January 1997

Seasonal Changes in Protein Degradabilities of Sandhills Native Range and Subirrigated Meadow Diets and Application of a Metabolizable Protein System

Greg Lardy
University of Nebraska-Lincoln

Don C. Adams
University of Nebraska-Lincoln, dadams1@unl.edu

Terry J. Klopfenstein
University of Nebraska-Lincoln, tklopfenstein1@unl.edu

Dick Clark
University of Nebraska-Lincoln

Jim Lamb
University of Nebraska-Lincoln

Seasonal Changes in Protein Degradabilities of Sandhills Native Range and Subirrigated Meadow Diets and Application of a Metabolizable Protein System

Greg Lardy
Don Adams
Terry Klopfenstein
Dick Clark
Jim Lamb[1]

Meadow and range diets increased in digestibility, crude protein, and escape protein during periods of active growth.

Summary

Diet samples from native range and subirrigated meadows were collected with esophageally-fistulated cows and analyzed for CP, IVDMD, in situ protein degradability, and fiber components. Escape protein (EP) and degradable intake protein (DIP) of the samples were calculated. Native range and subirrigated meadow samples were higher in CP, IVDMD and escape protein during periods of active growth. For spring calving cows, the metabolizable protein system, in general, predicted during gestation that degradable protein was more deficient than metabolizable protein. However, during lactation, metabolizable and degradable protein were deficient when cows were fed meadow hay or grazed dormant forage.

Introduction

The Nebraska Sandhills have two distinctly different forage resources; native upland range and subirrigated meadow. Upland range and subirrigated meadow have different grass species and different plant growth characteristics. Familiarity with the nutritional composition of cattle diets from upland range and subirrigated meadow can be a valuable management tool for cattle producers. Cattle select a diet higher in nutritive value than what would be obtained from clipped samples of the same pasture. Samples collected from esophageally-fistulated cattle give a reliable estimate of the animal's diet.

The latest NRC beef cattle requirements (NRC, 1996) uses a metabolizable protein system to express protein requirements on a degradable intake protein (DIP) and a metabolizable protein (MP) basis. Degradable intake protein is the protein degradable in the rumen and available to the microorganisms present in the rumen. Metabolizable protein is the sum of the digestible microbial protein flowing to the small intestine and the digestible escape protein flowing to the small intestine. Metabolizable protein is the protein the animal uses for maintenance, growth, lactation, and gestation.

For the metabolizable protein system to be most effective, precise values for protein degradability of feedstuffs are necessary. Presently, diets throughout the year on upland range and subirrigated meadow have not been adequately characterized for DIP and EP.

The objectives of this research were to characterize the seasonal changes in forage quality and protein degradability of upland range and subirrigated meadow diets and to use a metabolizable protein system to calculate energy, degradable protein, and metabolizable protein status of cows grazing upland range or subirrigated meadow or consuming subirrigated meadow hay.

Procedure

Throughout 1992 and 1994 diets were collected using esophageally-fistulated

(Continued on next page)

cows from both subirrigated meadows and native range at the University of Nebraska's Gudmundsen Sandhills Laboratory. Subirrigated meadow hay used in the NRC model calculations was average in quality and values were based on the work of Villalobos (1994 Beef Cattle Report, p. 5). Samples were freeze-dried, ground, and analyzed for CP, IVDMD, NDF, ADF, neutral detergent insoluble nitrogen (NDIN), in situ protein degradability, and acid detergent insoluble nitrogen (ADIN). From these values, rumen escape protein and rumen degradable protein of the samples were calculated.

In 1992, precipitation during April and May was 1.8 and 2.8 inches below normal, respectively. Total precipitation for the 1992 calendar year was four inches below normal. Average high temperatures in June, July and August were 7 to 10°F below normal. In late May, two consecutive days of below freezing overnight lows (30 and 20°F) were recorded which likely influenced grass growth and quality patterns. During 1994, temperatures and precipitation were average.

