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Supplementation of encapsulated cinnamaldehyde and garlic oil on pre- and postweaning growth performance of beef cattle fed warm-season forages

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ABSTRACT

Two experiments evaluated the effects of cinnamaldehyde and garlic oil on performance of grazing (Exp. 1) and drylot beef cattle (Exp. 2). Treatments in both experiments consisted of daily supplement fortification with (CNG) or without (CON) cinnamaldehyde and garlic oil (300 mg/d). In Exp. 1, 24 cow-calf pairs were allocated into limpograss (*Hemarthria altissima*; n = 4) or bahiagrass (*Paspalum notatum*; n = 4) pastures, which were randomly assigned to treatments (4 pastures per treatment) until weaning. Thereafter, 24 weaned heifers were allocated into bahiagrass pastures (4 pastures per treatment) for 72 d. In Exp. 2, 20 Brangus steers were fed bahiagrass hay ad libitum and concentrate DM supplementation at 1% of BW for 30 d. Effects of forage type, treatment, and interactions were not detected for growth, fecal egg counts, and plasma glucose and urea nitrogen of heifers and cows ($P \geq 0.11$). The fly counts of CNG heifers on limpograss was less at weaning than for CON heifers ($P = 0.03$) but did not differ between CNG and CON heifers grazing bahiagrass ($P = 0.66$). Effects of treatment and treatment × day were not detected for postweaning growth, fecal egg counts, and plasma haptoglobin ($P \geq 0.43$). In Exp. 2, effects of treatment and treatment × day were not detected for growth and total fly counts ($P \geq 0.34$). Hence, daily supplementation of cinnamaldehyde and garlic oil did not affect growth and fecal egg counts of grazing or drylot cattle. Cinnamaldehyde and garlic oil reduced fly counts of heifers grazing limpograss but not heifers grazing bahiagrass.

Key words: beef cattle, cinnamaldehyde, garlic oil, fecal eggs, fly count

INTRODUCTION

The beef cattle industry is searching for alternative feed additives because the use of antibiotics as growth promoters in animal feeds have been questioned by the public and some types of antibiotics were banned by the European Union legislation in 2006 (European Union, 2003). Plant extracts, such as cinnamaldehyde and garlic oil, are generally recognized as safe for human and animal consumption and can modify ruminal microbial fermentation and end products formation in vitro (Cardozo et al., 2004; Busquet et al., 2005) and in vivo (Cardozo et al., 2006; Khorrami et al., 2015). For instance, the addition of cinnamaldehyde decreased the concentrations of acetate and NH_3-N but increased concentrations of propionate, small peptides, and AA in the ruminal fluid of Holstein steers fed barley straw–based diets (Cardozo et al., 2006). Similarly, the addition of garlic oil (30 and 300 mg/L) to a 50:50 forage: concentrate diet decreased the postincubation molar proportion of acetate and increased the proportion of propionate and butyrate in ruminal fluid (Busquet et al., 2005). Despite the capacity of modifying ruminal fermentation, there is a limited amount of studies focusing on growth performance of beef cattle fed cinnamaldehyde and garlic oil (Yang et al., 2010a,b; Beck et al., 2017), particularly on productive measurements of beef cattle grazing warm-season forages. Hence, 2 experiments were conducted to evaluate the effects of daily supplementation of cinnamaldehyde and garlic oil on pre- and postweaning growth, blood parameters associated with energy and protein metabolism, and internal parasite and horn fly infestation of grazing beef cow-calf pairs (Exp. 1), and total and forage DMI of growing beef steers (Exp. 2).

MATERIALS AND METHODS

The experiments described herein were conducted at the University of Florida, Institute of Food and Agricultural Sciences, Range Cattle Research and Education Center, Ona, Florida (27°23′N and 81°56′W) from July to December 2016. All animals were cared for by acceptable practices approved by the Institutional Animal Care and Use Committee from the University of Florida (#201609469).

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Exp. 1

Animals and Diets. Sixty-one days before weaning (d −61), 24 Brangus crossbred cow-calf pairs were stratified by initial cow age, BW, and BCS, and age of heifer calves, and then randomly allocated into 1 of 4 limpograss (*Hemarthria altissima*; 1 ha/pasture) or 4 bahiagrass (*Paspalum notatum*; 1 ha/pasture) pastures using a fixed continuous stocking rate (3 cow-calf pairs per pasture). All cows received daily concentrate supplementation at 0.454 kg/cow (as fed; 50:50 ground corn and cottonseed meal mix) and their respective treatment in calf-exclusion feed bunks located at 1 m above ground level. All calves received daily creep-feed supplementation at a rate of 0.9 kg/calf (as fed; 50:50 ground corn and cottonseed meal mix) and their respective treatment in 6-m^2 cow-exclusion areas. Treatments were randomly assigned to pastures (4 pastures per treatment; 2 pastures per forage type) and consisted of daily fortification of cow and calf supplements with (**CNG**) or without (**CON**) a proprietary blend of encapsulated cinnamaldehyde and garlic oil (300 mg; Cargill, Minnetonka, MN). Cows and calves grazed their respective pasture and received their respective supplementation at 0800 h for 61 d until weaning (d 0).

