Prevent hypocalcaemia by increasing calcium absorption, not supply

With the onset of milk production at calving, daily calcium (Ca) excretion of dairy cows suddenly increases from about 10g to about 30g per cow. This requires swift adaptation of the Ca-metabolism to keep Ca-homeostasis.

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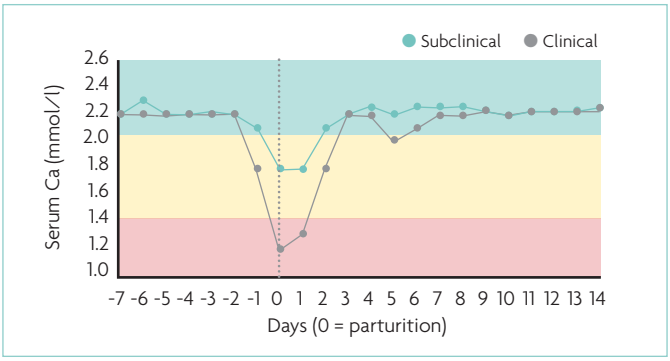


Fig. 1. Development of serum Ca in dairy cows with subclinical and clinical hypocalcaemia (adapted from Kimura et al., 2006).

Whereas a small drop in serum Ca during the first 48 hours post-partum is a normal physiological reaction to adjust to these changed circumstances, some cows experience problems with this increased Ca excretion (Fig. 1).

In these cows, the serum Ca drops below 2 mmol/l (8mg/dl), which is generally considered the threshold for hypocalcaemia. In up to 10% of the cows, serum Ca drops so low that they develop clinical signs of hypocalcaemia, such as paralysis and thus the inability to stand.

This parturient paresis, also known as milk fever, is a life-threatening condition and requires immediate treatment like intravenous supplementation of Ca. More widespread than clinical hypocalcaemia, however, is subclinical hypocalcaemia.

As it often goes undetected, its prevalence is difficult to measure, but has been estimated to affect up to 50% of multiparous cows. Hypocalcaemia has been linked to a variety of secondary diseases such as metritis, mastitis, displaced abomasum, and retention of placenta. The risk of developing hypocalcaemia is higher in certain breeds, in multiparous cows and in cows with a history of hypocalcaemia.

Measures to reduce the risk of hypocalcaemia

To reduce the risk of hypocalcaemia various preventive measures are recommended. They can be nutritional to train the metabolism of the cow for efficient Ca absorption. Such measures include low dietary Ca content, and/or low dietary cation-anion difference (DCAD), which are implemented several weeks before the estimated calving date. In addition, Ca-boli or vitamin D injections are applied at calving, mostly to cows with increased risk.

However, nutritional measures to prepare the cow for increased Ca requirement at calving can be difficult to achieve, especially in forage-based systems.

Such diets naturally have a high Ca and/or DCAD content. At the same time, a strategy that only focuses on cows at risk of clinical milk fever might miss cows at risk for subclinical hypocalcaemia.

Vitamin D in the prevention of hypocalcaemia

Vitamin D_3 is a key player in Ca-metabolism. It is produced with the help of UV-B in the skin or ingested as such via the diet.

In the liver, vitamin D_3 is converted to its circulating form, 25-hydroxyvitamin D_3.

To become metabolically active, a second conversion step in the kidneys to 1,25-dihydroxy-cholecalciferol ($1,25(OH)_2D_3$) is necessary.

Due to its direct effects on intestinal Ca absorption, $1,25(OH)_2D_3$ has been considered a valuable additional approach in the prevention of hypocalcaemia in dairy cows in the peripartum to support the sudden metabolic adaptations to maintain Ca-homeostasis.

However, due to practical issues (dosage, timing, gradual reduction in release) this approach could not get a hold in dairy management. A valid alternative to synthetic $1,25(OH)_2D_3$ are natural sources of this bioactive molecule.

There are a few plant species naturally producing $1,25(OH)_2D_3$-glycosides. The plant with the highest amount of $1,25(OH)_2D_3$-glycosides is waxy-leaf nightshade or Solanum glaucophyllum (SG) and its efficacy in the prevention of hypocalcaemia in dairy cows has been described in several publications in the last 30 years.