When laboratory analysis was completed, the metabolizable protein system (NRC, 1985) was used to predict dietary deficiencies in net energy for maintenance (NE_m), MP, and DIP. Estimates of grazed dry matter intake were based on previous research conducted at the Gudmundsen Sandhills Laboratory. **All requirements calculated in Tables 3-5 were obtained using thermoneutral conditions. Under conditions of cold stress, requirements for energy increase.** No supplement was included in the calculations of nutrient balances. Degradable protein requirements were based on a 13 percent efficiency value for conversion of TDN to bacterial CP. This value may be lower on dormant forages. The consequence of a lower efficiency would be a reduction in the amount of DIP required for the microorganisms. Therefore these should only be used as guidelines.

Assumptions were as follows:

1. Mature cow body weight = 1100 lb
2. Milk production = 18 lb per day
3. Calving Date = March 1 for spring calving cows
4. Weaning Date = October 15 for spring calving cows
5. Meadow hay was assumed to be of average quality (8% CP, 56% TDN)
6. No supplement was included in any calculations.
7. DIP requirement equals IVDMD x .13.
8. Estimates of dry matter intake were based on previous research conducted at the Gudmundsen Sandhills Laboratory (Hollingsworth-Jenkins, 1995 and 1996 Beef Cattle Reports).

Results

Seasonal changes in chemical composition and digestibility for diet samples collected from the subirrigated meadows in 1992 and 1994 are shown in Table 1. Because the subirrigated meadows at Gudmundsen Sandhills Laboratory are made up predominantly of cool season species, CP and IVDMD increased rapidly in the spring and then declined over the summer before increasing again during the fall as regrowth occurred. Meadows were hayed in July of each year, values reported for August through December would represent meadow regrowth. Neutral detergent fiber and ADF values were lower during periods of active growth and higher during periods of dormancy. The diet samples collected on the subirrigated meadow were also relatively high in IVDMD as only the January and December samples were appreciably below 60 percent IVDMD. Escape protein of the meadow diet samples ranged from .9 to 3.6 percent of dry matter. The highest EP values were noted in April.

Seasonal changes in chemical composition and digestibility of diet samples collected from native upland range are shown in Table 2. On the native upland range, CP increased later relative to the subirrigated meadows since the upland sites contain more warm season grass species. Grass growth on upland range started in late April as shown by the increasing CP content of the diet. The cool season species present on upland range initiate growth earlier than the warm season species and the CP content was higher than expected in April. However, forage quantity produced at this time would be quite low. Crude protein values for the diet samples re-

Table 1. Laboratory analysis of meadow diet samples collected at Gudmundsen Sandhills Laboratory in 1992 and 1994, DM Basis.

Sample Date	# OBS[a]	CP	NDFIP[a]	ADFIP[a]	Escape protein	Degradable protein	NDF	ADF	IVDMD
JAN	1	10.3	4.0	.6	1.2	9.1	65.4	42.6	51.1
MAR	1	14.1	4.8	1.1	1.0	13.1	56.6	35.9	61.3
APR	1	25.3	4.9	.1	3.6	21.7	42.3	23.4	71.9
MAY	1	15.3	5.9	.9	2.7	12.6	63.5	36.8	67.9
JUNE	3	14.9	4.0	.7	2.0	12.9	59.0	33.8	67.9
JULY	3	10.9	3.7	.7	1.8	9.2	63.6	36.8	64.3
AUG	2	14.9	3.4	.4	2.0	12.9	54.6	38.4	62.7
SEPT	3	13.1	3.6	.8	1.5	11.6	59.3	36.7	59.6
OCT	1	12.0	3.4	.7	1.0	11.0	51.6	35.7	60.2
NOV	1	7.8	2.6	1.3	1.0	6.8	67.5	46.2	47.9
DEC	2	6.7	2.5	1.0	.9	5.9	69.3	46.6	53.5

[a]# OBS, number of diets analyzed for a given month; NDFIP, Neutral Detergent Insoluble Protein (NDIN * 6.25); ADFIP, Acid Detergent Insoluble Protein (ADIN *6.25).

Table 2. Laboratory analysis of range diet samples collected at Gudmundsen Sandhills Laboratory in 1992 and 1994, DM basis.

