RUMINAL ESCAPE PROTEIN SUPPLEMENTATION AND ZERANOL IMPLANTATION EFFECTS ON PERFORMANCE OF STEERS GRAZING WINTER ANNUALS[1,2]

M. A. McCann[3], R. S. Donaldson[3], H. E. Amos[3] and C. S. Hoveland[4]

The University of Georgia, Athens 30602

ABSTRACT

Fifty-four crossbred steers (275 kg) were assigned randomly to one of three isoenergetic but not isonitrogenous ruminal escape protein (EP) supplements: high ruminal escape protein (HEP), low ruminal escape protein (LEP), or corn. The supplements contained corn, distillers' dried grains with solubles (DDGS), and fish meal. Supplements were fed at approximately 1.5 kg/d; the HEP and LEP supplements provided .25 and .12 kg more EP per day than corn, respectively. These supplements also supplied .20 and .10 kg more CP per day than corn. Fish meal and DDGS provided 66.7 and 33.3% of the supplemental EP, respectively. One-half of the steers in each supplement treatment were implanted once with 36 mg of zeranol. Steers grazed wheat (*Triticum aestivum* L.)-annual ryegrass (*Lolium multiflorum* Lam.) pastures for 73 d (March 1 to May 12). Daily gains (kg/d) increased linearly ($P < .07$) as EP increased (HEP, 1.61; LEP, 1.54; corn, 1.47); responses were apparent only during the later periods as forage quality declined. Zeranol implants increased ($P < .02$) ADG (kg/d) by 9.7% (1.58 vs 1.44). After grazing, all cattle were fed a finishing ration for 76 d. Pre-feedlot EP level produced a negative linear ($P < .04$) response on feedlot ADG (kg/d) (HEP, 1.44; LEP, 1.50; corn, 1.59). Zeranol implantation during the grazing phase did not affect ($P > .2$) performance during the feedlot phase or carcass characteristics other than increased ribeye area ($P < .08$). Compensatory feedlot performance negated all weight gain advantages elicited by EP supplementation during the grazing period. However, the additional 10 kg of gain of zeranol-implanted steers during grazing was maintained during the feedlot phase despite no further implants. Carcass characteristics did not differ ($P > .2$) between EP treatments. No interactions ($P > .2$) between EP and zeranol were noted in either the grazing or feedlot phase.

Key Words: Protein Supplements, Steers, Wheat, Ryegrass

J. Anim. Sci. 1991. 69:3112–3117

Introduction

Winter animal pastures are used widely to produce economical gains in stocker cattle. Traditionally, these forages are presumed to need no supplementation to produce maximum daily gains growing cattle. The CP content of winter annuals can be as high as 33% (Beever, 1984). However, a large portion of the digestible N is soluble and is converted quickly to ammonia in the rumen (Vogel et al., 1987). Ruminal ammonia levels in sheep grazing perennial ryegrass (*Lolium perenne* L.) can be as high as 20 mg/dl (Losada et al., 1982) Ulyatt et al. (1975) demonstrated that only 47% of the digestible N was recovered as nonammonia N in the small intestine of sheep grazing perennial ryegrass; the other 53% presumably was absorbed from the rumen as ammonia.

[1]This study conducted at the Central Georgia Branch Exp. Sta., Eatonton.

[2]Appreciation is expressed to V. H. Calvert for technical assistance and to K. R. Harwell for animal care and data collection.

[3]Anim. and Dairy Sci. Dept.
[4]Agron. Dept.

Received May 31, 1990.
Accepted March 11, 1991.

Supplementation of ruminants grazing high quality forages with ruminal escape protein (EP) has been shown to enhance performance. Daily gains of growing beef cattle grazing high-quality forage have been increased by supplementing the cattle with blood meal and corn gluten meal rather than corn and molasses (Craig, 1983). In addition, cottonseed meal and meat meal supplementation has increased ADG of heifers grazing wheat pastures (Horn et al., 1987).

