INFLUENCE OF MEAT MEAL SUPPLEMENTATION ON FORAGE INTAKE AND SITE AND EXTENT OF DIGESTION OF STEERS GRAZING WHEAT PASTURE

M.A. Andersen[1], G.J. Vogel, G.W. Horn[2] and K.B. Poling[3]

Story in Brief

Eight cannulated steers grazed wheat pasture and were fed a corn-based supplement or a supplement containing 24% meat meal. Supplements provided similar amounts of TDN, calcium, phosphorus and magnesium. Meat meal supplementation resulted in a slight (i.e., 12%) increase in forage organic matter intake. Meat meal supplementation did not alter organic matter and nitrogen digestion in the rumen or their flow to and absorption from the post-ruminal tract. Although efficiency of metabolizable energy utilization theoretically could be improved if the ratio of protein absorbed to energy intake were increased, meat meal supplementation did not increase this ratio. The increased performance of wheat pasture stocker cattle fed meat meal supplements probably is related primarily to increased forage intake.

(Key Words: Wheat Pasture, Protein Supplementation, Growing Cattle.)

Introduction

Wheat pastures are high in crude protein, and typically contain 20-30% during most of the grazing season. However supplementing wheat pasture stocker cattle with a high bypass protein feed, such as meat meal, has increased daily weight gains approximately .25 lb/day (Horn et al., 1987; Lee, 1985). This may be partially due to (1) greater protein flow to the small intestine, compensating for the ruminal degradation and loss of wheat forage nitrogen (Zorrilla-Rios et al., 1985) or (2) a more optimum amino acid balance at the small intestine. Supplementing steers on wheat pasture with meat meal did not affect ruminal pH, ammonia concentration or molar proportions of volatile fatty acids (Andersen et al., 1987). These data represent the results from our second year evaluating the effect of including meat meal in supplements on the site and extent of nutrient digestion and on forage intake of steers grazing winter wheat pasture.

Materials and Methods

Eight ruminally, duodenally and ileally cannulated Hereford and Hereford x Angus steers grazed a common winter wheat pasture during the 1987 grazing season. Steers were randomly allotted to two treatments and fed 2.6 lb (as-is) of a corn based (control) supplement or a supplement containing 24% meat meal (as-fed basis). Supplements were placed directly into the rumen once daily. Ingredient composition of supplements are reported by Andersen et al. (1988) elsewhere in this research report. Forage intake, and site and extent of nutrient

[1]Graduate Assistant [2]Professor [3]Animal Care Supervisor

digestion were determined while steers grazed forage of two distinct maturities. Immature forage was characterized as rapidly growing forage in the early spring; mature forage was characteristic of wheat shortly after heading. Hand clipped forage samples were taken during each experimental period. Samples were frozen immediately over liquid nitrogen and subsequently lyophilized. Nitrogen (N) of wheat forage was determined by the kjeldahl procedure, non-protein nitrogen (NPN) content was determined by difference between total N and protein N precipitated in a 10% H_2SO_4 and Na-tungstate solution. Soluble N was determined as N soluble in the mineral mixture (2% v/v; pH = 6.5) of the "Ohio" in vitro fermentation media (Johnson, 1969). Soluble carbohydrates were determined by the procedure of Balwani (1965). A second set of forage samples, obtained from esophageal cannulated steers were assayed for indigestible neutral detergent fiber. Chemical composition of forage is shown in table 1.

Chromic oxide was utilized as a nutrient flow and fecal output marker. Organic matter (OM) digestibility was determined using indigestible neutral detergent fiber as an internal indigestible marker. Forage OM intake was corrected for supplement intake by subtracting the indigestible portion of the supplement determined in vitro, from the estimated fecal output. Digestion of nutrients in the rumen, small intestine, and large intestine were determined by difference.

Results and Discussion

Effects of meat meal supplementation on forage intake and digestion measurements are shown in table 2. Meat meal supplementation did not significantly influence (P>.10) any of the measurements reported. Data of one steer were deleted from analysis because of problems that developed with an intestinal cannula while grazing immature forage. A second steer was removed from the study while grazing mature forage because of a similar problem.

Table 1. Chemical composition of immature and mature wheat forage.

