Use of oral boluses comprised of readily absorbed calcium salts and *Solanum glaucophyllum* leaf administered a single time after calving to reduce hypocalcemia in dairy cows

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Introduction

Hypocalcemia is commonly observed in periparturient cows. If persistent beyond the first day of lactation, it contributes to poor milk production and other health problems (Neves et al., 2017). Oral Ca boluses can provide Ca for rapid absorption of Ca to support blood Ca concentration. Because their actions are short-lived (3-6 hrs), they are often administered at calving and again 12-24 hrs later. 1,25-dihydroxyvitamin D (1,25 VD) and its analogs have been utilized to prevent milk fever, but must be given 1-3 days prior to parturition to be effective as 12-24 hrs are required to stimulate intestinal Ca absorption (Hove and Kristiansen, 1982). A major obstacle to the use of 1,25 VD to prevent hypocalcemia is administration within the effective window. Given too early, the dose must be repeated. Given too late, the cow can still suffer severe hypocalcemia. *Solanum glaucophyllum* (SG) is a plant whose leaves contain an inactive glycoside form of 1,25 VD. Within the rumen the glycoside is cleaved by rumen bacteria, liberating 1,25 VD which is rapidly absorbed into the blood. Our hypothesis is that administering a bolus with readily absorbable Ca and SG leaf will improve plasma Ca in periparturient cows when administered at the time of calving. The Ca will sustain improved blood Ca concentrations for up to 12 hrs after calving and the SG leaf will stimulate intestinal Ca absorption from 12 hrs until 72 hrs after calving.

Materials and methods

Boluses: Oral boluses were prepared that contained 39 g Ca as Ca chloride and Ca propionate, and dry SG leaf material at 5, 7, or 7.5 g/bolus. Assay of the leaf determined it supplied 14 ug 1,25 VD activity/g.

Trial 1. Multiparous periparturient Holstein cows fed an anionic diet with urine pH average of 6.6. Six cows received 2 39 g Ca + 5 g SG boluses within 4 hrs of calving. Seven cows received 2 39 g Ca + 7.5 g SG boluses. Nine cows were treated with 1 43 g Ca bolus at calving and again 12-24 hrs after calving.

Trial 2. Multiparous periparturient Holstein cows were fed an anionic diet with urine pH average of 5.68. Seven cows were not given any bolus after calving. Nine cows were treated with an oral calcium bolus at calving and again 12-24 hrs after calving-each bolus supplying 50 g Ca primarily as calcium chloride. Ten cows received 2 boluses at calving, supplying 78 g Ca and 14 g SG leaf in total.

In both trials plasma Ca concentration was determined (Ca Arsenazio method) in blood collected at calving, prior to treatment, and at 3, 12, 24, 36, 48 and 72 hrs in both trials and also at 96 hrs after treatment in Trial 1. The data were subjected to a repeated measures analysis of variance with cow nested within treatment and time after calving the repeated measure. Tukey's method was used to compare means at the same time point across treatments.