Likewise, zeranol implantation can increase weight gain in forage-fed growing cattle by 5 to 15% (Mader et al., 1985; Thonney, 1987; Williams et al., 1987). In addition, Sharp and Dyer (1971) demonstrated that zeranol increased carcass protein content. Thus, zeranol implantation may increase the protein requirement of cattle.

The objectives of this study were to determine the influence of EP and (or) zeranol implantation on grazing steer performance and the effects of EP supplementation on subsequent feedlot performance.

Materials and Methods

Forage

Nine 2-ha paddocks were seeded with 136 kg of Stacey wheat (*Triticum aestivum* L.) plus 17 kg of Marshall annual ryegrass (*Lolium multiflorum* Lam.) per hectare on September 10, 1987. Paddocks were fertilized with 200 kg/ha of 10-20-30 fertilizer in August 1987, 60 kg of N/ha in October 1987, and 60 kg of N/ha in February 1988. Forage availability was not allowed to drop below 6 kg of DM/100 kg of BW in order to ensure maximum performance (Mott, 1984). Ten .3-m^2 random forage samples per 2-ha paddock were clipped at a stubble height of 2.5 cm on d 1, 28, 58, and 73 of the grazing trial to monitor forage quality and availability. Harvested samples were dried in a forced-air oven at 65°C, ground through a 1-mm screen, and stored for future chemical analyses. In order to monitor forage quality over the grazing season, forage samples were analyzed for CP (AOAC, 1980), IVDMD (Tilley and Terry, 1963), NDF, and ADF (Robertson and Van Soest, 1981).

Steers

Fifty-four Hereford × Brangus steers (12 to 14 mo of age; 275 kg) were blocked into nine groups based on body weight and allotted randomly to one of three isoenergetic supplement treatments; HEP, LEP, or corn (Table 1). Ruminal escape protein was provided by a mixture of distiller's dried grains with solubles (DDGS) and menhaden fish meal (FM); FM provided 66.7% and DDGS provided 33.3% of the supplemental EP based on escape estimates by Satter (1986). No isonitrogenous supplements were used and CP content of the supplements increased with increases in EP. Steers were group-fed their respective supplements daily. One-half of the steers in each supplement treatment were implanted with 36 mg of zeranol. Steers also were assigned to one of three stocking densities (i.e., five, six, or seven steers per paddock, which was determined by forage availability at the initiation of grazing). These different stocking densities were used to provide similar forage availability per steer across stocking densities.

TABLE 1. SUPPLEMENTS FED TO STEERS GRAZING WHEAT-RYEGRASS PASTURE

	Protein treatments[a]		
Item	HEP	LEP	Corn
Ingredient[b]			
Cracked corn	60.0	79.5	100
Distiller's gains with solubles dried	23.5	12.0	—
Menhaden fish meal	16.5	8.5	—
Daily supply/steer			
Total feed, kg	1.52	1.50	1.48
CP, kg	.34	.24	.14
Escape protein, kg[c]	.25	.12	0

[a]HEP = high ruminal escape protein, LEP = low ruminal escape protein.

[b]Percentage of supplement, as-fed basis.

[c]In addition to EP provided by corn.

TABLE 2. DIET FED TO STEERS DURING THE FINISHING PHASE

Ingredients[a]	%
Ground corn	72.3
Cottonseed hulls	10.1
Soybean hulls	10.1
Cottonseed meal	6.2
Limestone	.5
Trace mineral salt[b]	.5
Vitamin A, D, and E[c]	.1
Sodium bicarbonate	.2

[a]Percentage of diet, as-fed basis.

[b]95% NaCl, .30% Mn, .25% Zn, .15% Fe, .015 Cu, .009% I, and .005% Co.

[c]Provided 4,400 IU vitamin A, 440 IU vitamin D, and 44 IU vitamin E/kg of diet.