Item	Forage maturity	
	Immature	Mature
Dry matter (DM), %	27.76	24.85
Organic matter (OM), %	95.34	93.38
OM digestibility, %	87.26	70.60
Crude protein, % of DM	19.31	13.75
Nitrogen		
Total N, % of DM	3.09	2.20
Soluble N		
% of DM	1.50	.76
% of total N	48.52	34.22
Non-protein nitrogen		
% of DM	.28	.37
% of total N	8.89	17.16
Soluble carbohydrates, % of DM	30.24	21.43
In vitro dry matter digestibility, %	84.69	80.92

Table 2. Effect of meat meal supplementation on forage intake and site of digestion of steers grazing winter wheat pasture.

Item	Immature		Mature		Stage of maturity
	Control	Meat meal	Control	Meat meal	
No. of observations	3	4	3	3	
Body weight, kg	477	503	550	587	**
Forage organic matter intake,					
kg	12.1	14.3	8.9	10.6	*
g/kg body weight	22.1	25.0	11.3	12.5	**
Total nitrogen intake, g	502	621	246	372	*
True ruminal digestion, g/kg intake					
Organic matter	687	767	403	349	**
Nitrogen	685	691	224	284	**
Ruminal N loss, %[b]	50.3	54.0	-24.8	1.6	**
Degraded N/kg OMTDR[c]	32.4	34.6	9.0	13.7	*
Flow to small intestine					
Organic matter					
g	5000	5419	6712	7653	*
g/kg intake	421	374	759	746	*
g/kg body weight	10.5	10.7	12.3	13.2	
Non-ammonia nitrogen					
g	243	274	307	351	
g/kg N intake	500	460	1248	984	**
g/kg body weight	.51	.54	.56	.61	
Bacterial N, %	37.4	32.4	37.0	25.2	
Feed N, %	62.6	67.6	63.0	74.8	

Table 2. continued

Item	Immature		Mature		Stage of Maturity
	Control	Meat meal	Control	Meat meal	
Absorption from small intestine					
Organic matter					
g/kg intake	187	151	181	222	
% of flow	44.6	40.2	24.0	28.9	**
g/kg body weight	4.72	4.31	2.96	3.92	*
Non ammonia nitrogen					
g/kg N intake	282	266	677	545	**
% of flow	58.2	58.6	54.2	55.5	
g/kg body weight	.31	.32	.31	.34	
Absorbed protein:energy					
g NAN/kg DOMI[d]	13.8	12.6	26.8	26.6	**
g NAN/MJ ME intake	1.24	1.14	3.9	3.88	**
Flow to large intestine, g/d					
OM	2744	3245	5097	5384	**
NAN	95	113	140	156	*
Absorption from large intestine					
Organic matter					
g/kg intake	97	104	279	229	**
% of flow	38.3	46.4	47.9	43.5	
g/kg body weight	2.2	3.0	4.5	4.1	*
Non-ammonia nitrogen					
g/kg intake	119	103	266	192	*
% of flow	46.6	53.3	46.3	42.7	
g/kg body weight	.10	.12	.12	.12	

[a] * = (P<.05), ** = (P<.01).
[b] Ruminal N loss = nitrogen intake-N flow to small intestine.
[c] Nitrogen absorbed per kg OM truly digested in the rumen.
[d] Grams NAN disappeared from small intestine per kg digestible organic matter intake.

Organic matter (OM) intake of immature and mature forage by steers supplemented with meat meal was 13.6% and 10.6% greater, respectively. Although not significant (P>.10), this trend of increased forage intake was similar to that seen in wheat pasture heifers supplemented with meat meal (Andersen et al., 1988). Using net energy system equations for a 400 lb steer consuming wheat forage at 2.5% of body weight, a 10% increase intake could account for the .25 lb/day increase in daily gains observed by Horn et al. (1987) and Lee, (1985).

Meat meal supplementation did not influence ruminal digestion of OM or N. Nitrogen degraded per kg OM truly digested in the rumen, and N loss before the small intestine also were not affected by meat meal supplementation. Loss of N before the small intestine averaged more than 50% while steers were grazing immature forage. Beever and Siddons (1986) reported a loss of 30% of N before the small intestine in cattle fed medium to high N forages, and considered their loss to be high. They suggested it was the result of a dietary imbalance of N:readily digested carbohydrate. However, ruminal pH values of our steers in this study were low, averaging only 5.5, and volatile fatty acid concentrations were high (145 m moles/L), suggesting the presence of a large amount of soluble carbohydrates for ruminal fermentation. Calculated amounts of non-ammonia nitrogen (NAN) absorbed from the small intestine averaged 1.2 grams/MJ metabolizable energy (ME) intake while steers grazed immature wheat forage. Improving this ratio may improve the efficiency of ME utilization (MacRae et al, 1985).

