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Effects of a Single Dose of Direct-Fed Microbials on Performance of Stocker Calves Grazing Annual Cool-Season Grasses[1]

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Abstract

Previous research has shown that beef calves have less ADG during the first 3 wk of grazing winter wheat pastures. Three experiments were conducted to determine the impact of a single oral dose of direct-fed microbials (DFM) on the overall performance of stocker calves grazing annual cool-season grass pastures. Calves received 0 g (control) or 15 g (DFM) of a gelatinous paste that contained 10 million cfu of bacteria/g of product before initiation of grazing. Within an experiment, control and DFM calves were grazed together in the same pasture. In Exp. 1, steer calves (n = 241) grazed wheat pastures in the spring for 77 d. Calves in the DFM group gained more (P=0.02) BW than did calves in the control group. Experiments 2 and 3 were conducted in the fall. Heifers (n = 53; Exp. 2) and steers (n = 61; Exp. 3) grazed pastures containing a mixture of wheat, triticale, and annual ryegrass for 73 d (Exp. 2) and 83 d (Exp. 3). A single dose of DFM did not increase BW gains during the fall and winter grazing periods. Comparison of stocker performance during the spring and fall grazing periods was confounded by breed of calf, forage source, and seasonal differences in forage chemical composition. A single dose of DFM may improve performance of stocker calves grazing cool-season grasses in the spring, but daily feeding of DFM may be needed during the fall grazing period to overcome the greater plant concentrations of digestible DM and N.

(Key Words: Wheat Pasture, Stocker Calf, Gain, Probiotics, Diet Adaptation.)

Introduction

Over 75% of the beef calves born in the U.S. will spend some time as a stocker calf (Peel, 2000). In the U.S. Southern Great Plains region, winter wheat is used as a dual-purpose crop for grazing stocker cattle and for producing grain for human consumption (Redmon et al., 1995a; Phillips et al., 1996). Nitrogen, digestible DM, and digestible energy content of small grain forages, such as wheat forage, are high and should support excellent BW gains in stocker calves (Lippke et al., 2000). Conversely, ADG during the first 21 d of grazing wheat pasture is less than anticipated based on forage chemical composition (Phillips et al., 2000). Previous research has shown that lambs do not readily consume wheat forage when it is first offered to them, resulting in less initial ADG (Gallavan et al., 1989; Phillips and VonTungeln, 1995). During the first 2 to 3 wk of wheat pasture grazing, stocker calves may experience bouts of subclinical acidosis, which reduce DMI (Lippke et al., 2000). Krehbiel et al. (2003) concluded that direct-fed microbials (DFM) have the potential to decrease ruminal acidosis and may improve animal performance. However, any improvement in ADG during the initial early part of the grazing season must be detectable in overall performance to be economically important. The objective of this experiment was to determine whether a single, oral dose of DFM prior to initiation of grazing annual cool-season grass pastures increases overall stocker performance.

Materials and Methods

The procedures used in these experiments were approved by the USDA-

[1]Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.
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ARS Grazinglands Research laboratory Animal Use and Care Committee. Annual cool-season grass pastures were established each fall approximately 70 d before grazing was initiated. Winter wheat (*Triticum aestivium* L.; Exp. 1) or a combination (Exp. 2 and 3) of winter wheat, annual ryegrass (*Lolium multiflorum* Lam.), and triticale (X. *Triticosecale*) were used for these studies. A total of 302 steers and 78 heifers were provided by cooperators for grazing at the USDA-ARS Grazinglands Research Laboratory over a 2-yr period. Just prior to initiation of grazing, a single dose (15 g) of a commercially available paste (Probios; Chr. Hanson Biosystems, Milwaukee, WI) was administrated to one-half of the calves within each pasture. The 15-g dose of DFM contained no less than 10 million cfu/g of a combination of *Enterococcus faecium*, *Lactobacillus acidophilius*, *Lactobacillus casei*, and *Lactobacillus plantaruim*. Forage availability at the beginning of the grazing season was estimated visually to be adequate to meet ad libitum intake demands of the cattle.