On March 1 and 2, steers were weighed full and an average of the two weights was used for the initial weight of the 73-d grazing period. Steers were weighed full on grazing d 28, 58, 72, and 73 in order to monitor performance. Steers were removed from the grazing paddocks on May 12. The average of the 72- and 73-d nonshrunk weights was used for both the final grazing weight and for the initial feedlot weight.

Immediately following the grazing period, steers were combined into two groups with steers from each treatment combination represented equally and fed a finishing diet (Table 2) for a 2-wk adjustment period. At the beginning of the adjustment period, steers had ad libitum access to sericea (*Lespedeza cuneata* [Dumont] G. Don) hay and were fed 3 kg/steer daily of their finishing diet. During this 2-wk period, .5 kg more hay was replaced with .5 kg of feed each day until cattle were on full feed. After the adjustment period, the cattle had ad libitum access to feed for 62 d. Implanted cattle were not reimplanted. Weights were monitored on feedlot d 14, 35, 56, 75, and 76; the average of d 75 and 76 served as final feedlot weight. At the end of the feeding period, cattle were transported to a local slaughter facility; they were slaughtered and carcass measurements were recorded. Gains were calculated for the adaptation plus feedlot period (76 d) and the animal, not the pen, was used as the experimental unit.

Statistics

A split-plot analysis was used to determine statistical differences. Between-pasture variables included stocking density and EP treatment; pasture was used as the experimental unit. The within-pasture variable, zeranol implant, used animal as the experimental unit. After a preliminary analysis indicated that stocking density and all stocking density interactions were not significant ($P > .20$), they were excluded from the final statistical model. Dependent variables were analyzed using the GLM least squares mean procedure (SAS, 1985). Orthogonal contrasts were used to determine the linear and quadratic effect of additional EP supplemented assuming that EP supply was as listed in Table 1.

Results and Discussion

Implant and EP treatment means for steer performance for the grazing period are presented in Table 3. Steer ADG increased linearly ($P < .07$) as EP increased. This is in contrast to the quadratic response observed by Anderson et al. (1988) with EP supplementation of steers grazing smooth bromegrass (*Bromus inermus* Leyss.) pastures. Gibb and

TABLE 3. EFFECTS OF RUMINAL ESCAPE PROTEIN AND ZERANOL ON THE PERFORMANCE OF STEERS GRAZING WHEAT-RYEGRASS PASTURES (73 DAYS)

	Protein supplement[a]				Zeranol implant		
Item	HEP	LEP	Corn	SE	+	−	SE
Initial wt, kg	275	275	275	1.9	275	275	1.5
Final wt, kg	393	387	382	3.3	390	380	2.8
Weight gain, kg[bc]	118	112	107	3.3	115	105	2.8
ADG, kg/d[bc]	1.61	1.54	1.47	.05	1.58	1.44	.04

[a]HEP = high ruminal escape protein, LEP = low ruminal escape protein.

[b]Linear effect of supplement ($P < .07$).

[c]Implant main effect ($P < .02$).

TABLE 4. FORAGE AVAILABILITY AND QUALITY ON OFFER TO STEERS DURING THE GRAZING PHASE

Item	Period 3/1	3/29	4/28	5/12
NDF, %	43.3	43.4	56.4	60.5
ADF, %	17.7	21.2	29.6	31.9
ADL, %	1.7	1.8	2.4	5.6
CP, %	29.3	25.5	12.5	8.8
IVDMD, %	71.3	68.7	62.5	58.7
Forage available, DM/100 kg of BW	37	54	169	189

