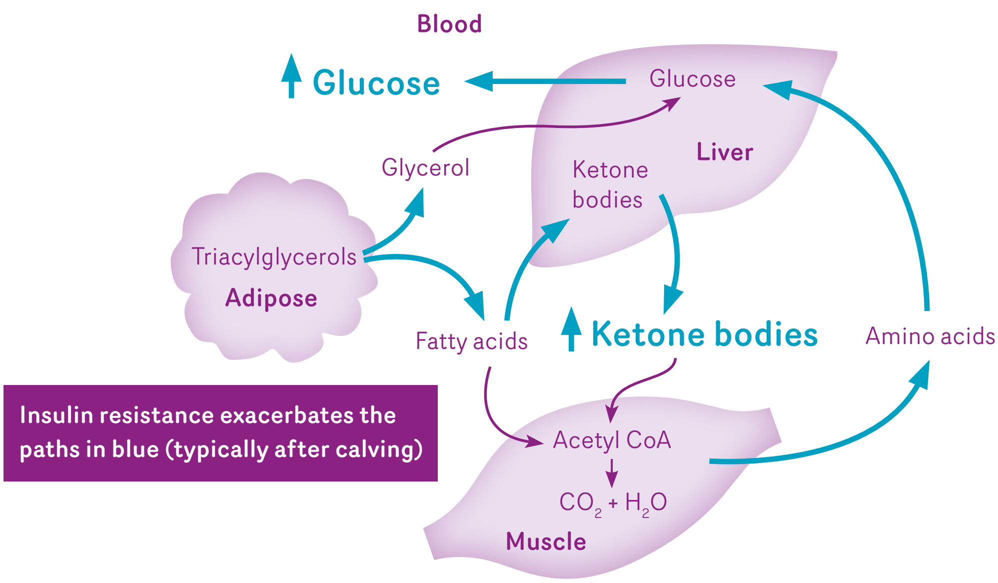
1. ***Compensate the assumed decreased feed intake as calving approaches.***
2. ***Minimise body fat mobilisation, ketosis and development of fatty liver after calving.***
3. ***Adapting the rumen microflora for a high nutrient dense ration (that will be fed post-calving).***
4. ***Foster the growth of rumen papillae to minimise the risk of rumen acidosis during lactation through an improved absorption (and removal) of volatile fatty acids from the rumen.***

Objectives 1 and 2: compensate the reduction of feed intake and minimise body fat mobilization

The first two objectives do not seem to be attained by feeding high-energy diets before calving. Several studies have shown that high-energy density diets fed prepartum do not physically limit intake of cows (VandeHaar *et al*., 1999; Mashek and Beede, 2000; Rabelo *et al*., 2003) resulting in over-consumption of energy. Overconsumption of energy prepartum has been linked to decreases in feed intake postpartum compared with cows that are fed to meet their energy requirements (Agenäs *et al*., 2003; Dann *et al*., 2006; Douglas *et al*., 2006; Guo *et al*., 2007). Furthermore, Janovick *et al*. (2011) described that a bulky diet with a low energy density fed prepartum improved metabolic status postpartum and reduced the incidence of health problems. Interestingly, overfeeding energy to cows during the last 21 days before parturition triggered a robust upregulation of lipogenic gene expression in adipose tissue (Ji *et al*., 2012), suggesting that insulin sensitivity may not be impaired by the hyperinsulinemic response to overfeeding energy (Janovick *et al*., 2011; Ji *et al*., 2012). This situation may increase the odds for cows to accumulate fat pre-calving when fed high energy density diets.

In fact, Drackley *et al*. (2014) have recently shown that overfeeding energy to nonpregnant-nonlactating cows drastically increases omental, mesenteric and perirenal adipose tissue of dairy cows, without resulting in detectable changes in body condition of the animals. Furthermore, Graunard (2013) reported that cows that were moderately over-fed during the prepartum period have an altered immune response and more prone to sustain liver lipidosis than those fed low energy diets. Recent evidence (Huang *et al*., 2014) supports feeding low energy diets (~1.30 Mcal of NEl/kg) prepartum as they result in increased dry matter intake postpartum, increased milk yield and alleviation of negative energy balance. Thus, the current view is that recommending high energy feeding during the dry period, especially as calving approaches, may be detrimental to cow health, or at least unnecessary, as a much lower energy density is sufficient to meet the energy requirements of the late pregnant cow.

An average pre-partum cow requires about 15 Mcal of NEl/d, and feeding a ration with an energy density of 1.60 Mcal of NEl/kg ration would readily provide more than 19 Mcal of NEl/d. Consequently, lower energy rations (approx. 1.32 Mcal/kg of NEl) should be sufficient to meet the energy requirements of dry cows. Cereal straw provides an excellent source of fiber in such rations as well as an important energy diluent provided the ration is well mixed to avoid ingredient selection by the cows. With respect to dietary protein, feeding rations of approximately 13% crude protein are recommended, possibly marginally greater when a significant number of first-calving heifers are being fed.