Experiment 1. Crossbred steer calves (n = 241) were purchased from regional cattle auctions, treated for internal parasites, and vaccinated for infectious bovine rhinotracheitis, bovine viral diarrhea, and parainfluenza-3 at the assembly point. Calves were preconditioned for 21 d at a feedlot in Kansas before being transported (525 km) to El Reno, Oklahoma. Calves were given ad libitum access to warm-season grass hay and water for 7 d after arrival. Prior to initiation of grazing on March 8, 2000, calves were individually weighed and identified with an ear tag. Calves were implanted with Ralgro (36 mg of Zeranol; Schering-Plough Animal Health Corp., Union, NJ) and received either 0 (control) or 15 g of DFM. Within treatment groups, calves were randomly assigned to one of two wheat pastures (16 and 61 ha) at a stocking rate of 2.8 calves/ha for a 77-d spring grazing period. Both control and DFM-treated calves were grazed in the same pasture. During the grazing period, calves had ad libitum access to trace mineral blocks and water. Individual unshrunk BW were collected after 1000 h. Data were analyzed as a randomized block design using animal as the experimental unit, pasture (df = 1), treatment (df = 1), and pasture × treatment interaction (df = 1) were tested with the residual mean square.

Experiment 2. Crossbred heifer calves (n = 53) were born in the spring and reared at the Texas A&M Research and Extension Center (Uvlade). All heifers were sired by Wagu bulls from Angus × Angus, Brahman × Angus, Tuli × Angus, or Senepol × Angus cows. The preweaning environment was semi-arid mixed brush rangeland consisting primarily of *Acacia*, *Prosopis*, *Setaria*, *Helaria*, and *Bouteloua* spp. Calves were vaccinated for infectious bovine rhinotracheitis, bovine viral diarrhea, and parainfluenza-3 bovine prior to weaning in the fall and were allowed 7 d to recover from weaning before being transported (800 km) to El Reno, Oklahoma. Calves arrived at El Reno on November 14, 2001. From arrival until initiation of the experiment on November 16, heifers had ad libitum access to warm-season grass hay and water. Calves were blocked by dam breed (n = 4) and assigned randomly to either control or DFM treatments as previously described. Within each treatment group, calves were randomly assigned to one of two pastures (24 and 26 ha) containing a mixture of wheat, triticale, and annual ryegrass. Pastures were grazed at a stocking rate of 4.2 calves/ha for 73 d. Unshrunk BW were collected on d 0, 34, and 73 of the experiment. Data were analyzed using animal as the experimental unit with the following model: pasture (df = 1), breed of dam (df = 3), pasture × breed of dam (df = 3; Error A), treatment (df = 1), treatment × breed of dam (df = 3), treatment × pasture (df = 1), treatment × breed of dam × pasture (df = 3), and residual (df = 41; Error B). Pasture, breed of dam, and pasture × breed of dam were tested with Error A. All other components were tested with Error B.

Experiment 3. Crossbred steer calves (n = 61) used in this experiment were born from January to February (early), March to April (middle), or May to June (late) at the USDA-ARS Fort Keogh Livestock and Range Research Laboratory (Miles City, MT). Sires; dams were a combination of ½ Red Angus, ¼ Charolais, and ¼ Tarentaise. All calves were weaned in October and shipped to El Reno, Oklahoma (1700 km), arriving on October 30, 2001. Eight days after arrival, calves were blocked by calving season (n = 3) and randomly assigned within each block to control or DFM treatments. All calves grazed a single pasture, which was a combination of wheat, annual ryegrass, and triticale at a stocking rate of 1.5 calves/ha. Unshrunk BW were recorded on d 0, 48, and 83 of the grazing period. Animal was used as the experimental unit. Data were analyzed using the following model; calving season (df = 2), treatment (df = 1), calving season × treatment (df = 2), and residual (df = 53), which was used as the error term.

Results and Discussion

In Exp. 1, overall ADG was used to determine the impact of a single dose of DFM on stocker performance. Any improvement in performance during the first 3 wk of grazing would have to be evident at the end of the grazing period to be practical. The ADG observed in Exp. 1 was similar to previously reported ADG of 0.86 to 1.05 kg (Phillips, 1986; Phillips et al., 1995a; Phillips and Albers, 1999) for steers grazing these same wheat fields. Hersom et al. (2004) and Choat et al. (2003) also reported similar gains for steers grazing wheat pastures in the spring. Steers receiving 15 g of DFM gained more (P=0.02) BW than did steers in the control group (Table 1). In previous experiments, we observed increases in both ADG and DMI when DFM were fed

TABLE. 1 Performance of steer calves treated with a single dose of direct-fed microbials (DFM) prior to grazing wheat pasture in the spring (Exp. 1).

