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Nutritive value of forage species grown in the warm temperate climate of Australia for dairy cows: Grasses and legumes

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Abstract

The objective of this study was to quantify the differences in the nutritive value over 4 seasons, of 7 C_3 temperate grasses, 2 C_4 tropical grasses and 11 clover species used as forages for dairy cows. The nutritive value was assessed in terms of nutrient content and the availability of effective rumen degradable protein, rumen by pass protein, metabolisable protein (MP) and fermentable metabolisable energy.

All species were grown in plots as monocultures under conditions of non limiting nutrients and moisture and harvested by mechanical means. All species had a high crude protein content and this resulted in a high effective rumen degradable protein: fermentable metabolisable energy ratio varying from 15, for cowpeas (*Vigna unguiculata*) to 29 for birdsfoot clover (*Lotus corniculatus*), and all were above the ratio of 11 required for optimal microbial protein synthesis in the rumen of dairy cows. The calculated availability of MP varied from 105 g/kg dry matter (DM) for cowpeas to 173 g/kg DM for berseem clover (*Trifolium alexandrinum*) indicating that all forages would be able to meet the requirements of dairy cows producing up to 30 L/milk/day, provided they were able to consume over 19 kg DM of forage/cow/day.

Grasses had much higher hemicellulose (neutral detergent fibre minus acid detergent fibre) content than legumes. Kikuyu (*Pennisetum clandestinum*), a C_4 grass, had a higher proportion of hemicellulose content than the C_3 temperate grasses. Perennial ryegrass (*Lolium perenne*) and kikuyu had a similar metabolisable energy (ME) density (9.9 MJ/kg DM) in summer. The mean ME density of perennial ryegrass, prairie grass (*Bromus wildinowii*) and short rotation ryegrass (*Lolium multiflorum*) winter was similar at 10.6 MJ/kg DM and slightly higher than cocksfoot (*Dactylus glomeratus*), phalaris (*Phalaris tuberosa*) and fescue (*Fescue arundunicea*) which had a mean ME density of 10 MJ/kg DM.

All forages grown were able to satisfy MP and ME requirements of dairy cows producing up to 30 L milk/cow/day, provided they were able to consume sufficient forage to achieve this level of production.

Keywords: Rumen degradability; Metabolisable protein; Nutritive value; Forages; Dairy cows

1. Introduction

Grazed pasture is the predominant feed source for dairy cows in Australia. However, most cows are fed

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some supplement to address quantity and quality deficits in pasture availability. The predominant pasture species used to graze dairy cattle is perennial ryegrass (*Lolium perenne*) for reasons of high nutrient quality and, under an appropriate environment, a long growing season. However, the climate in most dairy regions of Australia is marginal for the growth of perennial ryegrass with many farmers reestablishing pastures every 2–4 years or oversowing on an annual basis. Previous studies by Fulkerson et al. (2003), confirmed the lack of persistence of perennial ryegrass in diverse dairy regions of Australia. Furthermore, these studies indicated that management could only go so far to improve persistence. In this context, the dairy industry was interested in alternative forage species to perennial ryegrass with selection based on more industry-relevant criterion such as water use efficiency, nutrient content and palatability, than yield which has been the predominant selection criteria in the past.

Nutrient (protein, carbohydrates, minerals and vitamins) content and metabolisable energy (ME) density changes in relation to season (Fulkerson et al., 1998; Smith et al., 1998; Stockdale, 1999), stage of growth (Reeves et al., 1996; Mulholland et al., 1996; Nandra et al., 1998; Ayres et al., 1998; Fulkerson et al., 1999), time of day (Minson, 1990; Fulkerson et al., 1995; Reeves et al., 1996; Lindgren and Lindberg, 1998), soil fertility or fertilizer application rate (particularly nitrogen (N)) (Reeves et al., 1996) and probably soil moisture status. Thus, an awareness of the factors influencing nutrient content of forage is required to allow more efficient supplementation of animals.

In a pasture-based farming system, energy is usually the first limiting nutrient for milk production of dairy cows (van Vuuren, 1993). The nonstructural carbohydrates (NSC) (such as low molecular-weight sugars, starch and fructosans), and structural polysaccharides or dietary fibre (consisting of cellulose, hemicellulose and lignin) which comprise the principal components of cell walls (Theander et al., 1993) are considered to be the primary energy source for ruminant animals. However, the fibre content of ryegrass can vary from being deficient when the plant is in a vegetative state (between May and August) (Fulkerson et al., 1998), to excess (Delagarde et al., 2000), after seed set or where moisture is deficient in summer. Non-structural carbohydrates are important in that they are a readily fermentable source of energy in the rumen and may also be important in synchronizing with rumen ammonia from the high protein intakes common in cows grazing pasture (Trevaskis et al., 2004).

The crude protein (CP) content of perennial ryegrass is commonly over 25% and can be as high as 35%, whilst the CP content of kikuyu (*Pennisetum clandestinum*), another pasture species of major importance to the dairy industry, can be over 20% (Fulkerson et al., 1998). Thus, these pastures can provide protein levels in excess to cow requirements (NRC, 2001). While ME requirements of ruminants can be calculated reasonably accurately (ARC, 1980), determination of protein requirements has proven more difficult and an understanding of ruminant requirements lag behind those of mono-gastric species.

Protein digestion in ruminants is a two-stage process from (1) microbial protein synthesized in the rumen from feed degradation (and non-protein-N (NPN)), and (2) feed protein which reaches the small intestine intact i.e. by passing degradation in the rumen (UDP). Recognition of these processes led to development of the rumen degradable protein (RDP)/UDP system (ARC, 1980, 1984). Recent feeding standards (e.g. AFRC, 1993) suggest that protein requirements of ruminants should be based on metabolisable protein (MP). The major advance in using MP over the RDP/UDP system is that microbial protein availability is

Table 1
Details of forage species evaluated for nutrient content

Forage species		Cultivar
Common name	Scientific name	
Temperate grasses		
Perennial ryegrass	*Lolium perenne*	Bronsyn
Cocksfoot	*Dactylus glomerata*	Kara
Fescue	*Fescue arundinacea*	Quantum
Phalaris	*Phalaris tuberosa*	Holdfast
Prairie grass	*Bromus wildenowii*	Matua
Short rotation ryegrass	*Ll. multiflorum*	Concord and Tetila
Perennial legumes		
Lucerne	*Medicago sativa*	Spectre
Red clover	*Trifolium pratense*	Astred
White clover	*Trifolium repens*	Kopu
Birdsfoot clover	*Lotus corniculatus*	Dawn
Annual legumes		
Sulla	*Hedysarum coronarium*	Aokan
Lablab	*Lablab purpureus*	Highwarth
Cow pea	*Vigna unguiculata*	Red Caloon
Persian clover	*Trifolium resupinatum*	Shaftal
Berseem clover	*Trifolium alexandrenum*	Elite-11
Balansa clover	*Trifolium michelianum*	Paradena
Melilotus	*Melilotus indicus*	Vicia
Tropical grasses		
Kikuyu	*Pennisetum clandestinum*	Whittet
Paspalum	*Paspalum dilatatum*	Common