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USE OF SELF-LIMITING SUPPLEMENTAL ENERGY AND PROTEIN FOR BRAHMAN AND SIMMENTAL CROSSBRED CALVES GRAZING RYE-RYEGRASS

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SUMMARY

Grazing trials were conducted in 1986 and 1987 to determine the influence of protein and energy supplementation on performance of two breed types of weaned calves while grazing rye-ryegrass pasture. In both trials, Simmental crossbred (Bos taurus) and purebred Brahman (Bos indicus) calves responded in live weight gain to supplemental energy. Live weight gain was positively related to level of supplemental energy intake. Supplemental energy was converted to extra gain at a ratio of less than 2:1. Therefore, it is thought that the supplemental energy was enhancing microbial protein synthesis and delivering more amino acids to the small intestines for tissue growth.

INTRODUCTION

Protein of ryegrass has been reported to be extensively degraded (80-90%) in the rumen (Beever, 1984). Ruminants grazing ryegrass pastures are therefore largely dependent on microbial protein to meet their protein requirement. Since microbial protein has been reported to be relatively constant in amino acid composition (Meyer et al., 1967) and deficient in the indispensible amino acids lysine and/or methionine, young growing ruminants grazing winter annual pastures such as ryegrass may be protein deficient for maximum live weight gain even though this type of forage may contain 20% or more crude protein (CP). Storm and Orskov (1984) showed that an increased quantity of microbial protein reaching the small intestines can overcome an amino acid imbalance due to lysine or methionine. Alternatively, supplemental energy may enhance microbial protein synthesis. The objective of this trial was to compare the influence of supplemental protein and energy on performance of calves grazing winter annual pastures of rye-ryegrass.

PROCEDURES

Trial I

On February 13, 1986, thirty fall-weaned, spring-born Simmental crossbred (1/2 Simmental X 1/4 Hereford X 1/4 Brahman) steers (n=15) and heifers (n=15) were weighed (670 lb), implanted with Ralgro, and given a visual condition score (VCS). A VCS of 1 denoted an animal which was extremely thin, while a VCS of 10 denoted an animal which was extremely fat. Calves were allotted by weight and VCS to the following three treatments: (1) 'Elbon' rye (Secale cereal L) - 'Marshall' ryegrass (Lolium multiflorum (L.) Lam.) pasture with free-choice minerals (PAS); (2) PAS plus a pelleted protein supplement containing specially selected low-solubility Menhaden fishmeal plus 90 mg/lb monensin (FMR); and (3) PAS plus a pelleted energy supplement containing corn plus 90 mg/lb monensin (CRN). The CP, net energy for maintenance (NEm), and net energy for gain (NEg) content of the FMR and CRN supplements are presented in Table 1. Each treatment was replicated with 5 steers (Rep 1) and 5 heifers (Rep 2). Calves were initially allotted to pastures at a stocking rate of 1.67 hd/acre for a 14-day period to allow the animals to adjust to the forage and supplements, and to reduce the influence of rumen fill on live weight gain. Average daily gain (ADG) was determined by weighing calves directly off pasture at the initiation, every 28 days throughout the trial, and at the termination of the grazing trial. Calves were given a final VCS at the termination of the study. The average daily supplement consumption (ADC) for calves in each pasture was estimated by weighing supplement offered weekly, discarding the orts, and replacing with fresh supplement.

Pastures were fertilized with N-P_2O_5-K_2O at the rate of 60-60-60 lbs/ac in November and 50 lb/ac of nitrogen (N) at 4 to 6 week intervals thereafter (total fertilizer = 210-60-60). Forage-on-offer was monitored by pasture samples taken at 14-day intervals by hand-clipping four, 1 ft square areas to ground level. Each sample was intended to represent 1/4 of the pasture. Forage was also visually maintained as equal as possible across treatments by the put-and-take method throughout the grazing period. The primary objective was to maintain an adequate level of forage to allow animals to graze selectively for ad libitum intake, but to have sufficient grazing pressure to prevent forage maturation. Grazer or forage regulator animals were added to pastures throughout the trial as needed to regulate the level of forage-on-offer.

