West Virginia University
Extension Service

Forage Management

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August 1996

Forage Quality - Protein

Protein is the source of amino aids and nitrogen in feeds. It is needed by livestock for growth and milk production. Protein is also needed by rumen bacteria, which digest much of the feed for ruminant animals like cattle, sheep and goats.

The feed **crude protein (CP)** can be divided into classed based on how fast it is degraded in the rumen. These classes are termed the soluble, degraded, and undegraded intake protein fractions. **Soluble intake protein (SIP)** is protein which is rapidly degraded to ammonia in the rumen. Some of this rapidly available protein is needed by the rumen bacteria when their growth rate is high. **Degraded intake protein (DIP)** is all the protein that is degraded to ammonia in the rumen and includes the SIP.

The DIP is used by the rumen bacteria for their growth and for digesting feeds in the rumen for the animals. However, if the ration contains too much DIP, the excess ammonia is lost from the rumen, going into the blood stream. The excess ammonia is converted to urea and is excreted from the body in urine. This results in wasted protein. This process requires energy and increases the energy requirement of the animal. In extreme cases this can result in lower milk production or loss of body condition. DIP is less likely to be wasted if carbohydrate energy sources are available to the bacteria.

Undegraded intake protein (UIP) is protein that is not degraded in the rumen. This protein may be digested in the intestinal tract by the cow. The aim of balancing a ration is to ensure that there is enough CP and that the proportion of SIP, DIP, and UIP will meet the needs of the cow and its rumen bacteria.

Perennial forage crops vary in their protein content (Table 1). Those having a higher legume content are usually higher in crude protein, depending on the state of maturity. Conserved forages put up as dry hay tend to have protein levels below silage and well managed pastures. Silages have much of their protein in the readily soluble form (high in SIP).

Pastures managed under rotational grazing are high in protein. The CP content of pasture usually exceeds to the needs of a milking cow (Table 2). However, the degradability of pasture protein is not in balance with the needs of the high-producing dairy cow and the rumen bacteria. The UIP of pasture is lower than the need of the high-producing cow. Supplemental feeds, such as ground shell corn, distillers and brewers grains, heat-treated soybean products, and fish meal, can provide the additional UIP needed. At moderate levels of production, corn is the best supplemental feed because it provides carbohydrates for the rumen bacteria, some UIP, and is relatively low cost. At high levels of production heat-treated soybean products and fish meal are of value. These products provide high levels of UIP and high-quality amino acids.

Well-managed pastures, hay, and hay-crop silage are high-protein feeds. Be aware of the effects of protein and protein degradation in the rumen on the animal's production. Good managers

can improve milk production and animal growth by providing supplemental feed when needed to optimize animal production.

Table 1. Crude protein (CP), soluble intake protein (SIP), degraded intake protein (DIP), and undegraded intake protein (UIP) content of pasture, hay, silage and supplemental feeds in the Northeast (average ± standard deviation) (adapted from Rayburn 1994 and Sirois 1995).

Feed	CP	SIP	DIP	UIP
	% of DM	----------% of CP----------		
Pasture				
Grass	20±4	28±5	72±5	28±5
Mixed mostly grass	22±4	24±5	72±5	28±5
Mixed mostly legume	22±4	30±5	72±5	28±5
Legume	24±4	31±5	72±5	28±5
Hay				
Grass	11±3	28±6	61	39
Mixed mostly grass	12±3	29±6	61	39
Mixed mostly legume	16±3	32±6		
Legume	19±3	41±6	69	31
Silage				
Grass	13±4	45±12	64±1	36
Mixed mostly grass	14±4	46±11	63±8	37
Mixed mostly legume	17±3	55±10	65±8	35
Legume	19±3	58±10	66±10	34
Corn	8±1	47±12	61±11	39
Energy and protein supplements				
barley	13±2	26±8		
blood meal	98±5	4		
brewers grains, wet	27±	4±2		
corn, dry	9±1	12	30	70
corn, high moisture shell	9±1	27±11	65	35
corn, high moisture ear	8±1	33±14		
cottonseed, whole	25±3	22±6		
distillers grains, dry	30±4	19±10		
poultry litter	25±7	48±5		
oats	13±2	23		
soybeans	42±6	36±22		
soybeans, heated	43±4	14±5		
soybean meal	53±3	22±9	72	28
wheat	14±3	33±7		
wheat, midds	19±5	41±8		

Table 2. Dry matter intake (DMI), crude protein (CP), soluble intake protein (SIP), degraded intake protein (DIP), and undegraded intake protein (UIP) content of the ration required by a 1350 lb., second lactation cow to meet protein requirements at different levels of milk production (Hoover and Stokes, 1991).

Milk Production	DMI	CP	SIP	DIP	UIP
lb./day	lb./day	------% of Crude Protein------			
20	31	12.0	30-33	72	28
50	40	15.0	30-33	70	30
70	46	16.6	30-33	68	32
90	55	17.7	30-33	65	35
110	58	18.8	30-33	62	38

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