Nutritive value of subtropical grasses invading North Island pastures

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Abstract

A study was undertaken to ascertain the possible nutritional impact of subtropical grass invasion into pastures, by chemically analysing five common subtropical grasses. Leaves taken from kikuyu *(Pennisetum clandestinum)*, paspalum *(Paspalum dilatatum)*, smooth witchgrass *(Panicum dichotomiflorum)*, crowfoot *(Eleusine indica)*, and summer grass *(Digitaria sanguinalis)* were collected from grassland in the North Auckland, Waikato and Manawatu regions. Leaves of perennial ryegrass *(Lolium perenne)* were also taken from each pasture as a reference temperate grass. Relative to perennial ryegrass the subtropical species clearly showed increased levels of neutral detergent fibre (NDF; 38.4% vs 57.5%) but reduced levels of total protein (23.0% vs 13.2%), soluble sugar (11.7% vs 5.9%) and *in vitro* organic matter digestibility (OMD; 84.0% vs 66.6%). Similar results were obtained for grasses grown in each of the three areas. Of the subtropical grasses, summer grass was of the highest nutritive value and crowfoot was of the lowest. The results of an *in vitro* rumen protein degradation experiment showed net ammonia produdtion from pasture fermentation was significantly lower for the subtropical species than for perennial ryegrass. The present study indicates that the subtropical grasses are of considerably lower nutritive value than perennial ryegrass. Their continued spreading into grazing pastures will probably substantially decrease the nutritive value of the pastures and animal production.

Keywords: nutritive value, subtropical grasses

Introduction

Perennial ryegrass *(Lolium perenne)* - white clover *(Trifolium repens)* mixtures are by far the most prevalent type of grazing pastures sown in New Zealand, but an increasing number of subtropical grasses have recently become established in some areas of the North Island, especially in dairying regions, i.e., Auckland, Waikato and Bay of Plenty. Both perennial species such as kikuyu *(Pennisetum clandestinum)* and paspalum *(Paspalum dilatatum)*, and annual species such as summer grass *(Digitaria sanguinalis)*, crowfoot grass *(Eleusine indica)* and smooth witchgrass *(Panicum dichotomiforum)*, are common in pastures.

Although subtropical grasses grow readily, remain green and produce more dry matter than traditional pasture mixtures during a prolonged dry summer, their chemical composition has not been extensively evaluated. Previous studies (Minson 1972; Joyce 1974; Forde *et a/.* 1976) have identified that paspalum and kikuyu can have lower nutritive values than temperate species such as perennial ryegrass, but little is known of the nutritive value of the common annual species which regularly appear as volunteers in pasture, especially crowfoot and smooth witchgrass.

The objective of this experiment was to compare the chemical composition of invading subtropical grasses with that of perennial ryegrass and to determine if the increasing quantities of subtropical grasses invading North Island pastures will alter the nutritive value of the feed.

Materials and methods

Leaves from five subtropical grasses and the temperate grass perennial ryegrass were harvested during mid-summer from grassland in the Manawatu, Waikato and North Auckland regions and transported on dry ice to Palmerston North. Leaf samples of kikuyu, paspalum, smooth witchgrass, crowfoot, summer grass and perennial ryegrass were immediately freeze-dried on arrival at AgResearch, Palmerston North and ground to pass through a l-mm sieve. Analysis was undertaken at Massey University and AgResearch, Palmerston North for total nitrogen (N) by the Kjeldahl procedure with crude protein calculated as total N x 6.25, condensed tannin (CT) using the extractable and bound method of Terrill *et al. (1992)* and soluble sugars as described by Bailey (1967). Neutral detergent fibre (NDF; total cell wall) was analysed using the niethod of Robertson & Van Soest (1981), and organic matter digestibility (OMD) was determined using the method of Roughan & Holland (1977).

