INFLUENCE OF DRYING METHOD AND TEMPERATURE ON RUMINAL DEGRADABLE PROTEIN OF SWITCHGRASS

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ABSTRACT

The nutritional value of herbage protein fed to ruminant livestock can be influenced greatly by the extent to which it is degraded in the rumen. This study was conducted to determine if drying method and temperature alters measurements of *in situ* ruminal escape protein (EP) of switchgrass herbage. Switchgrass harvested at the pre-heading stage was either air dried, freeze dried, or oven dried at 38, 49, 60, or 71^0 C. Samples from each of the six drying treatments were digested *in situ* in Dacron bags for 4, 8, 12, or 16 h. Drying treatment had a significant impact on EP with freeze-dried samples resulting in the lowest values. Oven and air drying resulted in higher estimates of EP than those obtained from freeze-dried samples. However, the magnitude of difference was greatly affected by drying temperature. Escape protein percentages for samples oven dried at 38^0 C were 2.4 units higher than freeze-dried samples, suggesting that while freeze drying would be the preferable method, oven drying at 38^0 C seems to be an acceptable alternative.

INTRODUCTION

Forage protein in ruminant diets is degraded to various extents in the rumen or escapes the rumen intact (bypass or EP). Ammonia released from protein degradation in the rumen is utilized by rumen microorganisms for biosynthesis of amino acids and microbial protein (Merchen and Bourquin, 1994). Microbial and dietary proteins escaping the rumen are digested in the small intestine to yield amino acids which are absorbed to meet protein requirements of the animal (Broderick, 1994). Utilization of dietary protein which escapes rumen fermentation is more efficient than that which is degraded in the rumen, and converted to microbial protein (Merchen and Bourquin, 1994).

Ruminant livestock grazing perennial warm-season grasses frequently perform better than expected based on the relatively low herbage protein and high fiber concentration of these grasses (Abrams et al., 1983; Reid et al., 1988). Mullahey et al. (1992) reported that EP of switchgrass was greater than for smooth bromegrass, when averaged across all growth stages, possibly because of anatomical differences between these grasses. Enzyme proteins are concentrated within parenchyma bundle sheaths in warm-season grasses such as switchgrass. Mullahey et al. (1992) postulated that because these cells are relatively resistant to microbial breakdown, warm-season grasses may have a greater proportion of protein N as EP compared with cool-season grasses.

Protein degradation in the rumen has been estimated by using the *in situ* rumen bag technique (Mehrez and Orskov, 1977). Herbage contained in synthetic fiber bags is suspended in the rumen of fistulated steers. Loss of N from bags is used to determine rate and extent of rumen protein degradation. *In situ* estimates of degradable and bypass protein may differ from actual ruminal degradable and bypass protein if drying method alters degradable protein. The objective of this study was to determine if drying method and temperature alters laboratory estimates of ruminal EP in switchgrass herbage.

METHODS

Switchgrass forage used in this study was grown at the Iowa State University Agronomy and Agricultural Engineering Research Center (42× N, 93× W). Samples were collected from plots of established switchgrass (*Panicum virgatum* L. cv. Cave-in-Rock) which were either unfertilized or fertilized with 120 kg N ha^{-1}.

Samples were collected by clipping at 20-cm above ground level when switchgrass was in the elongation stage (Moore et al., 1991). Samples were immediately transported from field to laboratory, and stored briefly under refrigeration until drying treatments were initiated, except for freeze-dried samples which were frozen before lyophilization. Six drying treatments were imposed on representative subsamples of harvested plant material. Drying treatments included air-dried (greenhouse), freeze-dried, and oven-dried in a forced-air oven at either 38, 49, 60, or 71^0 C.