Baker (1987) also demonstrated that ADG was increased when steers receiving perennial ryegrass silage were supplemented with fish meal. Steers receiving low ruminal escape protein (LEP) gained .07 kg/d more than steers receiving corn, resulting in a EP supplementation to gain ratio (kg of additional EP supplemented/added kg of gain) of 1.8. The ratio of the added EP to gain remained constant comparing the high ruminal escape protein (HEP) treatment to either the corn or LEP treatments, indicating that the efficiency of utilization was similar at the higher EP supplementation rate. Steers that were implanted gained 9.7% faster ($P < .02$), 1.58 vs 1.44 kg/d, than nonimplanted steers. This corresponds to data presented by Altom et al. (1979) and Laudert et al. (1983) that indicated that gain was increased 10 to 20% by implanting steers grazing small grain pasture. There was no interaction between implant and EP ($P > .20$). The absence of an implant × EP interaction indicates that we did not detect that the implant increased steer N requirement above the amount supplied by corn and forage. This is in agreement with Van der Wal (1975), who reported that the N requirement (g/d) of steers was not altered by zeranol implants.

Forage availability was monitored during the grazing period and did not begin to increase until April (Table 4). Likewise, forage quality (CP, fiber components, and IVDMD) was monitored over the entire season and did not fluctuate until it declined linearly when forage availability began to increase. Forage CP was 29% at the initiation of the trial and declined to 8.8% at the end. Forage ADF, NDF, and lignin increased during the trial. The ADF content increased from 18.0% at the initiation to 31.9% at the end of the trial. Likewise, NDF increased from 43 to 60%. This decrease in forage quality was reflected in

TABLE 5. MAIN EFFECT TREATMENT MEANS OF FEEDLOT PERFORMANCE (76 DAYS) AND CARCASS CHARACTERISTICS OF STEERS PREVIOUSLY GRAZING WHEAT-RYEGRASS PASTURES AND IMPLANTED WITH ZERANOL

Item	Protein supplement[a] HEP	LEP	Corn	SE	Zeranol implant +	–	SE
No. of steers	18	18	18		27	27	—
Initial wt, kg[bc]	393	387	382	3.3	390	380	2.9
Final wt, kg	502	501	502	5.5	504	495	4.5
Wt gain, kg[b]	109	114	120	3.6	114	114	3.0
ADG, kg[b]	1.44	1.50	1.59	.05	1.50	1.51	.04
Hot carcass wt, kg[c]	286	287	286	3.3	288	281	2.7
12th rib fat, mm	11.3	10.3	10.8	.82	11.0	10.6	.69
Rib eye area, cm^2[c]	67.9	71.2	70.5	1.2	71.1	68.6	1.0
Yield grade	3.3	3.1	3.2	.13	3.2	3.2	.1
Quality grade[d]	15.9	16.3	16.1	.21	16.1	16.1	.17

[a]HEP = high ruminal escape protein; LEP = low ruminal escape protein.

[b]Linear effect of supplement ($P < .05$).

[c]Implant main effect ($P < .08$).

[d]USDA quality grade: 14 = Standard, 15 = Select–, 16 = Select+, 17 = Choice–.

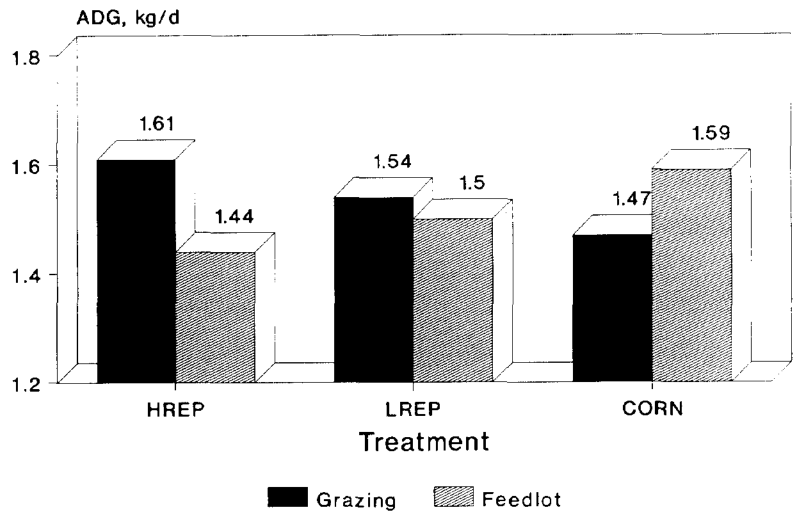

Figure 1. Comparison of grazing and feedlot average daily gain (ADG) for high ruminal escape protein (HEP), low ruminal escape protein (LEP), and corn treatments (SE = .05).