Before calving, insulin sensitivity at adipose tissue level is high regardless of energy supply

Objective 3: adapting the rumen microflora to a high-starch diet

The third objective is also debatable. In ruminant nutrition it has typically been assumed that at least 3 weeks are needed for the rumen microflora to adapt to a dietary change. However, the vast majority of organisms in the rumen are bacteria and they can double their population in as fast as 20 min.

Thus, 3 weeks seems like an extremely long time to consolidate a change in terms of bacteria lifespan. In fact, Fernando *et al*. (2014) have recently evaluated changes in the rumen microbial population when shifting steers from a prairie-based diet to a high-grain ration. Within a week of each step-up (animals were gradually moved to a high-grain diet), the authors reported drastic changes in the rumen microbial population.

Objective 4: fostering growth of rumen papillae

Lastly, the fourth objective could also be argued. The NRC (2001) made this recommendation based on the study by Diksen *et al*. (1985) that compared the characteristics of rumen papillae between cows fed a straw-based gestation ration to a high concentrate lactation ration. However, studies substituting barley for forage in the diets of late-gestation dairy cows, in an attempt to increase rumen acid load and alter rumen volatile fatty acid concentrations, had no effect on rumen papillae characteristics (Andersen *et al*., 1999) or subsequent lactation performance (Ingvartsen *et al*., 2001). Furthermore, a more recent study (Reynolds *et al*., 2004) that compared a high fiber diet vs the same diet plus additional 800 g/d of barley precalving reported that the total mass of rumen papillae excised from the floor of the cranial sack was not affected by transition diets. However, the number of rumen papillae tended to be greater when barley was fed, and this was associated with a marked reduction in average width, which resulted in a reduced average surface area. Thus, it would seem that there would be no need to 'adapt' rumen papillae before calving by providing high-starch diets.

There are, however, other reasons for feeding special diets pre-calving. These reason include minimising the incidence of hypocalcemia and udder oedema. Dairy cows have between 2 and 4 g of calcium in blood, half of which is in the ionized form. On the first day of lactation, synthesis and secretion of colostrum impose major losses of calcium equivalent to 7 to 10 times the amount of calcium present in blood (Horst *et al*., 2005). The incidence of clinical hypocalcemia postpartum ranges between 3.5% in the USA and Australia and 6% in Europe (DeGaris and Lean, 2008); but the threat for dairy cattle lies in the subclinical cases, which have been estimated to be about 50% (Goff, 2008). Cows with milk fever are at increased risk of developing other periparturient problems, including dystocia and ketosis (Curtis *et al*., 1983), displaced abomasum (Massey *et al*., 1993), uterine prolapse (Risco *et al*., 1984), and retained placenta (Melendez *et al*., 2004).

Furthermore, hypocalcemic cows have increased plasma concentrations of cortisol (Horst and Jorgensen, 1982), reduced proportion of neutrophils with phagocytic activity (Ducusin *et al*., 2003; Martinez *et al*., 2012) and impaired mononuclear cell response to an antigen-activating stimulus (Kimura *et al*., 2006). This reduction of immune response has linked hypocalcemia to metritis (Martinez *et al*., 2012) and mastitis (Curtis *et al*., 1983). Thus, preventing or minimising the incidence of hypocalcemia should be a priority when feeding prepartum dairy cattle. Strategies to minimise hypocalcemia consist of feeding anionic salts and low calcium diets.

Dry cow diets that are high in potassium, sodium or both, alkalinise the cow's blood and increase the susceptibility for milk fever (NRC, 2001). For many years, it has been known (Ender *et al*., 1971; Ender and Dishington, 1967; Block, 1984) that addition of dietary anions before calving could prevent hypocalcemia.

An acidic diet ameliorates parturient hypocalcemia by enhancing calcium mobilization before parturition by increasing calcium absorption and bone resorption (Damir *et al*., 1994). When supplementing pre-calving rations with anions, urine pH should be monitored. In Holstein cows, effective anion addition should reduce urine pH to 6.8 (Oetzel and Goff, 1998). The second strategy to minimise hypocalcemia, as stated above, consists of limiting the amount of dietary calcium pre-calving to force the cow to initiate calcium mobilisation mechanisms well before parturition. Diets providing less than 15 g/d of calcium and fed for at least 10 days before calving reduce the incidence of hypocalcemia (Boda, 1954; Goings *et al*., 1974).

Summary

At dry-off, cows should have a functional and effective immune system. Minimising body fat mobilisation will ensure that NEFAs do not compromise immune function at dry-off.

After dry-off, cows should be fed a low-energy diet (about 1.32 Mcal of NEl/kg; and 13-13.5% CP) for the entire dry period. This not only facilitates management (avoids pen movements and prevents mixing errors during feed preparation) but it also promotes a healthier lactation onset.

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VEL05 L272-0216-2.4K