Effects of supplementation with a bioactive phyto-compound on intake, growth performance, and health of newly received feedlot calves

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INTRODUCTION

Bovine respiratory disease (BRD) is a major cause of clinical disease and death in the feedlot industry (Blakebrough-Hall et al., 2020), with clinical symptoms observed in up to 60% of newly received calves (Snowder et al., 2006). The low dry matter intake (DMI) during the receiving period, usually below 2% of body weight (BW; Hutcheson and Cole, 1986), likely augments the negative effects of stress on immune function (Duff and Galyean, 2007), increasing the incidence of BRD.

Including feed additives in receiving diets is largely used by feedlot nutritionists in the United States to optimize ruminal fermentation and growth performance. According to Samuelson et al. (2016), on average 92.3% of feedlot nutritionists include some type of ionophore in the receiving diets, and monensin was the primary ionophore used (77.3%). However, feeding monensin can decrease DMI on average by 3% in finishing beef cattle (Duffield et al., 2012) and 8.9% in receiving calves (Duff et al., 1995), respectively, at 28.1 and 25.0 mg/kg DM. According to the NASEM (2016), ionophores can negatively affect DMI and their concentrations are often limited in receiving diets to avoid these negative effects.

Curcumin, a natural bioactive phyto-compound isolated from the plant turmeric, has shown potent anti-inflammatory and antimicrobial activities (Lelli et al., 2017). Dietary supplementation of curcumin reduced oocyst output, inflammation, and oxidative stress-related effects caused by Eimeria spp. infection in lambs (Cervantes-Valencia et al., 2016). According to Molosse et al. (2019), curcumin showed positive effects on animal health since it improved performance and enhanced antioxidants and the immune system of nursing lambs fed diets containing 100 mg/kg of curcumin. According to Cervantes-Valencia et al. (2016) and Molosse et al. (2019), feeding turmeric did not affect DMI of lambs.

Based on the aforementioned information, it was hypothesized that decreasing inflammation and oxidative stress during the receiving period through dietary supplementation with turmeric would lead to improved animal performance compared with traditional feeding practices of supplementing monensin. Also, supplementing turmeric in receiving diets would decrease the negative effects of stress on the immune function of newly received feedlot calves, thereby reducing BRD morbidity and mortality.

MATERIALS AND METHODS

This study was conducted at the Clayton Livestock Research Center, Clayton, NM. All procedures involving live animals were approved.
by the New Mexico State University, Institutional Animal Care and Use Committee (protocol number: 2020-004).

**Animals and Treatments**

A total of 331 crossbreed calves (British and British × Continental; initial shrunk BW = 201 ± 14 kg and approximately 8 mo of age: 108 steers [initial BW = 200 ± 15 kg] and 223 heifers [initial BW = 201 ± 15 kg]) were sourced from commercial auctions and transported approximately 1,300 km in commercial trailers from Delhi, LA, to the Clayton Livestock Research Center in Clayton, NM (16 h on truck), over the course of 3 wk (1 truckload/wk). Upon arrival, within each receiving week, calves were processed before access to feed or water (off-truck shrunk BW). All calves were individually weighed, given a unique ID and pen tag, dewormed, vaccinated against respiratory disease and clostridiosis, and received a growth-promoting implant. Once processed, calves were ranked by shrunk BW and assigned to 24 soil-surfaced pens in a manner that pens, within each receiving week (one truckload), had equivalent initial shrunk BW. All pens (12 × 35 m; 13 or 14 calves/pen and 6 pens/treatment) were equipped with automatic water fountains and 11 m of feed bunk space.

The experiment was a randomized complete block design with four treatments: Control (CRT); no feed additive; Monensin (MON): 22 mg/kg dry matter (DM; Rumensin 90, Elanco Animal Health, Greenfield, IN); Turmeric 100 (TUR100): 100 mg/kg DM; and Turmeric 200 (TUR200): 200 mg/kg DM (Turmeric extract 95%; Jiaherb Inc., Pine Brook, NJ). The dose of monensin was based on NASEM (2016). The doses of turmeric were based on Molosse et al. (2019).