IVDMD, which decreased from 72 to 59% by the end of the trial. Forage quality data indicate that the response to supplementation may have been due to the lack of available nutrients in the forage; however, forage quality of these samples may not represent the quality of that consumed because quadrat sampling resulted in whole-plant analysis. When forage is abundant, ruminants select forage parts that are more digestible than the total forage on offer (Hamilton et al., 1973). Furthermore, McCann et al. (1991) noted no interaction between season (October to June) and similar EP supplements when fed to steers grazing wheat-annual ryegrass pastures. This lack of a season effect was also noted in an unsupplemented control group included in the trial.

Comparison of EP treatment means indicates that ADG during the feedlot phase was related inversely to ADG during the grazing period (Table 5). Feedlot daily gain decreased linearly ($P < .04$) with increased EP supplementation during the grazing phase. This supports the findings of Hancock et al. (1987), who reported that treatment groups with the highest ADG on pasture exhibited the lowest feedlot rate of gain.

There were no differences ($P > .2$) in carcass characteristics between groups of steers receiving various EP treatments (Table 5). Total weight gain accmumulated during the trial, including the pasture plus feedlot period, was similar between EP treatments ($P > .2$) because steers compensated during the feedlot period for their poorer ADG during the grazing phase (Figure 1). Implant treatment during grazing had no effect ($P > .2$) on feedlot performance; however, the added 10 kg in body weight gained during the grazing period was retained through the feedlot phase even though steers were not implanted during this time. This added weight was reflected in heavier carcass weights ($P < .08$) for the implanted steers. Implanting with zeranol during the grazing period also increased ribeye area ($P < .08$) 3.6% after the feedlot period. Covariate analysis using hot carcass weight did not diminish the implant's effect on ribeye area.

Implications

Supplementation with escape protein, which also increased CP intake, increased rate of gain of steers grazing winter annual pastures. The efficiency of conversion for EP to additional gain implies that it may be economical alternative to corn supplementation. However, the producer that retains ownership of the cattle after grazing may not want to supplement during grazing in view of supplementation's negative impact on feedlot gain. Zeranol implants increased weight gain during the grazing phase by 10 kg of body weight and increased ribeye area.

Literature Cited

Altom, W., C. Griffith and J. Pumphrey. 1979. Growth promotive implants. In: Winter Pastures and Stocker Cattle. pp 35–38. The Noble Foundation, Ardmore, OK.

Anderson, S. J., T. J. Klopfenstein and V. A. Wilkerson. 1988. Escape protein supplementation of yearling steers grazing smooth brome pastures. J. Anim. Sci. 66:237.

AOAC. 1980. Official Methods of Analysis (12^{th} Ed.). Association of Official Analytical Chemists, Washington, DC.

Beever D. E. 1984. Utilization of the energy and protein components of forages by ruminants – A United Kingdom perspective. In: G. W. Horn (Ed.) Proc. Natl. Wheat Pasture Symp., Oct. 24–25, 1983, Oklahoma Agric. Exp. Sta. Misc. Publ. 115, Stillwater.

Craig, B. D. 1983. Slowly degradable proteins in supplements fed yearling cattle while grazing irrigated pasture. M. S. Thesis. Univ. of Nebraska, Lincoln.

Gibb, M. J. and R. D. Baker. 1987. Performance of young steers offered silage of thermo-ammoniated hay with or without a fish meal supplement. Anim. Prod. 45: 371.

Hamilton, B. A., K. J. Hutchinson, P. C. Annis and J. B. Donnelly. 1973. Relationships between the diet selected by grazing sheep and the herbage on offer. Aust. J. Agric. Res. 24:271.