In addition to the chemical analysis, *in vitro* rumen incubations were, performed following the method described by McNabb *et al.* (1994) to measure the net conversion of plant nitrogen to ammonia, using rumen fluid from three sheep fed a basal diet of meadow hay (850 g/day) and lucerne chaff (150 g/day). Plants of the same species from the three different regions were bulked together. In addition lucerne (0% CT) and *Lotus corniculatus* (4% CT) were used as internal references to check the performance of the *in* vitro technique, Four replicates of each plant material were used. Freeze-dried material was weighed into stoppered flasks with 0.2% cellobiose (energy). Polyethylene glycol (PEG; MW 3,350) was added to one of each duplicate. PEG binds to CT, preventing the CT binding to protein (Jones & Mangan 1977); hence the effect of CT on forage protein degradation can be deduced by comparing control flasks (CT acting) with PEG flasks (CT inactivated). Sixty ml of freshly prepared artificial saliva (pH 6.8; McDougall 1948) was added to each flask along with 15 ml of strained rumen fluid, the flasks were then flushed with CO_2, stoppered and shaken (200 rpm) at 39ºC for 8 hours. 20 ml subsamples were removed at 0, 4 and 8 hours from each flask, acidified and stored at 4°C for ammonia analysis using a Cobas Fara automatic analyser (Cobas Fara, F. Hoffmann-La Roche Ltd, Switzerland).

Results

Relative to perennial ryegrass, all the subtropical species showed reduced levels of crude protein, soluble sugars and OMD with increased levels. of NDF (Table 1). OMD was on average 17% units lower than for perennial ryegrass. All grasses analysed contained trace levels of CT (0.07-0.30%) with the exception of crowfoot from both the Waikato and Manawatu regions, which contained negligible levels (0.01-0.04%) and kikuyu sampled from Waikato (0.03%). Crowfoot stood out among the subtropical species as having very low levels of crude protein (6.6-8.9%), high NDF (62-67%) and low OMD (52-67%). Summer grass was also notable for having the lowest NDF level (44-52% DM) and the highest OMD (71-76% OM).

Plants grown in North Auckland were consistently lower in OMD for all subtropical species analysed; kikuyu 65.4% vs 66.3% and 69.5% for Manawatu and Waikato respectively, paspalum 58.3% vs 67.8% and 64.7%, crowfoot 52.2% vs 67.5% and 64.0%. Perennial ryegrass followed the trend, with OMD 81.7% and 86.2% for North Auckland and Waikato respectively.

Table 1 Chemical composition of the leaves of subtropical grasses compared with perennial ryegrass leaves (samples were analysed in duplicate).

Area	Species	Crude protein* (% DM)	Total condensed tannin (% DM)	Soluble sugar (% DM)	NDF[3] (% DM)	OMD[4] (% DM)
North Auckland	Ryegrass'	24.2	0.30	12.1	40.3	81.7
	Kikuyu	17.5	0.10	4.3	58.8	65.4
	Paspalum	15.7	0.25	8.6	58.2	58.3
	Crowfoot	6.6	0.13	3.8	67.0	52.2
Manawatu	Kikuyu	16.8	0.14	6.6	56.1	66.3
	Paspalum	i5.5	0.09	6.4	63.3	67.8
	Witchgrass	6.5	0.21	9.7	57.9	71.2
	Summer grass	12.0	0.12	6.3	52.3	76.4
	Crowfoot	8.9	0.01	8.0	62.1	67.5
Waikato	Ryegrass[1]	21.8	0.07	11.3	36.5	86.2
	Kikuyu	15.6	0.03	5.1	59.4	69.5
	Paspalum	15.8	0.18	7.9	63.0	64.7
	Witchgrass	13.3	0.12	8.5	53.6	63.7
	Summer grass	19.2	0.20	5.7	44.2	71.2
	Crowfoot	8.9	0.04	0.0	62.8	64.0
Mean values	Ryegrass'	23.0	0.19	11.7	36.4	84.0
	Kikuyu	16.6	0.09	5.3	58.1	67.1
	Paspalum	15.6	0.17	7.7	61.5	63.6
	Witchgrass	9.9	0.17	9.1	55.8	67.5
	Summer grass	15.6	0.16	6.0	48.3	73.0
	Crowfoot	8.1	0.06	1.3	64.0	61.2