Forage samples for chemical analysis were taken biweekly by hand-picking portions of the sward which visually represented the diet selected by the grazing animals. The criteria used in approximating the forage selected by the animals was to observe the animals while grazing for 5 to 10 minutes and then to take forage samples in near proximity to the area where they were grazing. Samples for chemical analyses were analyzed for neutral detergent fiber (NDF) and CP.

Trial 2

On February 10, 1987, thirty spring-born (Feb.-Mar.), fall-weaned Simmental crossbred (1/2 Simmental X 1/4 Hereford X 1/4 Brahman; Bos taurus) steers (n=12) and heifers (n=18), and thirty-six spring-born (Apr.-May), fall-weaned purebred Brahman (Bos indicus) steers (n=18) and heifers (n=18) were weighed, implanted with Ralgro, and given a VCS. The average initial weights for Simmental crossbred and Brahman calves were 600 and 450 lbs, respectively. Simmental crossbred and Brahman calves were blocked by breed and allotted to the identical treatments discussed in Trial 1 (PAS, FMR, and CRN). Each breed type-supplement treatment in Trial 2 was assigned to two replicate pastures. Since there was no treatment by sex interaction in Trial 1, each replicate in Trial 2 contained both steers and heifers. Replicates of Simmental crossbred calves were composed of 3 heifers and 2 steers; whereas, replicates of Brahman calves consisted of 3 heifers and 3 steers. The ADC of supplements in each pasture was estimated as described in Trial 1. The ADG, VCS, forage, and forage quality was determined according to the procedures described in Trial 1. Data for both trials were analyzed by the General Linear Model procedure of SAS.

RESULTS

Trial 1

The ADG (lb/day) of calves receiving CRN (3.47) was higher ($P<.01$) than for calves on FMR (2.62) or PAS (2.21) (Table 2). Calves receiving FMR and CRN consumed .76 and 1.68 lb/day, respectively, which resulted in a daily monensin intake of 67.3 and 150.5 mg, respectively. This level of supplement intake supplied calves on FMR and CRN with .30 and .94 mcal/day of supplemental NEg. Incremental gain due to supplement was defined as the difference in the ADG of calves on supplemented treatment and the ADG of calves assigned to PAS. The incremental gain (IG) for FMR and CRN was .41 and 1.26 lbs/day, respectively (Table 2). The conversion ratio of supplement to extra gain (ADC:IG) for calves receiving FMR and CRN was 1.85 and 1:33:1, respectively. Calves on all treatments had similar (P>.05) VCS at the initiation of the trial, but at the termination of the trial, calves receiving CRN had a higher (P<.01) VCS than calves assigned to FMR or PAS.

Forage allowance [lb dry matter (DM)/100 lb body weight (BW)] in pastures grazed by the Simmental crossbred calves assigned to PAS, FMR, and CRN was 150, 119, and 127, respectively (Table 3). The average CP of forage samples collected from pastures grazed by calves on PAS, FMR, and CRN was 24.0, 23.4, and 24.2%, respectively, while the NDF of their respective pastures was 44.7, 44.3, and 42.9% (Table 3). The CP levels remained above 20% throughout the grazing period as applications of N were made on regular intervals. As expected, NDF levels tended to increase with season as the forage matured.

Trial 2

Performance for the individual Bos taurus and Bos indicus breed types is presented in Table 4. The ADG (lb/day) of Simmental crossbred calves receiving CRN (2.77) was higher (P<.05) than for calves receiving FMR (2.53) or PAS (2.40). The incremental gain for FMR and CRN supplemented calves was .13 and .37 lb/day, respectively. Simmental crossbred calves receiving FMR and CRN consumed .32 and 1.13 lb/day, respectively, which was converted to extra gain at a ratio of 2.46 and 3.05:1 (Table 4). The VCS of Simmental crossbred calves was similar (P>.05) among treatments at the initiation and the termination of the grazing trial. The VCS indicated, however, that calves were fatter at termination than at the beginning of the grazing period. Calves assigned to PAS, FMR, and CRN had 300, 299, and 294 lb of available forage DM/100 lb BW, respectively, which in turn contained

25.5, 24.8, and 25.3% CP and 42.2, 42.9, and 42.7% NDF (Table 5).