Hancock, D. L., J. E. Williams, H. B. Hedrick, E. E. Beever, D. K. Larrick, M. R. Morrow, J. A. Paterson and J. R. Gerrish. 1987. Performance, body composition and carcass characteristics of finishing steers as influenced by previous forage systems. J. Anim. Sci. 65:1381.

Horn, G. W., C. Strasia, J. Martin and G. Vogel. 1987. Effect of inclusion of high protein feedstuffs in supplements on stocker cattle performance on wheat pasture. Oklahoma Agric. Exp. Sta. Res. Rep. MP-119:222.

Laudert, S. B., G. W. Horn and J. W. McNeill. 1983. Use of implants of anabolic compounds for growing cattle on small grain pastures. In: G. W. Horn (Ed.) Proc. Nat. Wheat Pasture Symp., Oct. 24–25, 1983, Oklahoma Agric. Exp. Sta. Res. Rep. Misc. Publ. 115, Stillwater.

Losada, H. R., S. B. Cammell, D. E. Beever and A. R. Austin. 1982. The effect of forage species and stocking rate on protein supply to duodenum of cattle. Br. Soc. Anim. Prod. Occ. Publ. 6:44.

Mader, T. L., D. C. Clanton, J. K. Ward, D. E. Pankaskie and G. H. Deutscher. 1985. Effect of pre- and post-weaning zeranol implant on steer calf performance. J. Anim. Sci. 61:546.

McCann, M. A., R. S. Donaldson, H. E. Amos, C. S. Hoveland, K. R. Harwell and V. H. Calvert. 1991. Effect of protein supplementation on steers grazing winter annuals. Southern Sect. Am. Soc. Anim. Sci. Abstr. 61. p 27.

Mott, G. O. 1984. Relationship of available forage and animal performance in tropical grazing systems. Proc. Am. Forage and Grassl. Council. pp 373–377. Houston, TX.

Robertson, J. B. and P. J. Van Soest. 1981. The detergent system of analysis and its application to human foods. In: P. J. James and O. Theander (Ed.) The Analysis of Dietary Fiber in Food. pp 123–158. Marcel Dekker, New York.

SAS, 1985. SAS Introductory Guide. SAS Inst., Inc., Cary, NC.

Satter, L. D. 1986. Protein supply from undergrade dietary protein. J. Dairy Sci. 69:2734.

Sharp, G. D. and I. A. Dyer. 1971. Effect of zeranol on the performance and carcass composition of growing finishing ruminants. J. Anim. Sci. 33:865.

Thonney, M. L. 1987. Growth feed efficiency and variation of individually fed Angus, Polled Hereford, and Holstein steers. J. Anim. Sci. 65:1.

Tilley, J.M.A. and R. A. Terry. 1963. A two stage technique for the in vitro digestion of forage crops. J. Br. Grassl. Soc. 18:104.

Ulyatt, M. J., J. C. Macrae, R.T.J. Clarke and P. D. Pearce. 1975. Quantitative digestion of fresh herbage by sheep. IV. Protein synthesis in the stomach. J. Agric. Sci. (Camb.) 84:453.

Van der Wal, P. 1975. General aspects of the effectiveness of anabolic agents in increasing protein production in farm animals, in particular bull calves. In: F. Coulston and F. Korte, (Ed.) Environmental Quality and Safety, Suppl. Vol. 5. pp 60–78. George Thieme, Stuttgart, FRG.

Vogel, G. J., M. A. Andersen and G. W. Horn. 1987. Rate and extent of ruminal digestion of wheat forage and protein supplements by steers grazing wheat pasture. Oklahoma Agric. Exp. Sta. Res. Rep. MP-119:205.

Williams, J. E., S. J. Miller, T. A. Mollett, S. E. Grebing, D. K. Bowman and M. R. Ellersieck. 1987. Influence of frame size and zeranol on growth, compositional growth and plasma hormone characteristics. J. Anim. Sci. 65:1113.