1 Perennial ryegrass
2 Crude protein Nx 6.25
3 NDF; Neutral detergent fibre; total cell wall
4 OMD; Organic matter digestibility

Ammonia accumulation after 8 hours, in vitro rumen fermentation, expressed as a percentage of forage total N added (Table 2), averaged 0.85% for the subtropical grasses, 5.3% for perennial ryegrass and 12.2% for lucerne, values being similar in the presence and absence of PEG. Among the subtropical grasses, highest values were recorded for kikuyu, with negative values for crowfoot. *Lotus corniculatus* was the only plant to show a significant increase in ammonia accumulation with the addition of PEG, indicating its CT were reducing degradation of forage protein to ammonia.

Table 2 Ammonia accumulation after 8 hours' *in vitro* rumen fermentation, expressed as a percentage of forage total nitrogen added (mean values ± SE determined for 4 replicates of each treatment).

Species	Total N (% DM)	PEG -	PEG +	Level of significance
Perennial ryegrass	3.68	5.3 ± 0.60	5.3 ± 0.71	NS
Kikuyu	2.66	4.7 ± 0.32	4.6 ± 0.25	NS
Paspalum	2.50	1.3 ± 0.61	1.7 ± 0.31	NS
Witchgrass	1.59	0.3 ± 0.30	0.4 ± 0.35	NS
Summer grass	2.50	0.2 ± 1.17	0.2 ± 1.29	NS
Crowfoot	1.30	-2.2 ± 0.26	-2.1 ± 0.29	NS
Lucerne	4.61	12.2 ± 1.08	12.7 ± 1.36	NS
Lotus corniculatus	3.85	4.7 ± 0.38	10.7 ± 1.56	**

NS, $P > 0.05$; **, $P < 0.01$.

Discussion

The present study indicated that the invasion of perennial ryegrass-white clover pastures by subtropical grasses would considerably reduce nutritive value. This was true for all five invading species analysed, the OMD values being on average 17 digestibility units lower for the subtropical grasses compared with perennial ryegrass. This decrease would be expected to lower voluntary feed intake (VFI) (Minson 1981) and in combination with the lower OMD would be likely to decrease animal production.

Differences in nutritive value were evident within the subtropical grasses, kikuyu, paspalum and summer grass having the highest crude protein contents. Crowfoot had the lowest nutritive value, with high fibre content and crude protein content so low that ammonia supply could be restricting rumen microbial growth. This is consistent with observations that it is often rejected by grazing livestock.

Summer grass contained moderate levels of crude protein and OMD with a lower NDF than the other subtopical grasses, indicating that of the invading species summer grass would have the least effect on pasture nutritive value. There may be some opportunities to develop more agronomically desirable varieties of this subtropical grass if more leafy varieties could be developed, as the leaf material is clearly of some nutitional value.

There is increasing interest in New Zealand in CT for improving the efficiency of nitrogen digestion in ruminants fed fresh forages (Waghorn *et al.* 1990). The results from this study shows that three subtropical grasses and perennial ryegrass contained traces of CT. However, the levels of CT were too low to be effective in reducing the net degradation of plant nitrogen to ammonia, and the nutritional advantages of CT in protecting protein degradation as seen in species such as *Lotus corniculatus* were not observed for any of the grasses.

It is concluded that without effective pasture management, the continued invasion of subtropical grasses will lower the nutritive value of traditional perennial ryegrass-white clover pastures. The spread of subtropical grasses may be limited by agronomic practices, e.g., spraying or resowing, or grazing strategies (e.g., harsh grazing in autumn). Conversely, a supplementary feeding strategy could be devised to ensure grazing stock are not deficient in the required nutrients for maximum production. Based upon the differences in chemical composition between perennial ryegrass and the subtropical grasses shown in Table 1, such supplements should have high concentrations of readily fermentable carbohydrate and contain rumen-undegradable protein.

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