DIGESTIBILITY AND DEGRADABILITY OF DRY MATTER AND CRUDE PROTEIN OF FOUR TEMPERATE AND ONE TROPICAL GRASS IN A SUBTROPICAL ENVIRONMENT

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SUMMARY

The digestibility and degradability of DM and crude protein of four temperate grasses (\textit{Lolium multiflorum} cv. Concord and \textit{L. perenne} cv. Yatsyn (ryegrasses), \textit{Bromus willdenodii} cv. Matua (prairie grass) and \textit{Festuca arundinacea} cv. AU Triumph (tall fescue)) and one tropical grass (\textit{Chloris gayana} cv. Callide, Rhodes grass), grown in a subtropical environment, were studied at the mid point of spring, summer, autumn and winter. The two ryegrasses had the highest digestibilities and highest rates of DM and protein degradability. Of the four temperate grasses, AU Triumph fescue was consistently lower in all attributes and in all seasons while Matua prairie grass was intermediate. The digestibilities of the four temperate grasses were highest in winter and lowest in summer. Callide Rhodes grass was lower in digestibility, and dry matter and protein degradability, than the temperate grasses except in summer when levels were similar to AU Triumph. The 24-hour \textit{in sacco} value provided a quick approximation of DM digestibility, although it overestimated values for higher quality forages and underestimated those for lower quality forages.

Keywords: temperate grasses, Callide Rhodes grass, subtropics, digestibility, protein degradability

INTRODUCTION

Wilson and Ford (1973) showed a consistent decline in \textit{in vitro} digestibility of most temperate grasses with increasing temperature in controlled environment studies. However, the influence of season on the quality of temperate pastures under field conditions has not been investigated in the subtropics. A field study to assess the quality of four temperate grasses and one tropical grass was conducted as part of a large-scale grazing experiment. This paper presents the results of \textit{in sacco} measurements of disappearance of dry matter and protein and \textit{in vitro} digestibility of the five forages at four times of the year.

MATERIALS AND METHODS

The irrigated experiment was located at Mutdapilly Research Station in southeastern Queensland (26° 46’S, 152° 41’E). There were three perennial temperate grasses (\textit{Lolium perenne} cv. Yatsyn, \textit{Festuca arundinacea} cv. AU Triumph and \textit{Bromus willdenodii} cv. Grasslands Matua) and one annual ryegrass (\textit{L. multiflorum} cv. Concord). Rhodes grass (\textit{Chloris gayana} cv. Callide) was in a separate experiment. However, in both experiments, pastures were irrigated with a similar fertiliser input and grazed on a one week on, three-week spell, with regrowth averaging 21 days.

In each season, pure samples of each grass were selectively cut to 5 cm from feed on offer on the paddocks prior to grazing. Where necessary, the cut forage of Callide and Matua were partitioned into leaf and stem. Samples were dried in a forced draught oven at 80°C for 24 hours, ground to 0.1 mm particles in a mill and stored in a refrigerator until the \textit{in sacco} studies were made.

Samples were analysed for \textit{in vitro} DM digestibility (IVDMD) using the modified technique of Goto and Minson (1977). These results were adjusted using standards of known \textit{in vivo} digestibility. Crude protein content was determined by the microkjeldahl method using an AutoAnalyser. The \textit{in sacco} technique followed that devised by Mehrrez and Orskov (1977). Nylon bag runs were carried out for each of the four sampling periods. Five g of oven-dried samples of each pasture were weighed into nylon bags (22 x 10 cm, pore size 44 microns) and incubated in each of three steers. Bags were serially removed at 0, 3, 6, 9, 12, 18, 24, 36, 48 and 72 hours, washed and dried at 60°C for 48 hours. DM and protein disappearance were calculated for the four seasons for each grass (except Rhodes grass in winter which was frosted) using the model of Orskov and McDonald (1979) to determine the respective digestion coefficients, \(a\) = immediately degradable or soluble fraction, \(b\) = insoluble but potentially degradable fraction, and \(c\) = rate constant for degradation of ‘\(b\)’. Parameter values were obtained by fitting the data to the equation \(p=a+b(1-e^{-ct})\) using a non-linear regression procedure (MicroQUASP NL). These fitted constants were then combined with the...
outflow rate \( (r) \), appropriate for the lactating dairy cows \( (r = 0.08/h) \), to calculate the quickly degradable (QD), slowly degradable (SD) and effective rumen degradable (ERD) protein and DM fractions, as suggested by AFRC (1993). For protein, ERD P was calculated as \( 0.8 \times \text{QD P} + \text{SD P} \) (AFRC 1993).