The basal diet consisted of a complete starter feed (RAMP; Cargill Sweet Bran; Dalhart, TX) that did not contain feed additives, prebiotics, or probiotics (composition [DM basis]: 65.0% DM, 21.3% crude protein, 40.4% neutral detergent fiber, 19.2% acid detergent fiber, 3.51% lignin, and 3.80% fat). The feed additives were mixed with dry distillers’ grains with solubles, which was top-dressed into the basal diet (0.45 kg of mixture/calve daily) to deliver the designed doses of each treatment.

**Management and Sampling**

Calves were fed the basal diet once daily at 0700 h, using a feed wagon (Roto-Mix 414-14, Dodge City, KS). The amount of feed offered to each pen was adjusted based on the DMI of the previous day, and bunks were managed to contain trace amounts of feed at 0630 h. Orts were removed as needed, weighed, and sampled for DM determination and DMI calculation.

The study was 49 d in length. Individual BW was collected on days 1 and 49 (after 16 h of feed and water deprivation) of the study for average daily gain (ADG) and feed efficiency (gain to feed ratio [G:F]) calculation. Throughout the study, one trained personal conducted animal health evaluations implementing a 4-point scale method based on depression, anorexia, respiratory, and temperature “DART” as described by Wilson et al. (2015). Initial medical treatment for a sick animal was an injection of florfenicol antibiotic with flunixin meglumine (Resflor Gold, Merck Animal Health, Madison, NJ). If a second medical treatment was warranted, the calf received an injection of ceftiofur crystalline-free acid (Excede, Zoetis, Florham Park, NJ), and a calf’s third medical treatment (if warranted) was an injection of oxytetracycline (Bio-Myacin 200, Boehringer Ingelheim Vetmedica, Inc., St. Joseph, MO). After each medical treatment, the calf received an ear tag to demonstrate that it had been treated and was assigned to 5-d moratorium before it could receive a subsequent medical treatment.

**Statistical Analysis**

Quantitative data were analyzed using the MIXED procedure of SAS (version 9.4, SAS Inst. Inc., Cary, NC, USA), whereas binary data were analyzed using the GLIMMIX procedure of SAS. All data were analyzed as a randomized complete block design. Pen was the experimental unit and the Satterthwaite approximation method was used to determine the degrees of freedom for the test of fixed effects. The statistical model included the fixed effects of treatment, sex, and the resulting interactions. Pen(treatment), calf(pen), and BW block effects of treatment, sex, and the resulting interactions were considered random variables for BW and ADG analyses, but for DMI and G:F only pen(treatment) was random variable. Since no effect of sex or interactions were observed (P > 0.05), these variables were dropped off the model to simplify data interpretation. If a significant effect of treatment was detected, orthogonal contrasts were used to evaluate the effects of feed additives (CRT vs. others), type of feed additive (MON vs. turmeric), and dose of turmeric (TUR100 vs. TUR200). Results are reported as least square means. Significance was set at P ≤ 0.05 and tendencies at P > 0.05 and ≤ 0.10.
RESULTS AND DISCUSSION

Feed additives did not affect BW, ADG, DMI, and G:F of newly received feedlot calves ($P \geq 0.15$; Table 1). According to Duffield et al. (2012), supplementing monensin for finishing beef cattle at the average concentration of 28.1 mg/kg DM increased G:F by 6.4%, decreased DMI by 3%, and increased ADG by 2.5%. According to Ellis et al. (2012), the positive effects on energetic efficiency of feeding monensin are a result of a shift in short-chain fatty acids profile in the rumen, increasing propionate and decreasing acetate and butyrate production (Russel and Strobel, 1989). In addition, monensin has also a coccidiostat effect, which has shown to be beneficial in receiving diets of feeder cattle (Duff et al., 1995). According to Duff et al. (1995), receiving feedlot diets containing monensin at 20 or 30 mg/kg dietary DM tended to decrease DMI compared with the control diet during the 28-d experiment. Contrary, no benefits of feeding MON at 22 mg/kg DM were observed in the current experiment. Further research is warranted to evaluate effects of dose of monensin for lightweight newly received feedlot calves.

