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Effects of crude protein level and degradability of limited creep-feeding supplements on performance of beef cow-calf pairs grazing limpograss pastures

Philipe Moriel*, Joao M.B. Vendramini, John D. Arthington, Andre D. Aguiar, Gregory Caputti

University of Florida – Range Cattle Research & Education Center, Ona 33865-9706, USA

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ABSTRACT

Two experiments evaluated the growth performance of cow-calf pairs offered limited creep-feeding supplementation (Exp. 1) and creep-feeding supplements with different crude protein degradability (Exp. 2). In Exps. 1 and 2, Brangus crossbred cow-calf pairs (*Bos* sp.; 24 and 16 pairs, respectively) were randomly assigned into 1 of 8 limpograss pastures (3 and 2 cow-calf pairs/pasture, respectively). Treatments were randomly assigned to pastures (4 pastures/treatment) and consisted of: (Exp. 1) no creep-feeding supplementation (**Control**) or daily limit creep-feeding supplementation (**Creep**; 0.40 kg/d of soybean meal) for 84 d; and (Exp. 2) daily limited creep-feeding supplementation of 0.40 kg/d of soybean meal (**SBM**; 35% RUP) or 0.40 kg/d of cooker-expeller processed SBM (**SP**; SoyPLUS, West Central, Ralston, IA; 60% RUP) for 112 d. In both experiments, creep-feed supplements were provided daily at 0800 h in cow-exclusion areas. Body weight of cows and calves were assessed monthly, following 16 h of feed and water withdrawal, whereas cow BCS was determined at the start and end of the study. In both experiments, herbage mass (HM) and hand plucked forage samples for nutritive value analysis were obtained at 14-d intervals from May to August (Exp. 1) and May to September (Exp. 2). Effects of treatment and treatment × time ($P \geq 0.16$) were not detected for HM, herbage allowance, in vitro digestible organic matter, and crude protein in both experiments. In Exp. 1, limited creep-feeding supplementation increased calf overall average daily gain (ADG, $P = 0.0005$), but not cow growth ($P \geq 0.19$). In Exp. 2, effects of protein degradability were not detected for calf and cow growth performance ($P \geq 0.14$). In summary, limit creep-feeding supplementation of 0.40 kg/d of soybean meal for 83 d addressed weather-induced calf nutritional deficiencies and increased calf growth grazing limpograss pastures, without affecting cow growth performance and forage responses. In addition, increasing supplemental RUP consumption from 67 to 115 g/d was not sufficient to impact limpograss herbage mass, nutritional composition, and growth performance of cows and calves.

1. Introduction

Meeting nutrient requirements is a challenge for forage-fed cattle production systems. Creep-feeding is a management tool used to provide supplemental nutrients to pre-weaned calves that may not be fully obtained from milk and forage. However, traditional creep-fed calves are often provided unlimited access to supplement, which leads to decreased gain:feed efficiency, and economic return (Stricker et al., 1979; Cremin et al., 1989; Faulkner et al., 1994). In contrast, limit-feeding creep-feed supplements to relatively small daily amounts increased animal performance, gain:feed efficiency, and profitability (Cremin et al., 1991; Moriel and Arthington, 2013; Aguiar et al., 2015).

Limpograss (*Hemarthria altissima*) is a perennial warm-season grass highly adapted to poorly drained soils and commonly found in South Florida. At advanced maturity, limpograss contains greater total digestible nutrients (TDN) concentration, but reduced crude protein (CP) concentrations compared to other warm-season grasses at late maturity (Sollenberger et al., 1988; Pitman et al., 1994), which limits calf pre-weaning growth. Therefore, protein supplementation to animals grazing limpograss may be a feasible management strategy to optimize animal production (Sollenberger et al., 1988; Newman et al., 2002). Aguiar et al. (2015) reported a linear increase in pre-weaning ADG from 0.33 to 0.62 kg/d for calves creep-fed 0, 0.20, or 0.40 kg/d of soybean meal (SBM) for approximately 90 d. Young growing cattle need rumen undegradable protein (RUP) in addition to the microbial protein supply to meet the metabolizable protein requirement (Klopfenstein,

* Corresponding author.
E-mail address: pmoriel@ufl.edu (P. Moriel).

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1996). It is unknown if the benefits to calf growth performance observed by Aguiar et al. (2015) could be increased by providing a greater daily RUP supply. Hence, the objectives of Exp. 1 were to replicate the study from Aguiar et al. (2015) and test the effectiveness of limited CP creep-feeding supplementation on performance of cow-calf pairs, whereas experiment 2 tested the effects of increased level of rumen degradable protein (RDP) on limited creep-feeding supplementation on forage responses and growth performance of cows and calves grazing limpograss pastures. The hypothesis of Exp. 1 was that supplying limited creep-feeding supplementation to calves grazing limpograss pasture would increase calf performance without affecting cow performance and forage characteristics. The hypothesis of Exp. 2 was that growth performance of calves grazing limpograss pastures would increase by providing greater RUP in limit-fed creep-feeding supplementation.

2. Materials and methods

2.1. Animals and experiment design

Exps. 1 and 2 were conducted at the UF/IFAS Range Cattle Research & Education Center (RCREC), Ona, FL (27° 26′ N and 82° 55′ W) from May to August in 2013 (Exp. 1) and from May to September in 2013 (Exp. 2). Animals were cared for in accordance with acceptable practices and experimental protocols reviewed and approved by the University of Florida Institutional Animal Care and Use Committee. Monthly rainfall precipitation and ambient temperature were collected on site and reported in Table 1.