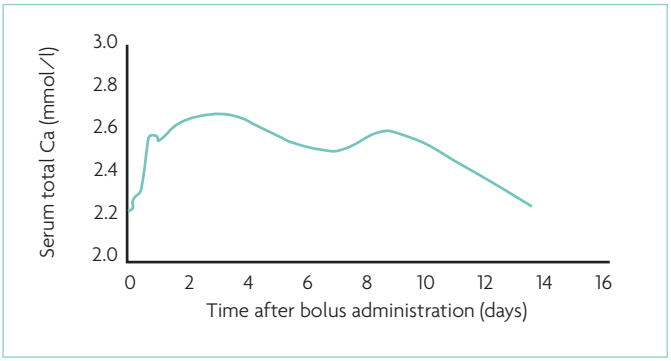
Herbonis Animal Health has developed a single application bolus based on SG. This bolus contains a defined amount of $1,25(OH)_2D_3$-glycosides and shows a specific release pattern, which overcomes the practical issues encountered so far when using vitamin D (-metabolites) in the prevention of hypocalcaemia in dairy cows.

Bolus based on Solanum glaucophyllum

In dry cows (220-257 days after successful insemination), a single bolus was applied. The bolus increased serum Ca between 12

Continued on page 12

Fig. 2. Change in serum Ca after bolus application to dry Holstein and Red Holstein cows (220-257 days after successful insemination) (adapted from Meyer-Binzegger et al., 2022).



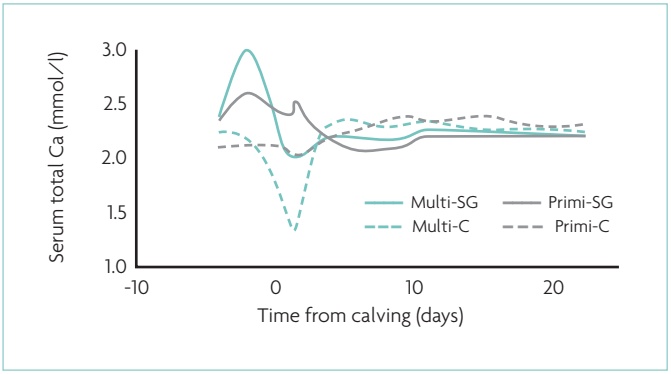


Fig. 3. Serum Ca of primiparous (Primi) and multiparous (Multi) cows around calving, either given a placebo bolus (C) or a bolus containing 1,25(OH)$_2$D$_3$-glycosides (SG) (adapted from Meyer-Binzegger et al., 2022).

Continued from page 11
hours and 11 days after application compared to the baseline (Fig. 2).

This allows for a wide window of application of between nine days to one day before the expected calving date, ensuring that serum Ca is elevated for at least 48 hours after calving.

The bolus was then applied to primi- and multiparous (≥ third lactation) Holstein and Red Holstein cows. Basal diet was 75% hay and 25% corn silage with a DCAD of +522 mEq/kg DM. The cows either received a placebo bolus or the bolus containing SG on average four days prior to the expected calving date.

None of the cows had a history of clinical hypocalcaemia. There was no effect of SG on serum Ca in primiparous cows (Primi-C and Primi-SG) and none of these cows showed signs of clinical or subclinical hypocalcaemia.

On the other side, the application of SG to multiparous cows (Multi-SG) prevented a drop of serum Ca below 2 mmol/l at any time point measured, whereas the minimum in the placebo group (Multi-C) was at 1.35 mmol/l approximately 36 hours after calving (Fig. 3).

Clinical milk fever was identified in a few Multi-C cows, which needed to be replaced and were not included in the data analysis. No animal in the Multi-SG group needed to be replaced due to clinical milk fever.

The results of these trials were confirmed in a field trial with Holstein cows fed a corn silage based TMR. The multiparous cows (average parity 2.4) either received an SG bolus or a placebo bolus approximately five days before their expected calving date. The cows receiving the SG bolus had a markedly higher serum Ca concentration at calving than the controls (Fig. 4). These results show that the single application bolus based on SG with a specific release pattern supports the prevention of hypocalcaemia in dairy cows and thus also prevents the negative effects of sub-optimal serum Ca concentrations at calving and during early lactation.

Additionally, application of the SG-bolus improved milk production during the fortnight after calving and reduced calving to oestrus interval (data not shown). ■

References are available from the authors on request

Fig. 4. Serum Ca in multiparous dairy cows around calving given a placebo or an SG bolus approximately five days before calving.