The ADG (lb/day) of the Zebu type calves receiving CRN (2.29) was higher (P<.01) than for Zebu type calves receiving FMR (1.88) or PAS (1.91). The incremental gain for FMR and CRN supplemented calves was -.03 and .38 lb/day, respectively. Calves receiving FMR and CRN consumed .45 and .74 lb/day of supplement, respectively. Brahman calves receiving the FMR supplement did not have a higher (P>.10) daily gain than calves on PAS. Calves receiving CRN converted the supplemental energy to IG at a ratio of 1.95:1. The VCS of Brahman calves was similar (P<.05) among treatments at the initiation and termination of the trial. Rye-ryegrass pastures grazed by calves on PAS, FMR, and CRN had 356, 316, and 333 lb of available forage DM/100 lb BW. The selected forage samples respectively contained 26.5, 25.0, and 26.5% CP, and 39.0, 38.2, and 37.2% NDF (Table 5).

The combined ADG of both types of calves was 2.16, 2.21, and 2.53 lb/day for the PAS, FMR, and CRN treatments, respectively (Table 4). The ADG for calves receiving CRN in Trial 2 was higher (P<.003) than the ADG of calves assigned to FMR or PAS. The ADC of FMR and CRN was .38 and .93 lb/day, which was converted to extra gain at a feed conversion of 7.6 and 2.51:1, respectively. The VCS was similar (P>.05) among treatments at the initiation and termination of the trial.

<u>Trial 1 + Trial 2</u>

When data from all calves on both trials were combined, the ADG of calves receiving CRN (2.85) was higher (P<.001) than calves receiving FMR (2.35) or PAS (2.22) (Table 6). The incremental gain of FMR and CRN supplemented calves was .13 and .63 lb/day, respectively. Calves on FMR and CRN consumed .50 and 1.16 lb/day, respectively, and converted their respective supplements at a ratio of 3.85:1 and 1.84:1. The VCS calves assigned to FMR was lower (P<.01) than calves on the other treatments at initiation, while the VCS of CRN supplemented calves was higher (P<.001) at the termination of the combined trial.

DISCUSSION

In each year of the two year trial, calves responded positively to energy supplementation (CRN) which may be explained in a number of ways. First, intake of the high moisture, high protein rye-ryegrass pasture may have resulted in an energy deficit for maximum gain by growing beef calves, and the energy supplement served as a direct source of dietary energy. Secondly, calves receiving CRN consumed more supplement than those receiving FMR; thus, they consumed more monensin. Thirdly, energy from the supplemental CRN ration provided a better pattern of readily fermentable energy for rumen microbes to maintain or increase synthesis of microbial protein.

Since the level of daily supplement intake was relatively low and the level of additional gain due to supplementation was relatively high for each supplemented treatment, it is unlikely that the supplemental energy per se served as a sufficient source of dietary energy to the grazing animal's tissues to support the magnitude of additional gains in these trials. This would assume an efficiency of supplement utilization of less than 2:1 (feed:gain ratio) for the energy supplement and less than 4:1 for the protein supplement, which is extremely efficient since feedlot cattle often convert a high energy diet at ratios of more than 7:1.

A portion of the increased gain was probably due to the level of daily monensin intake and this is supported by the fact that there was a near linear relationship between ADC and ADG ($r>.98$) among all treatments in the study. The daily monensin intake probably accounted for a portion of the gain; however, it is unlikely that it accounted for all of the increased gain of supplemented calves. This is supported by previous work with similar cattle by Rouquette et al. (1980), who reported a .2 to .4 lb increase in daily live weight gain due to monensin supplementation in two separate grazing trials with a daily monensin intake of 200 mg.