In Exp. 1, 24 cow-calf pairs (Angus-sired calves on crossbred Brangus cows) were stratified by initial BW (calf BW = 216 ± 12 kg; calf age = 6 months; cow BW = 474 ± 44 kg; cow BCS = 4.5 ± 0.47, according to Wagner et al. (1988)) and then randomly assigned into 1 of 8 limpograss pastures (1 ha and 3 cow-calf pairs/pasture). In Exp. 2, 16 cow-calf pairs (Angus-sired calves on crossbred Brangus cows) were stratified by initial BW (calf BW = 160 ± 23 kg; calf age = 6 months; cow BW = 469 ± 47 kg; cow BCS = 4.8 ± 0.15, according to Wagner et al. (1988)) and then randomly assigned into 1 of 8 limpograss pastures (1 ha and 2 cow-calf pairs/pasture).

In both experiments, treatments were randomly assigned to pastures (4 pastures/treatment) in a randomized complete block design using initial herbage mass (HM) as block criteria (2 blocks; 2 replicates/treatment/block). In Exp. 1, treatments consisted of calves receiving no creep-feeding supplementation (**Control**) or limit creep-feeding supplementation (**Creep**; 0.40 kg/d of SBM; 48% CP) for 84 d. In Exp. 2, treatments consisted of calves receiving limited creep-feeding supplementation of 0.40 kg/d of soybean meal (**SBM**; RUP = 35% of CP) or cooker-expeller processed SBM (**SP**; SoyPLUS, West Central, Ralston, IA; 48% CP; RUP = 60% of CP) for 112 d. In both experiments, creep-feeding supplements were provided daily at 0800 h in cow-exclusion areas. Body weight of cows and calves were assessed monthly, following 16 h of feed and water withdrawal, whereas cow BCS was determined at the start and end of the study.

Table 1
Monthly temperature (°C) and rainfall (mm) at the Range Cattle Research & Education Center from May to September of 2013 (Exp. 1) and 2014 (Exp. 2).

	May	June	July	August	September
Experiment 1					
Temperature, °C					
Max.	30.2	30.0	31.5	33.1	
Min.	15.8	19.9	21.9	22.5	
Average	23.0	25.0	26.7	27.8	
Total rainfall, mm	48.0	251.2	268.2	190.0	
Experiment 2					
Temperature, °C					
Max.	30.7	30.8	32.9	33.6	30.1
Min.	17.3	19.0	21.8	22.2	20.4
Average	24.0	24.9	27.4	27.9	25.3
Total rainfall, mm	150.9	167.6	214.4	96.8	302.5

2.2. Pasture description

The soil at the research site is classified as Pomona fine sand (siliceous, hyperthermic, Ultic Alaquod). Before the initiation of the study, mean soil pH (in water) was 5.1, and Mehlich-I (0.05 M HCl + 0.0125 M H_2SO_4) extractable P, K, Mg, and Ca concentrations in the Ap1 horizon (0- to 15-cm depth) were 35, 75, 155, and 1450 mg/kg, respectively. Pastures were fertilized with 50 kg N/ha in April 2013 and 2014 using ammonium nitrate. Limpograss pastures were established in 2010 and grazed annually from 2011 to 2014.

2.3. Forage measurements

In both experiments, HM and hand plucked forage samples were obtained at 14-d intervals from May to August (Exp. 1) and May to September (Exp. 2), but reported monthly using the average HM and nutritive value obtained every 28 d. Herbage mass was determined using the double sampling technique, as described by Aguiar et al. (2015). Herbage allowance (HA) was calculated as the average monthly HM divided by respective monthly total BW of cows and calves in each pasture (Sollenberger et al., 2005). Herbage samples were composited across sites within a pasture, dried at 60 °C for 48 h in a forced-air oven to constant weight, and ground in a Wiley mill (Model 4, Thomas-Wiley Laboratory Mill, Thomas Scientific, Swedesboro, NJ) to pass a 1-mm stainless steel screen. Forage samples were then analyzed for CP concentrations using the micro-Kjeldahl technique for N concentrations (Gallaher et al., 1975) and CP was determined by multiplying N concentration by 6.25. In vitro digestible organic matter (IVDOM) was analyzed using the two-stage technique described by Tilley and Terry (1963) and modified by Moore and Mott (1974).

2.4. Statistical analyses

All data of Exps. 1 and 2 were analyzed as randomized complete block design using the MIXED procedure of SAS (SAS Institute Inc., Cary, NC, USA, version 9.4) with Satterthwaite approximation to determine the denominator degrees of freedom for the test of fixed effects. Pasture was the experimental unit, whereas animal(pasture) and pasture(treatment) were included as random effects in all analyses. Calf ADG, calf BW, cow BW, cow BCS, HA, HM, and nutritive value of pastures were analyzed as repeated measures, and tested for fixed effects of treatment, time, and resulting interaction using pasture (treatment) as the subject. Cow and calf BW on d 0 did not differ between treatments in both experiments ($P \geq 0.40$), but were included as covariates in the analyses of calf and cow BW. Overall cow BW and BCS change were tested for fixed effects of treatment. Effects of block were removed from model if $P > 0.10$. All results are reported as least-squares means. Data were separated using PDIFF if a significant F-test was detected. Significance was set at $P \leq 0.05$, and tendencies were noted if $P > 0.05$ and ≤ 0.10.

3. Results

3.1. Experiment 1

Effects of time ($P \leq 0.002$), but not treatment and treatment × time ($P \geq 0.16$), were detected for HM, HA, IVDOM, and CP (Table 2). Herbage mass did not differ between June and July ($P \geq 0.11$), but decreased in August ($P < 0.0001$), whereas HA decreased from June to August ($P \leq 0.0005$). In vitro digestible OM decreased from May to June ($P = 0.0005$), and did not differ from June to August ($P \geq 0.11$), whereas CP decreased from May and July ($P \leq 0.01$), and did not differ between