To our knowledge, no study has examined if supplementation with turmeric would affect DMI or growth performance of receiving feedlot calves. Although no effects of feeding turmeric on rumen fermentation and nutrient digestibility would be expected, we hypothesized that anti-inflammatory properties of turmeric could reduce the negative effects of stress during the feedlot receiving, thereby increasing growth performance.

Feed additives did not affect the number of calves that received one ($P = 0.70$) or two ($P = 0.81$) treatments for BRD; however, a tendency was observed for the number of calves that received a third medication ($P = 0.09$; Table 2). Supplementation with turmeric decreased ($P = 0.04$) the number of calves that required a third medication for BRD compared with MON (3.08% vs. 8.49% for TUR vs. MON, respectively). No other effects of treatment were observed for morbidity and mortality ($P \geq 0.14$; Table 2).

Molosse et al. (2019) observed that curcumin supplementation in the concentrate of nursing lambs improved animal health. Supplementation with 200 mg/kg curcumin for nursing lambs altered the enzymatic activity of enzymes associated with adenosine triphosphate metabolism which can be considered an attempt to improve the energy metabolism (Molosse et al., 2019). Feeding 80 mg of curcumin/animal/d decreased total leukocyte count due to the reduction of neutrophils and lymphocytes in sheep (Jaguezeski et al., 2019). Curcumin also modulated the pathogenesis of viral-induced respiratory distress syndrome, manifested through the alteration of inflammation and myofibroblast differentiation in mice (Avasarala et al., 2013). Some of these effects previously reported in the literature

### Table 1. Intake and growth performance of newly received feedlot calves fed diets containing different feed additives

| Item                   | CTR | MON | TUR100 | TUR200 | SEM  | $P$-value |
|------------------------|-----|-----|--------|--------|------|-----------|
| Initial BW, kg         | 201 | 201 | 201    | 200    | 5.35 | 1.00      |
| Final BW, kg           | 247 | 252 | 248    | 244    | 8.33 | 0.87      |
| ADG, kg†               | 0.939 | 1.02 | 1.00  | 0.916  | 0.141 | 0.67      |
| DMI, kg†               | 4.41 | 4.29 | 4.50  | 4.32   | 0.363 | 0.91      |
| G:F, kg/kg             | 0.224 | 0.250 | 0.233 | 0.217  | 0.029 | 0.15      |

†RAMP; Cargill Sweet Bran, Dalhart, TX.

### Table 2. Effects of feed additives on morbidity and mortality of newly received feedlot calves

| Item                               | CTR | MON | TUR100 | TUR200 | SEM  | $P$-value |
|------------------------------------|-----|-----|--------|--------|------|-----------|
| Cattle treated for respiratory disease, % |     |     |        |        |      |           |
| First treatment                     | 38.6 | 43.3 | 35.0  | 41.5   | 6.53 | 0.70      |
| Second treatment                    | 17.0 | 15.8 | 12.2  | 13.5   | 5.82 | 0.81      |
| Third treatment†                    | 12.6 | 8.49 | 3.67  | 2.49   | 2.30 | 0.09      |
| Number of antimicrobial treatments required | 1.44 | 1.56 | 1.45  | 1.33   | 0.139 | 0.57      |
| Mortality, %                       | 6.00 | 9.60 | 4.80  | 7.36   | 4.10 | 0.64      |

†Contrast 1 (CRT vs. others): $P = 0.14$; Contrast 2 (MON vs. Turmeric): $P = 0.04$; Contrast 3 (TUR100 vs TUR200): $P = 0.70$.
can explain the reduction in the number of calves that required a third medication for BRD observed in our study.

**IMPLICATIONS**

The feed additives evaluated herein did not affect intake and growth performance during the feedlot receiving period. Supplementation with turmeric extract for newly received lightweight calves reduced the number of re-treatments for BRD, although the specific mechanisms by which turmeric can affect immune response in beef cattle should be investigated.

Conflict of interest statement. The authors declare no conflict of interest.

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