

The effects of an oral supplement containing calcium and live yeast on circulating calcium and production following IV lipopolysaccharide infusion in dairy cows

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Introduction

Administering lipopolysaccharide (LPS) decreases circulating calcium (Ca) and markedly reduces both feed intake and milk yield in lactating cows. Calcium is involved in immune system activation, but whether supplemental Ca benefits immune-challenged cows remains unclear. Therefore, study objectives were to evaluate if providing an oral supplement containing soluble Ca, live yeast and other micronutrients would ameliorate LPS-induced hypocalcemia and production parameters in lactating dairy cows.

Materials and Methods

Lactating Holstein cows (n = 12; 269 ± 20 DIM; 760 ± 13 kg BW; 2.7 ± 0.3 parity) were housed in individual box-stalls, jugular catheterized and allowed 4 d to acclimate. The trial consisted of 2 experimental periods (P). During P1 (3 d), cows were fed ad libitum and baseline data was collected. At the beginning of P2 (96 h) all cows were challenged i.v. with 0.375 µg/kg BW LPS (E. coli O55:B5; Sigma Aldrich, St. Louis, MO). Cows were assigned randomly to 1 of 2 treatments: 1) control (CON; no boluses; n = 6) or 2) a bolus containing Ca and live yeast, administered 0.5 pre- and 6.5 h post-LPS infusion (CLY; YMCP Vitall 44.718 g of elemental Ca; Techmix, LLC, Stewart, MN; n = 6). To isolate the effects of the oral supplement, cows were fasted for the first 12 h of P2. Blood samples were collected -1, -0.5, 0, 0.5, 1, 1.5, 2, 3, 4, 5, 6, 6.5, 7, 8, 9, 10, 11, 12, 24, 48, 72, and 96 h relative to LPS infusion. Circulating glucose and ionized Ca (iCa) concentrations were measured using an iStat handheld machine and cartridge (CG8+; Abbott Point of Care, Princeton, NJ). Area under the curve (AUC) for iCa was calculated through 96 h post-LPS by linear trapezoidal summation between successive pairs of iCa levels and time coordinates after subtracting baseline values.

Results

Following LPS administration, circulating iCa decreased in both treatments but supplemental CLY ameliorated the hypocalcemia (469% at the 48 h AUC: -10.8 vs -1.9 mmol/L·h; P < 0.01). Relative to baseline, circulating glucose in both CON and CLY cows decreased similarly between 3 and 12 h post LPS-infusion (17%; P = 0.40). LPS markedly decreased DMI (60%; P < 0.01) similarly for both treatments on d 1, but overall (d1-4) DMI tended to be reduced less (14 vs 30%; P = 0.06) in CLY supplemented vs CON cows. LPS reduced (P < 0.01) milk yield on d 1 and 2 (48 and 61%, respectively). Overall (d 1-4), CLY supplemented cows tended (P = 0.11) to produce more milk (32%) following the LPS challenge and this effect was most pronounced on d 4 (20.7 vs 28.0 kg/d; P < 0.04). Relative to CON cows, milk fat and total solid content were decreased in CLY cows (33 and 14%, respectively; P ≤ 0.03). Milk urea nitrogen was decreased (11%) in CLY cows compared to CON cows (P = 0.01). There were no treatment differences in milk protein or somatic cell count (P = 0.14).

Significance

In conclusion, providing an oral supplement containing Ca and live yeast prior to and following LPS administration markedly ameliorated the LPS-induced hypocalcemia and improved DMI and milk yield. Overall, utilizing an oral supplement may be a valuable management strategy to improve animal well-fare and productivity during and following immunoactivation. Additionally, infusing i.v. LPS appears to be an effective technique to model hypocalcemia and to evaluate dietary strategies aimed at increasing circulating calcium in lactating dairy cows.