Item	Control	DFM[a]	SE	*P*
Calves, no.	126	114		
Initial BW, kg	292	289	4.4	0.94
Gain, kg	74.3	81.6	0.4	0.02
ADG, kg	0.97	1.07	0.003	0.02

[a]A single 15-g dose of a commercially available paste containing ≥10 million cfu/g of a combination of *Enterococcus faecium, Lactobacillus acidophilius, Lactibacillus casei,* and *Lactobacillus Plantaruim* bacteria.

each day (Phillips and VonTungeln, 1985, 1991). In both of our previous experiments, DFM were fed at a greater rate and also on a daily basis. In Exp. 1, we used a single dose of DFM to determine whether the digestive system can be buffered against the initial surge of highly digestible DM that can reduce rumen stability on the first day of grazing. However, a single dose cannot provide long-term protection against acidosis.

It is also possible that low DMI is not due to acidosis, but rather a depression in appetite caused by a sudden change in diet. If calves are hesitant to consume wheat forage because it is a novel feed, a single dose of DFM may provide a positive nutrient feedback at the same time calves are grazing wheat forage for the first time. If this initial experience is positive, then calves might progress more quickly to include wheat forage in their diet. Daily feeding of DFM has been shown to decrease the stress of diet transition in beef calves and result in increased DMI and greater ADG (Phillips and Von Tungeln, 1985; Krehbiel et al., 2003). We hypothesize that DFM could modulate any negative feedback the calves might experience on d 1 of grazing small grain pastures in the spring or could stimulate appetite and override any hesitation to consume a novel feed.

When calves are first introduced to winter wheat pastures, BW gains are less than anticipated based on the chemical composition of the wheat forage and the observed ADG for the complete grazing season (Appeddu et al., 2003; Phillips et al., 2000). Lambs do not readily consume freshly harvested wheat forage, but will gradually replace more familiar feeds with wheat forage over a 21-d adaptation period (Gallavan et al. 1989; Phillips and VonTungeln, 1995). Wheat forage contains high concentrations of N, soluble N, and digestible DM (Phillips, 1986; Phillips et al., 1995b). Any of these plant constituents could generate metabolic by-products that would depress DMI. Tolley et al. (1988) reported lesser growth rate in beef calves for 2 wk following a shift in diet, regardless of the difference in energy densities of the two diets. Those researchers concluded that when a diet shift occurs, digestive kinetics change, and a 2-wk period is needed before steady state is achieved. Feeding DFM may facilitate the transition to the new diet by making the initial exposure a positive experience.

Overall performance of the heifer calves on fall wheat pasture in Exp. 2 was less than observed for steer calves on spring wheat pasture in Exp. 1 (Table 2). Heifers are expected to have less ADG than steers, and fall wheat pasture usually produces less ADG than spring wheat pasture (Phillips et

TABLE 2. Performance of heifers sired by Wagu bulls by crossbreed cows and treated with direct-fed microbials (DFM) before grazing cool-season grass pastures in the fall (Exp. 2).

			Period		
Item[a]	N	Initial BW, kg	0 to 34 d	34 to 73 d	0 to 73 d
			BW gain per calf (kg)		
Breed type[a]					
A × A	11	216	23.3	39.5	62.8
B × A	18	252	17.4	29.9	47.4
S × A	7	247	17.8	30.1	48.0
T × A	17	228	20.7	35.4	56.0
SE		8.8	3.1	3.5	4.9
P		0.17	0.11	0.21	0.16
Treatment					
Control	26	245	21.7	34.5	56.2
DFM[b]	27	227	17.9	32.9	50.8
SE		6.9	2.0	2.8	3.9
P		0.08	0.26	0.53	0.19
Overall	53	236	19.7	33.7	53.4

[a]Cow breed type is listed as sire × dam. A = Angus, B = Brahman, S = Senepol, and T = Tuli. All calves were sired by Wagu bulls.

[b]A single 15-g dose of a commercially available paste containing ≥10 million cfu/g of a combination of *Enterococcus faecium, Lactobacillus acidophilius, Lactibacillus casei,* and *Lactobacillus Plantaruim* bacteria.

TABLE 3. Performance of calves born in an early (January and February), middle (March and April), or late (May and June) calving season and treated with direct-fed microbials (DFM) prior to grazing cool-season pastures in the fall (Exp. 3).