Results

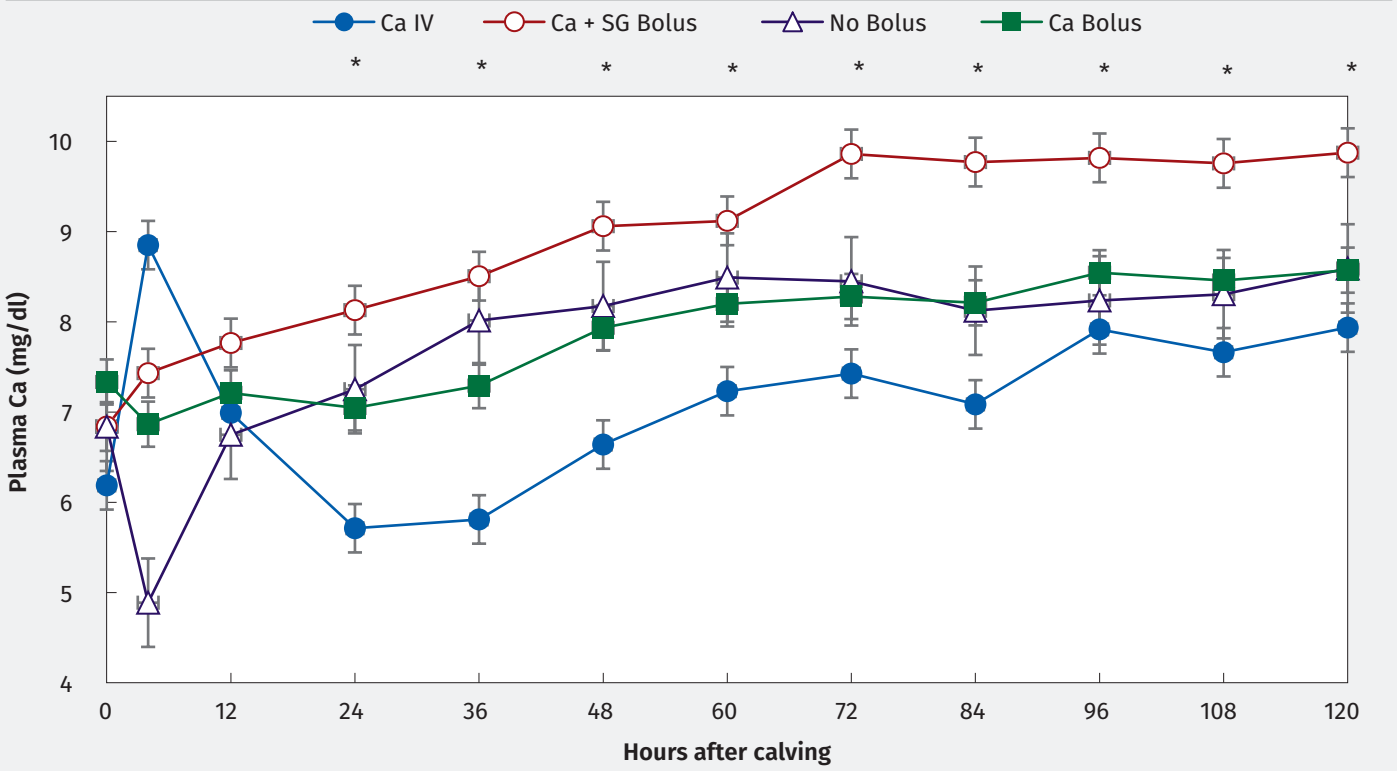
Trial 1. All cows receiving exhibited a small increase in blood Ca concentration at the 3-hr time point. At the 12-hr timepoint, the cows receiving Ca + SG leaf boluses had increased blood Ca from their blood Ca at calving, while cows receiving Ca only boluses had blood Ca concentrations similar to those observed at calving. The cows that received Ca only boluses at calving and 12-24 hrs later had mean plasma Ca below 8.5 mg/dl the first 3 days after calving. Cows receiving the Ca + 10 g SG leaf boluses at calving only had plasma Ca above 8.5 mg/dl by 48 hrs and cows treated with boluses with Ca + 15 g SG leaf had plasma Ca above 9 mg/dl by 48 hr after calving and 9.6 mg/dl by 96 hrs after calving. The cows receiving the Ca + 15 g SG leaf had significantly greater plasma Ca than in cows receiving the oral Ca only boluses from 24 to 96 hrs after calving.

Trial 2. Average plasma Ca concentration at calving was similar in all cows and averaged 7.4 + 0.23 mg/dl. Plasma Ca in No Bolus cows decreased at 3 hrs after calving to 7.0 + 0.32 mg/dl, while cows receiving either Ca containing boluses at calving had increasing blood Ca concentration at 3 hrs. Cows receiving the Ca only boluses had lower plasma Ca at 12 hrs than at 3 hrs and mean plasma Ca concentration was similar to No Bolus cows from 24-72 hrs. Only cows treated with Ca + 14 g SG leaf had plasma Ca concentrations above 8.25 mg/dl during the first 72 hrs.

Significance

A bolus that combines a high dose (78 g Ca) of a source of readily soluble Ca, absorbable across the GI tract by the passive paracellular route, with the SG leaf to supply a source of 1,25 VD to stimulate active Ca transport, improves plasma Ca concentration in periparturient cows over the use of Ca-only boluses and

Figure 1: Plasma Ca of multiparous cows from 5 farms that did not use an anionic diet. Treatments consisted of cows receiving prophylactic intravenous calcium at calving (Ca IV, N = 4), commercial oral calcium boluses administered at calving and 12-24 hours later (Oral Ca, N = 24), cows receiving oral calcium boluses containing *Solanum glaucophyllum* (SG) leaf at calving only (Ca + SG, N = 22), and cows that received no oral or intravenous prophylactic calcium after calcium (None, N = 6). • Designates time points when plasma Ca of Ca + SG treated cows were significantly different ($P < 0.05$) from Oral Ca treated cows.



over cows receiving no Ca boluses. The problem of timing of administration of 1,25 VD for it to be effective observed in earlier studies in the literature is overcome by the passive absorption of bolus Ca, which sustains blood Ca concentrations until the 1,25 VD can effectively turn on the Ca absorptive mechanisms in the GI tract, which takes from 12-24 hrs. The provision of the SG leaf raises blood 1,25 VD concentrations earlier than the endogenous production of 1,25 VD occurs in response to later hypocalcemia. This stimulates Ca transport as much as 12 hrs earlier than endogenous 1,25 VD synthesis would, effectively preventing hypocalcemia and in these trials, subclinical hypocalcemia (above 8 mg Ca/dl). The cows fed a moderate anion program with urine pH of 6.6 responded with higher blood Ca concentrations than the cows fed the higher anionic diet with urine pH of 5.68. Studies are currently underway to observe the effects of the Ca + SG bolus in Jersey cows and in herds that are not feeding an anionic salt. The results of these trials will also be presented.