Dried plant material was ground to pass a 2-mm screen. Samples weighing 5 g each were placed into Dacron bags (10 x 20 cm, 53 ± 10 mm pore size), and inserted into the rumen of a fistulated steer. Samples were digested *in situ* for 4, 8, 12, or 16 h using methodology described by Wilkerson et al., 1990. Ruminal digestion was replicated four times. After digestion, samples were immediately and thoroughly washed, dried, weighed, and digested with sulfuric acid and 50% hydrogen peroxide in a HACH (Ames, IA) Digesdahl®. Total plant N concentration of digested samples was determined using a Lachat (Milwaukee, WI) QuikChem® Ion Analyzer. These N values were used to estimate ruminal degradable protein N, and by difference, the amount that would likely pass on into the small intestine for further metabolism and absorption by the ruminant (EP).
Results and Discussion

Mean herbage CP concentration averaged 7.1% DM for N-fertilized switchgrass compared with 5.7% DM for unfertilized switchgrass. Escape protein expressed as a percentage of CP was greater ($P < 0.05$) for unfertilized than for N-fertilized switchgrass. Averaged over drying treatments, EP was 56.5% and 52.7 % for unfertilized and N-fertilized switchgrass, respectively. Thus, at least some of the apparent gain in switchgrass CP obtained by N fertilization does not contribute to increased protein nutritional value, because of greater ruminal degradation of protein in fertilized herbage.

Drying treatment had a significant impact on EP as determined by the *in situ* technique (Fig. 1). Freeze-dried samples had the lowest EP values while samples oven dried at 71^0 C had the highest values. For oven-dried samples, EP increased linearly with drying temperature (Fig. 2). Rates of increase in EP with respect to drying temperature were similar between N-fertilized and unfertilized samples, with each degree C increase in temperature resulting in approximately 0.24 percentage units increase in EP. Yang et al. (1990) similarly reported that oven heating of alfalfa hay resulted in increased EP, although their objective was to assess artificial methods for increasing EP.

There was an interaction ($P < 0.05$) between fermentation time and drying method, with the impact of drying method greatest for the shortest fermentation period and least for the longest fermentation period (Fig. 1). After 4 h of fermentation, samples dried at the highest temperature differed ($P < 0.05$) from freeze-dried samples by 18.8 percentage units compared to a difference of 10.6 units after 16 h of fermentation.

Oven drying caused EP to be over estimated when determined using

the *in situ* technique. However, magnitude of this error was greatly affected by drying temperature. Escape protein percentages for samples oven dried at 38^0 C were 2.4 percentage units higher ($P < 0.05$) than freeze-dried samples after 16 h of fermentation. The recommended ruminal digestion time for the standard NC-189 Dacron Bag Technique is 16 h (Wilkerson et al., 1990). While freeze drying would be the preferable method, oven drying at 38^0 C seems to be an acceptable alternative in situations where freeze drying facilities are either unavailable, or not capable of handling the sample volume.

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Figure 1
Influence of drying method and fermentation time on excape protein estimates determined by *in situ* digestion.

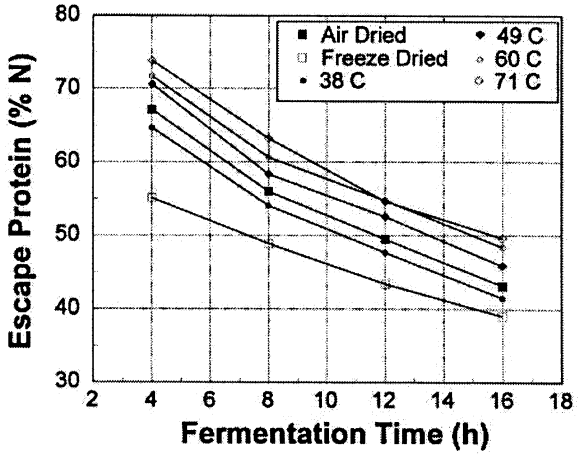

Figure 2
Influence of drying temperature and N fertilization on escape protein estimates determined by *in situ* digestion., 1996.