Forage organic matter intake and nitrogen intake of steers grazing mature forage was reduced approximately 50% (P<.01). When steers grazed mature forage, ruminal digestion of organic matter and nitrogen (g/kg intake) were greatly reduced (P<.01), nitrogen loss in the rumen shifted from more than 50% to -13%, N degraded per kg OM fermented in the rumen (degraded N/kg OMTDR) was significantly reduced (P<.01), and flow of OM and N (g/kg intake) was significantly greater. Digestion of OM in the small intestine was greater (P<.01), and NAN absorbed in the small intestine per kg of digestible OM intake was 2-fold greater (P<.01) in steers grazing mature forage.

Steers grazing mature wheat forage showed a gain of N in the rumen and N flowing to the duodenum, indicating a net gain of N by N recycling. Nitrogen recycling may indicate a need for more ruminal degradable protein, however ruminal ammonia concentration was more than adequate (38 mg/100 ml). Non-ammonia nitrogen flow to the small intestine of steers fed the control supplement averaged 125% of N intake while grazing mature forage. The N disappearance from the large intestine does not account for all of the additional N flowing to the small intestine, therefore some of the NAN absorbed in the small intestine in these steers must have been deaminated and recycled to the rumen, to account for the additional N flow. This indicates a portion of the protein absorbed from the small intestine may have been used as glycolytic precursors, possibly necessary for reducing equivalent production, which may be limiting in high acetate ruminal fermentations (MacRae et al., 1985).

These data are interpreted as indicating that the increased performance of wheat pasture stocker cattle supplemented with meat meal is probably related to an increase in forage intake. Supplementation with meat meal did not affect ruminal digestion, flow of nutrients to and(or) absorption of nutrients from the post-ruminal tract, of steers grazing winter wheat pasture. High ruminal N losses while steers were grazing immature forage suggests possible benefits for supplementation with a ruminal undegradable protein with the objective of improving the ratio of protein absorbed to ME intake. While steers grazed mature forage, there was a reduction in forage intake and a shift in digestion of OM and NAN to the post-ruminal tract. Nitrogen recycled from NAN absorbed in the small intestine while steers grazed mature wheat forage suggests that protein may have been utilized as glycolytic precursors. Although supplemental rumen undegradable protein might be expected to improve ME utilization of wheat forage, its influence on forage intake tends to explain the response to supplementation.

Literature Cited

Andersen, M.A., et al. 1988. Effect of meat meal supplementation of wheat pasture stocker cattle on forage intake and nitrogen balance. Oklahoma Agr. Exp. Sta. Res. Rep. MP-125:122.

Andersen, M.A., et al. 1987. Effect of meat meal supplementation of steers grazing wheat pasture on rumen fermentation. Oklahoma Agr. Exp. Sta. Res. Rep. MP-119:226.

Balwani, T.L. 1965. Soluble carbohydrates of the corn plant at different stages of maturity, and their digestibilities by rumen bacteria. M.S. Thesis. Ohio State University, Columbus.

Beever, D.E. and R.C. Siddons. 1986. Digestion and metabolism in the grazing ruminant. In: L.P. Milligan, W.L. Grovum and A. Dobson. (Ed.). Control of Digestion and Metabolism in Ruminants. pp. 479-497. Prentice-Hall, Englewood Cliffs, NJ.

Horn, G.W., et al. 1987. Effect of inclusion of high protein feedstuffs in supplements on stocker cattle performance on wheat pasture. Oklahoma Agr. Exp. Sta. Res. Rep. MP-119:223.

Johnson, R.R. 1969. Techniques and Procedures in Animal Science Research. p. 175.

Lee, Robert W. 1985. Bypass protein supplementation for cattle grazing wheat pasture. Kansas Cattle Feeders Day. Report of Progress 474. p. 7.

MacRae, J.C., et al. 1985. The efficiency of utilization of metabolizable energy and apparent absorption of amino acids in sheep given spring- and autumn-harvested grass. Brit. J. Nutr. 54:197.

Zorrilla-Rios, J., et al. 1985. In situ disappearance of dry matter and nitrogen of wheat forage, corn gluten meal, cottonseed meal and soybean meal in steers grazing wheat forage at two stages of maturity. Okla. Agr. Exp. Sta. Res. Rep. MP-117:169.