**RESULTS**

**Dry matter degradability**

The quickly degradable (QD) component of DM was highest in winter for the temperate grasses but for Callide Rhodes the highest level occurred in summer (Figure 1). There was little difference in levels between the other seasons except for Matua prairie grass leaf which was lowest in spring. In all seasons, levels in Matua stem were lower than that in Matua leaf. Generally QD DM levels in Matua were lower than for the other three temperate grasses. There were lower levels of slowly degradable (SD) DM compared with QD DM in all five grasses. Again, levels in the temperate grasses were highest in winter. For Callide, the highest levels of SD DM occurred in spring. AU Triumph and both leaf and stem fractions of Matua prairie grass had lower levels than the two ryegrasses and, generally, seasonal differences were greater. Levels in AU Triumph and Matua were lowest in summer. There was little difference in SD DM levels between the leaf and stem fractions of Callide Rhodes. The two ryegrasses had the highest effective rumen degradable (ERD) DM levels over all seasons; highest levels occurred in winter and there was little difference between levels in other seasons. Summer levels were lowest in AU Triumph and Matua stem, but the ERD DM level in Matua leaf was as high as that of Yatsyn ryegrass. Highest levels in Callide were in summer, with levels in all seasons substantially lower than in the other grasses. AU Triumph had similar ERD DM levels in summer to Callide but in other seasons its levels were higher than those of the tropical grass. Matua stem had lower ERD DM levels in summer than Callide Rhodes.

![Graph](image-url)

*Figure 1. In vitro, and 24 h in sacco digestibility and quickly degradable, slowly degradable and effective rumen degradable DM and protein levels in spring, summer, autumn and winter for four temperate grasses and one tropical grass grown in the subtropics. Data for the stem fraction of grasses are presented where present.*
Crude protein degradability

Crude protein (CP) levels varied considerably between seasons for all except Yatsyn perennial ryegrass (Figure 1). Concord had the highest levels in summer and autumn. Lowest levels were in stem of Callide Rhodes in summer and autumn, and stem of Matua in spring and summer. Autumn CP levels in Matua stem were high. AU Triumph had similar levels to Yatsyn and higher levels than Callide leaf except in summer. Quickly degradable protein (QD P) levels were more variable than CP levels. There were no consistent seasonal trends for the five grasses. Generally, Concord and AU Triumph had the highest levels of QD P over the four seasons although the highest level occurred during summer in Matua leaf. During winter, there were very low slowly degradable protein (SD P) levels in all grasses. Summer levels were also low for AU Triumph and Matua leaf and stem. Concord had higher SD P levels than Yatsyn in all seasons except winter. The levels in Matua were equivalent to those of Concord in spring and autumn. Callide Rhodes had considerably lower levels of effective rumen degradable protein (ERD P), compared with the temperate grasses, in all seasons, with highest levels occurring in spring. Concord had consistently higher levels of ERD P in all seasons except winter. Levels in Matua leaf were as high or higher than those in Yatsyn in all seasons while AU Triumph had similar levels to Yatsyn in spring and autumn and higher levels in winter.

Digestibility of forages

Figure 1 presents the DM digestibility of the five grasses, estimated by alternative techniques. There was a close relationship between the \textit{in sacco} estimate of DM digestibility and the \textit{in vitro} DM digestibility (corrected using standards of known \textit{in vivo} digestibility) and this relationship is determined by the equation: $Y (\text{in vitro DM}) = 305.3 + 0.542 (\text{in sacco} \text{ digestibility at 24 hours}); P<0.001; r^2 = 0.944$. The 24 hours \textit{in sacco} value tended to underestimate digestibility for low digestible forages such as the Callide Rhodes leaf and stem and to overestimate digestibility for the higher value temperate grasses (Figure 2).

DISCUSSION

The data show that the degradability of ryegrass DM is not affected by season of the year. On the other hand, protein degradability is more seasonal. Hot summer conditions do not appear to influence degradability in ryegrasses but do appear to reduce the degradability of both DM and protein in AU Triumph fescue and to a lesser extent Matua prairie grass. Despite these findings, growth rates of the temperate species are affected by temperature (Wilson and Ford 1973). Therefore, although the ryegrasses produced high quality forage during summer and autumn, the amount available was severely restricted for grazing stock (Lowe et al. 1995). On the other hand Matua prairie grass and fescue demonstrated high growth rates at these times of the year. The higher quality of Matua, compared with Callide Rhodes grass, makes it a good choice as a
temperate forage for the subtropics in summer. AU Triumph fescue was the only forage able to produce good autumn yields (Lowe et al. 1995) and, as its quality attributes were generally similar to those of the ryegrasses at this time of the year, appears a good choice for autumn feed.

Despite our data suggesting that these forages are highly degradable, they also indicate that between 30 and 60% of the protein available for degradation in the rumen remained undegraded. This is partly attributable to the oven drying of the sample material, but our data also indicate substantial seasonal variation, with the highest SD P levels occurring in winter. This suggests that even for highly digestible forages such as ryegrass, the rate of release of nitrogen should permit efficient microbial utilisation (AFRC 1993) and could still leave a considerable component of forage protein available for uptake in the hind gut when the rate of passage of feed is high. Further work could investigate this with fresh forage samples.

The tropical grass, Callide Rhodes grass, was considerably lower in degradable DM and protein compared with ryegrasses, but in mid summer Callide Rhodes grass leaf was similar to AU Triumph fescue leaf and to Matua prairie grass stem. This does suggest that, at least in summer, milk production from AU Triumph and to a lesser extent, Matua prairie grass, could be restricted to levels expected from tropical species by quality limitations.

The 24 hours in sacco estimate of digestibility provided a good measure of digestibility without the need to determine all estimates from 0 to 72 hours, although it was less accurate at the extremities of our digestibility data.

Our data confirm the high feed value of ryegrass even in the hotter conditions experienced in the subtropics. Matua prairie grass proved a good compromise between quality and yield while fescue was only deficient in quality in summer.

REFERENCES