Effect of 25-hydroxyvitamin D_3 [25-(OH)D_3; calcidiol] during transition and lactation on production, reproduction, and health of lactating dairy cows

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Despite the common practice of combining the feeding of products such as anionic salts, to achieve a negative dietary cation-anion difference (DCAD) and supplementation of vitamin D_3, which together reduce the decline in blood total calcium and the risk of hypocalcaemia, the prevalence of subclinical hypocalcaemia [calcium (Ca) < 2.0 mM] remains high during the first days of lactation (up to 54% in 5th parity; Reinhardt et al., 2011). The vitamin D signalling pathway is essential in the processes of increasing absorption of dietary calcium (Ca) from the rumen or intestines, increasing Ca mobilisation from tissue and bone, and renal conservation of Ca (DeGaris and Lean, 2008) to counteract plasma Ca deficits. When the vitamin D cascade is triggered, the circulating form of vitamin D, [25-hydroxyvitamin D_3 [25-(OH)D_3; calcidiol] is hydroxylated from vitamin D_3, an inactive form of the vitamin, and is converted to the active form, calcitriol to restore Ca homeostasis (Deluca, 1980). There is a need to investigate lactation, reproduction, and health responses to long term oral 25-(OH)D_3 supplementation during lactation as considerable benefits in inclusion during the prepartum period such as improved peripartum Ca metabolism (Wilkens et al., 2012), increased fat-corrected milk yield and reduced incidence of retained foetal membranes and metritis have been shown (Martinez et al., 2018a, b). Extended supplementation may be beneficial. We hypothesised that feeding 25-(OH)D_3 during lactation, and in transition in conjunction with diets that produce a mild metabolic acidosis, would improve milk production, reproduction, and health.

Dairy cows from 4 commercial farms that fed partial mixed rations or pasture with concentrates were used in 2 randomised exposure experiments. Experiment 1; cows in Control [*n*=645; no 25-(OH)D_3] or Treatment [*n*=537; 2 mg/d of 25-(OH)D_3 prepartum and 1 mg/d in lactation] groups assigned ~21 d prepartum were monitored for weekly milk, milk composition every 60 d, and health and reproductive measures and analysed by linear mixed and survival models in STATA V15. Experiment 2; 4 groups of cows (median 147 DIM) were monitored as per Experiment 1 to the end of that lactation (L1) and through the subsequent transition and lactation (L2). Groups were (1) Control-control [CON-CON; no 25-(OH)D_3], (2) Treatment-treatment [TRT-TRT; 1 mg/d of 25-(OH)D_3 in L1 and L2 and 2 mg/d prepartum], (3) Control-treatment [CON-TRT; 1 mg/d of 25-(OH)D_3 in L2 and 2 mg/d prepartum], and (4) Treatment-control [TRT-CON; 1 mg/d of 25-(OH)D_3 in L1]. For L1, 1,032 cows entered control groups 1 or 3 and 1,032 in groups 2 or 4. The *n*/group that entered L2 was 521, 523, 273, and 248, respectively. Plasma 25-(OH)D_3 concentrations were measured from 17 cows/group at 5 timepoints. All prepartum diets in Experiments 1 and 2 had a negative DCAD.

In Experiment 1, treatment did not influence the odds of survival/d up to 305 days in milk (P=0.764) or the censoring pattern (P=0.889). Treatment cows had 0.2 lower natural log somatic cell count (SCC) than Controls and multiparous Treatment cows had 41.1±23.4% higher rate of pregnancy/d than multiparous Controls, reducing days open by 22 d. Primiparous Treatment cows had 1.67±0.40 times greater odds of mastitis/d than primiparous Controls. No other milk production or health outcomes or the odds of being bred/d had a significant treatment effect (P>0.05). In Experiment 2, treatment did not influence the likelihood of survival (P=0.496) up to 300 d on study in L1. Treatment cows had 10.5±5.7% lower risk of censoring (removal; P=0.053) in L1. Treatment did not influence survival (P=0.721) or censoring pattern (P=0.231) in L2. Mean plasma 25-(OH)D_3 concentrations during the study were 83.0±13.4, 239.4±13.3, 169.7±13.5, and 163.4±13.6 for the CON-CON, TRT-TRT, CON-TRT, and TRT-CON groups, respectively. The TRT-TRT cows had 15.5-28.9% lesser odds to be bred/d than other groups (P=0.016). Multiparous CON-CON and TRT-CON cows had 21.4±7.8% and 30.3±16.6% greater odds of pregnancy, respectively, than multiparous TRT-TRT cows. No other milk production or health outcomes had a significant treatment effect (P>0.05).

Our hypothesis was partially supported. There were SCC benefits from treatment and indications of other benefits, particularly for multiparous cows including the time to pregnancy; however, responses varied.

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