An increased synthesis of microbial protein is thought to be the most likely explanation of increased animal performance from supplementation. Since the level of energy supplement consumed was relatively low (approximately .2% of BW) and the rye-ryegrass forage contained about 25% CP, which was subject to extensive degradation in the rumen (Beever, 1984), the rumen microbial population may have utilized the supplemental energy to synthesize microbial protein from ammonia nitrogen. The starch content of the supplemental corn ration was probably fermented less rapidly than sugars contained in the forage. Therefore, the supplemental energy had a more sustained release of energy to coincide with ammonia released from degraded forage protein. By increasing the rumen microbial population, more microbial protein may escape the reticulo-rumen and pass to the small intestines to serve as a source of protein.

The ADG of calves receiving FMR tended to be higher ($P<.06$) than for calves on PAS. The FMR supplement is considered a protein supplement; however it releases energy when digested. If the supplements fed in this trial are compared as to their supply of NEg, the positive relationship of ADC of NEg with ADG had a correlation coefficient of $r>.99$. The FMR and CRN supplemented calves consumed .30 and .94 mcal/day, respectively, of supplemental NEg; whereas, they consumed .44 and 1.42 mcal/day of NEm. The tendency for the FMR supplement to increase ($P<.06$) daily gain may have been due to increasing the amount of dietary amino acids bypassing rumen degradation, or the energy released by the FMR supplement may have been released more slowly than the energy released by the CRN supplement. Therefore the response to FMR may have been due to a slow release of energy or more dietary amino acids reaching the small intestines.

CONCLUSIONS

Performance of Bos taurus and Bos indicus type calves grazing high quality rye-ryegrass pastures was acceptable and was further increased by energy supplementation. Whether or not calves grazing rye-ryegrass pastures should be supplemented with protein or energy ultimately becomes a matter of economic concern. The economics of feeding supplement on pasture depends primarily on the price of the supplement, the cost of the additional gain, and the cost of labor to feed the supplement. Since all supplements used in this trial were self limiting, the labor cost of supplementation was minimized. Comments will pertain only to the incremental gain due to supplementation; therefore, the principal factors to consider are the value of additional live weight gain and the price of the supplement. The feed conversions for incremental gain reported for calves receiving the FMR and CRN supplements were 1.89 and 1.33, respectively. Table 7 shows the breakeven price of supplement for $.10/lb increments in feeder calf price. Breakeven price, as it is used here, refers to the price which may be paid for a supplement within a calf price category with no profit or loss due to cost of supplementation. The calculated breakeven price assumes the ADC:IG ratios reported in these trials. Bulk quantities of FMR and CRN supplements would cost approximately $16.00 and $6.00/cwt, respectively. Using the feed conversions and incremental gains of Trials 1 and 2, the cost of supplemented gain was $.616 and $.11 per pound, respectively for FMR and CRN. Since the supplements were self-limiting, and the feed conversions were efficient, it would most likely be feasible to supplement beef calves grazing rye-ryegrass pasture with small quantities of supplemental energy (CRN) which contains an ionophore. The economy of gain from CRN appears to be favorable under most conceivable pricing situations; whereas, the use of supplemental FMR may only be feasible when cattle prices exceed $62.50 to $65.00 per cwt.

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TABLE 1. COMPOSITION OF SUPPLEMENTS FED TO CALVES GRAZING RYE-RYEGRASS PASTURES IN TRIALS 1 AND 2

	SUPPLEMENTS	
	FMR	CRN
INGREDIENT	------% of Dry Matter-----	
Rolled corn	-	70.00
Fishmeal (Menhaden)	48.50	-
Cottonseed hulls	27.00	-
Wheat mill run	11.34	-
Animal fat	-	.98
Cane molasses	2.88	2.88
Salt	2.94	2.94
Minerals	1.24	10.21
Rumensin 60[†]	.15	.15
Formulated crude protein (%)	37.2	8.3
Formulated NEm[‡] (mcal/lb)	.59	.45
Formulated NEg[§] (mcal/lb)	.36	.56

[†] Fishmeal (FMR) and corn (CRN) with 90 mg/lb monensin.