Sample Date	#OBS[a]	CP	NDFIP[a]	ADFIP[a]	Escape protein	Degradable protein	NDF	ADF	IVDMD
JAN	1	5.5	2.4	.8	.7	4.8	72.9	45.7	55.7
MAR	2	5.2	2.6	.5	.8	4.3	71.4	46.1	52.1
APR	2	10.1	4.4	.6	1.1	9.1	68.5	38.2	61.4
JUNE	3	12.4	4.8	.6	2.3	10.2	65.1	36.5	68.2
JULY	4	10.9	5.0	.8	2.0	8.9	70.6	38.5	67.1
AUG	3	10.0	4.4	.9	1.6	8.4	69.4	41.3	63.5
SEPT	2	6.6	2.9	.6	.9	5.7	70.5	43.2	59.2
NOV	1	5.2	2.1	1.5	.6	4.6	74.5	49.5	48.9
DEC	2	5.6	2.1	.7	1.0	4.6	73.8	46.8	51.3

[a]# OBS, number of diets analyzed for a given month; NDFIP, Neutral Detergent Insoluble Protein (NDIN * 6.25); ADFIP, Acid Detergent Insoluble Protein (ADIN *6.25).

Table 3. Daily nutrient balances for a spring calving cow as predicted by the metabolizable protein system (NRC, 1996).

Diet	Meadow hay		Meadow Grazing		Range				Meadow		Range		Meadow hay	
Item	April	May	May	June	June	July	August	Sept.	Sept.	Oct.	Dec.	Jan.	Feb.	March
NEm balance, Mcal	-1.7	-2.7	3.1	3.7	3.8	5.9	4.0	.6	3.3	5.1	-.6	-1.0	-.8	-2.4
MP available, g	687	687	932	874	902	928	787	566	737	670	504	457	625	625
MP requirement, g	755	828	828	788	788	714	639	577	577	412	441	423	522	602
MP balance, g	-68	-141	103	85	114	214	148	-11	160	257	64	35	103	23
DIP available, g	659	659	1514	1538	1208	1160	1005	565	1390	1259	461	455	599	599
DIP requirement, g	799	799	1057	1057	1062	1132	989	768	928	898	666	180	727	727
DIP balance, g	-141	-141	457	481	146	28	16	-203	462	361	-205	-180	-128	-128
DM Intake, lb	24.2	24.2	26.4	26.4	26.4	28.6	26.4	22	26.4	25.3	22	22	22	22

mained between 10 and 12 percent for the duration of the summer before declining to 6 percent by late September. In vitro dry matter digestibility was highest during the summer months (the period of active growth). Cows selected a diet containing greater than 5 percent CP throughout the winter months. Escape protein of the range diet was highest during the summer months (1.6 to 2.3% of DM).

Table 3 shows the nutrient balances for a mature spring calving cow. When cows were fed meadow hay during lactation (April and May), they were in negative energy balance, had a MP deficit, and were deficient in DIP. A DIP deficiency also occurred when cows grazed native range in September, December, and January. The MP system predicted a DIP deficiency of about 200 g/d for gestating cows grazing dormant winter range.

In general, the metabolizable protein system predicted that when lactating cows were fed meadow hay or grazed dormant forage, they were deficient in DIP, MP, and energy. For gestating cows which were not lactating, the metabolizable protein system predicted that only DIP was deficient.

Protein supplements differ in the proportion of DIP and EP. Examples of sources high in DIP (as a % of CP) would be sunflower meal, alfalfa hay, corn steep liquor, urea, and biuret. Sources which contain both degradable and escape protein would be soybean meal and cottonseed meal. Sources which are high in escape protein but contain very little DIP would be blood meal and feather meal.

For the gestating cow, a supplement high in DIP is adequate because she is not deficient in MP. For the lactating cow, which needs both DIP and MP, a supplement which contains both degradable and escape protein is necessary.

Use of the metabolizable protein system should allow producers to more accurately predict the type and amount of supplements necessary to maintain the cow herd year long. By feeding the correct type of supplement at the proper time, overall cost of supplementation could be reduced and performance either maintained or improved over traditional supplementation programs.

---

[1]Greg Lardy, research technician, Animal Science, Lincoln. Don Adams, Professor, Animal Science, West Central Research and Extension Center, North Platte. Terry Klopfenstein, Professor, Animal Science, Lincoln. Jim Lamb, research technician, Animal Science, West Central Research and Extension Center, North Platte.