Item	N	Initial BW, kg	Period: 0 to 48 d	Period: 48 to 83 d	Period: 0 to 83 d
Calving season			BW gain per calf (kg)		
Early	13	282	29.2	60.5	89.7
Middle	19	242	30.1	51.8	81.9
Late	19	190	24.2	49.7	73.8
SE		4.4	3.1	4.6	2.7
P		0.005	0.31	0.29	0.06
Treatment					
Control	25	232	27.1	52.8	79.8
DFM[a]	26	233	28.2	53.7	81.9
SE		3.6	2.6	3.8	2.0
P		0.41	0.63	0.90	0.45

[a]A single 15-g dose of a commercially available paste containing ≥10 million cfu/g of a combination of *Enterococcus faecium, Lactobacillus acidophilius, Lactibacillus casei,* and *Lactobacillus Plantaruim* bacteria.

al., 1991, 2001). Treating calves with a single dose of DFM did not (P=0.19) increase BW gain (Table 2). The amount of BW gained during the last 39 d of the winter grazing period was almost twice the amount of BW gained during the first 34 d. Heifers most likely had low or even negative BW gains during the first 14 to 21 d of this period to reduce overall period gains by 41%. These observations agree with those previously described by Tolley et al. (1988).

There was a trend (P=0.11) for heifers from dams with 50% tropical breeding (Brahman × Angus, Senepol × Angus, and Tuli × Angus) to gain less BW than heifers from temperate (Angus × Angus) dams during the first 34 d of the grazing period. As compared with calves with temperate breeding, calves with tropically breeding are less tolerant of cold temperatures that are typical of winters on the Southern Great Plains (Phillips et al., 2002). If DMI was also depressed during this period, then energy balance would become negative, and animals would lose BW.

Delaying the calving season decreased (P=0.005) the initial BW observed at the beginning of the grazing season (Table 3). Older, heavier calves gained more (P=0.06) BW over the 83-d winter grazing season than lighter, younger calves. Giving calves a single dose of DFM on the first day of grazing a mixture of annual cool-season grasses did not (P=0.45) affect BW gain. As observed in Exp. 2, BW gains during the second half of the grazing season were greater than during the first half. Calves gained about one-third of season-long gains during the first 48 d or 57% of the grazing period and gained two-thirds of season-long gains during the last 35 d or 43% of the grazing period. We hypothesize that these calves experienced low or negative gains during the first 14 to 21 d of the grazing period, which resulted in lesser overall gains for the first half of the grazing season.

The amount of forage available for grazing can impact ADG (Redmon et al., 1995b; Lippke et al., 2000). As forage mass increases, ADG will increase, but increasing herbage mass >1000 kg/ha will not increase ADG (Lippke et al., 2000). Visual estimates of herbage mass based on sward height at the initiation of our experiments were likely >1000 kg/ha.

In conclusion, the mode of action of DFM on ADG and DMI of young ruminants is not clear. Therefore, situations in which a positive response to the addition of DFM in the diet is hard to predict. We have reported increases in animal performance when DFM were fed continuously or when animals were under stress (Phillips and VonTungeln, 1985, 1991). In the present experiments, we assumed that the calves were under some stress with the introduction of an unfamiliar feed, but DFM were administered only once. We did conclude that calves most likely had a period of lesser ADG following the shift to vegetative annual cool-season grass pastures and that a single dose of DFM did not consistently alleviate the low performance. Overcoming initial low DMI of annual cool-season grasses may not mitigate a period of lesser ADG. Consumption of normal amounts of vegetative annual cool-season grasses by stocker calves may dramatically increase ruminal concentrations of VFA and (or) ammonia (Phillips, 1986; Gallavan et al., 1989), which can exert a negative feedback on DMI (Muir et al., 1981; Gallavan et al., 1989). Spring wheat forage contains less soluble N and digestible DM than fall wheat forage (Mader et al., 1983). Therefore, the impact of negative metabolic feedback would be less in the spring than in the fall and might explain why we observed a positive effect of DFM treatment in the spring but not in the fall. A single dose of DFM may improve performance of stocker calves grazing cool-season grasses in the spring, but daily feeding of DFM may be needed during the fall grazing period to overcome the higher plant concentrations of digestible DM and N.

Implications

When stocker calves are first introduced to annual cool-season grass pastures they experience an adaptation period during which they gain very little weigh. Feeding of DFM has been shown to increase ADG in calves experiencing stress. The results of these experiments have shown an increase ADG of steer calves grazing wheat pasture in the spring when DFM were given in a single dose just prior to initiation of grazing. However, treating stocker steers and heifers with a single dose DFM in the fall did not increase BW gain. The lack of a consistent response to DFM might have been due to differences in plant chemical composition of spring and fall wheat forage. Annual cool-season grasses are higher in total N, soluble N, and digestible DM content in the fall than in the spring. As a result, the appetite-depressing effect of higher ruminal concentrations of ammonia and (or) VFA cannot be overcome by a single dose of DFM.

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