Immediately after weaning (d 0), heifer calves were sorted by treatment and allocated into 1 of 8 drylot pens with free-choice access to water and long-stem stargrass hay (*Cynodon nlemfuensis*), and were supplemented with a soybean hulls–based supplement (concentrate DMI = 0.5% of BW; DM basis) with or without CNG (300 mg/d) for 7 d to overcome the stress of weaning. On d 7, calves were stratified by previous treatment and pasture assignment and then randomly allocated into 1 of 8 bahiagrass pastures (1.0 ha/pasture; 4 pastures per treatment). Calves grazed their respective pasture using a fixed continuous stocking rate (3 heifers per pasture) and received daily supplementation of soybean hulls–based concentrate at 0800 h (1% of BW; DM basis) added or not with CNG (300 mg/d) for 72 d. All cow-calf pairs received daily free-choice access to a commercial vitamin–mineral mix thought the entire study (University of Florida Cattle Research Winter Mineral; Vigortone, Brookville, OH; 16.8, 1.0, 20.7, and 4.0% of Ca, Mg, NaCl, and P, respectively, and 60, 1,750, 350, 60, and 5,000 mg/kg of Co, Cu, I, Se, and Zn, respectively).

Data Collection. Cow shrunk BW and BCS were assessed on d −61 and 0, and calf shrunk BW were collected on d −61, 0, and 72, after 12 h of feed and water withdrawal. Calf BW was also collected at 0800 h on d 7 immediately before the morning concentrate supplementation. Fecal samples were collected on d −61 and 0 from all cows and calves, and on d 49 and 72 from all calves, to determine total fecal egg count (**FEC**). Individual fecal samples were collected and sealed in plastic bags, identified, and sent in an insulated container with ice to a commercial laboratory (Myers Parasitology Services, Magnolia, KY) for analysis of parasite egg count using the Modified Wisconsin Sugar Flotation Technique (Cox and Todd, 1962). The laboratory staff were blinded to treatment assignments. Individual FEC (observed total egg count + 1) were log-transformed before statistical analyses and reported as $\log_2$ FEC.

Blood samples (10 mL) were collected via jugular venipuncture into sodium-heparin-containing tubes (Vacutainer, Becton Dickinson, Franklin Lakes, NJ) for plasma harvest on d −61 (all cows and calves), and 3 to 4 h after concentrate supplementation on d −1 (all cows and calves) and 72 (calves only), to determine the plasma concentrations of glucose and urea nitrogen (**PUN**). The approach of collecting blood samples 3 to 4 h after feeding was used previously to correspond to the peak of ruminal fermentation and end-products release after concentrate consumption (Moriel et al., 2012; Artioli et al., 2015). Additional blood samples (10 mL) were collected via jugular venipuncture into sodium-heparin-containing tubes (Vacutainer, Becton Dickinson) for plasma harvest on d 0, 1, 3, and 7 to determine plasma concentrations of haptoglobin and on d 51, 58, 65, and 72 to determine the plasma concentrations of progesterone (**P4**). Heifers were considered pubertal if 2 consecutive serum P4 concentrations were ≥1.5 ng/mL (Cooke et al., 2007). Puberty attainment was declared on the first day of high serum P4 concentration.

Commercial quantitative colorimetric kits were used to determine the plasma concentrations of glucose (G7521; Pointe Scientific Inc., Canton, MI) and BUN (B7551; Pointe Scientific Inc.). Intra- and interassay CV for glucose and BUN assays were 3.5 and 6.7%, and 4.1 and 5.2%, respectively. Plasma concentrations of haptoglobin were determined in duplicate samples using a biochemical assay assessing haptoglobin–hemoglobin complex by the estimation of differences in peroxidase activity (Cooke and Arthington, 2013). Intra- and interassay CV for haptoglobin assays were 5.3 and 2.2%, respectively. Plasma P4 concentrations were determined using a solid-phase, competitive, chemiluminescent enzyme immunoassay (Immulite 1,000, Diagnostics Products Corp., Siemens, Munich, Germany) previously validated for bovine samples (Martin et al., 2007).

Total horn fly populations were assessed on individual cows and calves using video recording while animals were grazing their respective pasture from 0700 to 0900 h on d −61, −32, −2, 35, and 71. Number of horn flies per side on individual animals were counted by the same trained individual throughout the study. Horn flies were counted individually until the number of flies exceeded 25, and then flies were counted in groups of 5 (Steelman et al., 1991).

Herbage mass (**HM**) was determined at 14-d intervals from d −54 to 74, as described by Vendramini and Arthington (2008). Average herbage allowance was calculated as the average HM (kg of DM/ha) multiplied by the area of each experimental unit (ha) and divided by total BW (kg) on the experimental unit (Sollenberger et al., 2005). Hand-plucked samples of pastures were collected every 28 d from d −61 to 74. Samples of concentrate and pasture offered from d −61 to 72 were collected monthly, dried