[‡] NEm - Net energy for maintenance.

[§] NEg - Net energy for gain.

TABLE 2. PERFORMANCE OF SIMMENTAL CROSSBRED CALVES GRAZING RYE-RYEGRASS PASTURES AND RECEIVING SUPPLEMENTAL FEED IN TRIAL 1

ITEM	TREATMENT† PAS	FMR	CRN
Average Daily Gain, lb/day	2.21[b]	2.62[b]	3.47[a**]
Average Daily Consumption (ADC), lb/day	0	.76	1.68
Incremental Gain (IG), lb/day	0	.41	1.26
ADC:IG (lb:lb)	0	1.85	1.33
Visual Condition Score‡			
Initial	6.10	5.85	6.00
Final	6.80[b]	7.00[b]	7.85[a]

**Means within the same row and followed by the same letter did not differ (P<.01; Student-Newman-Keuls' Test).

†PAS = rye-ryegrass pasture with free-choice minerals.
FMR = PAS plus fishmeal and monensin.
CRN = PAS plus corn and monensin.

‡Ranges from 1-10, with 1 being a very thin animal and 10 being a very fat animal.

TABLE 3. FORAGE ALLOWANCE [LB DRY MATTER(DM)/100 LB BODY WEIGHT (BW)] AND NUTRITIVE VALUE OF RYE-RYEGRASS PASTURES IN TRIAL 1

	Forage Allowance			Crude Protein			Neutral Detergent Fiber		
DATE	PAS†	FMR‡	CRN§	PAS	FMR	CRN	PAS	FMR	CRN
1986	lb DM/100 lb BW			--------%---------			-------%--------		
Feb. 25	154	146	146	24.0	27.0	22.9	42.2	33.1	39.9
March 5	155	139	136	20.2	19.3	21.8	39.4	40.3	39.9
March 20	102	82	135	18.7	19.6	21.6	45.8	45.1	43.4
April 2	195	135	177	30.8	27.6	29.8	41.4	43.5	42.4
April 17	147	97	103	27.0	26.1	26.9	34.9	40.4	42.6
May 2	68	77	229	24.1	21.1	20.1	51.8	45.1	44.0
May 16	146	75	107	24.2	23.0	26.3	49.8	52.6	42.6
May 28	189	104	116	22.9	23.4	24.5	52.0	53.7	48.5
Average	150	119	127	24.0	23.4	24.2	44.7	44.3	42.9

†PAS = rye-ryegrass pasture with free-choice minerals.

‡FMR = PAS plus fishmeal and monensin.

§CRN = PAS plus corn and monensin.

TABLE 4. PERFORMANCE OF SIMMENTAL CROSSBRED AND BRAHMAN CALVES GRAZING RYE-RYEGRASS AND RECEIVING SUPPLEMENTAL FEED IN TRIAL 2

ITEM	TREATMENT†		
Simmental X (n=30)	PAS	FMR	CRN
Average Daily Gain, lb/day	2.40[b]	2.53[b]	2.77[a*]
Average Daily Consumption (ADC), lb/day	0	.32	1.13
Incremental Gain (IG), lb/day	0	.13	.37
ADC:IG (lb:lb)	0	2.46	3.05
Visual Condition Score‡			
Initial	5.21	4.79	5.00
Final	6.50	6.71	6.67
Brahman (n=36)			
Average Daily Gain, lb/day	1.91[b]	1.88[b]	2.29[a**]
Average Daily Consumption (ADC), lb/day	0	.45	.74
Incremental Gain (IG), lb/day	0	-.03	0
ADC:IG (lb:lb)	0	--	1.95
Visual Condition Score			
Initial	4.50	4.50	4.50
Final	6.12	6.08	6.42
Simmental X + Brahman (n=66)			
Average Daily Gain, lb/day	2.16[b]	2.21[bc]	2.53[a**]
Average Daily Consumption (ADC), lb/day	0	.38	.93
Incremental Gain (IG), lb/day	0	.05	.37
ADC:IG, lb:lb	0	7.60	2.51
Visual Condition Score			
Initial	4.85	4.65	4.75
Final	6.31	6.40	6.54

*Means within the same row and followed by the same letter did not differ (P<.05; Student-Newman-Keuls' Test).

**Means within the same row and followed by the same letter did not differ (P<.01; Student-Newman-Keuls' Test).

†PAS = rye-ryegrass pasture with free-choice minerals.
FMR = PAS plus fishmeal and monensin.
CRN = PAS plus corn and monensin.

‡Ranges from 1-10, with 1 being a very thin animal and 10 being a very fat animal.

TABLE 5. FORAGE ALLOWANCE [LB DRY MATTER(DM)/100 LB BODY WEIGHT (BW)] AND NUTRITIVE VALUE OF RYE-RYEGRASS PASTURES GRAZED BY SIMMENTAL CROSSBRED AND BRAHMAN CALVES IN TRIAL 2

	Forage Allowance			Crude Protein			NDF		
DATE	PAS[†]	FMR[‡]	CRN[§]	PAS	FMR	CRN	PAS	FMR	CRN
1987	lb DM/100 lb BW			---------%---------			-------%--------		
				Simmental Crossbred Calves' Pasture					
Feb. 10	275	300	280	30.1	30.1	30.1	27.8	27.8	27.8
March 11	355	372	346	27.6	27.6	27.6	35.6	35.6	35.6
April 2	295	240	298	25.8	23.4	27.2	39.2	42.4	38.9
May 1	272	263	275	22.5	21.0	21.1	49.4	46.4	50.7
June 2	276	321	255	21.5	21.9	20.7	59.2	62.6	60.8
Average	295	299	291	25.5	24.8	25.3	42.2	42.9	42.7
				Brahman Calves' Pasture					
Feb. 10	537	529	521	32.1	28.7	29.5	26.3	28.8	28.2
March 11	259	223	268	26.9	26.5	29.5	35.6	35.3	35.7
April 8	334	227	251	25.7	25.8	26.6	42.9	35.9	32.3
May 6	272	305	314	28.3	27.8	29.0	40.6	39.3	38.7
June 3	378	298	310	19.3	17.8	17.8	49.7	51.8	50.9
Average	356	318	333	26.5	25.0	26.5	39.0	38.2	37.2

[†] PAS = rye-ryegrass pasture with free-choice minerals.

[‡] FMR = PAS plus fishmeal and monensin.

[§] CRN = PAS plus corn and monensin.

TABLE 6. PERFORMANCE OF TWO BREED TYPES OF CALVES COMBINED DURING THE TWO-YEAR STUDY

ITEM	TREATMENT[†]		
Trial 1 + Trial 2	PAS	FMR	CRN
Simmental X + Brahman (n=96)			
Average Daily Gain, lb/day	2.22[b]	2.35[b]	2.85[a**]
Average Daily Consumption (ADC), lb/day	0	.50	1.16
Incremental Gain (IG), lb/day	0	.13	.63
ADC:IG, lb:lb	0	3.85	1.84
Visual Condition Score			
Initial	5.27[a]	5.05[b]	5.17[a]
Final	6.47[b]	6.60[b]	6.98[a]

**Means within the same row and followed by the same letter did not differ ($P<.01$; Student-Newman-Keuls' Test).

†PAS = rye-ryegrass pasture with free-choice minerals.
FMR = PAS plus fishmeal and monensin.
CRN = PAS plus corn and monensin.

‡Ranges from 1-10, with 1 being a very thin animal and 10 being a very fat animal.

TABLE 7. BREAKEVEN PRICE ($/TON) OF SUPPLEMENT

FEEDER CALF PRICE ($/lb)	SUPPLEMENT[†] FMR	CRN
	-----------$/ton-----------	
.40	208	435
.50	260	543
.60	312	652
.70	364	761
.80	416	870
.90	468	978

†FMR = PAS plus fishmeal and monensin.
CRN = PAS plus corn and monensin.