Effects of *Desmodium*, *Sesbania* and *Calliandra* Supplementation on Growth of Dairy Heifers Fed Napier Grass Basal Diet

R. J. Kaitho[1] and J. N. Kariuki
Kenya Agricultural Research Institute, National Animal Husbandry Research Centre
P. O. Box 25, Naivasha, Kenya

ABSTRACT : The effect of feeding heifers young Napier grass (7-weeks regrowth) or old Napier (16-weeks regrowth) supplemented with either wilted *Desmodium intortum*, *Sesbania sesban* or dried *Calliandra calothyrsus* leaves on intake and live weight changes was evaluated in a 67-day trial. Thirty-two Friesian heifers with an average live weight of 271 kg and 16.8 months old were randomly allocated to the four diets. The diets were either *ad libitum* young Napier grass or old Napier grass supplemented with 25% of either *Sesbania*, *Desmodium* or *Calliandra*. There was significant difference in chemical composition between the young and old Napier grass. Significant differences ($p < 0.05$) were observed on intake of dry matter, organic matter, crude protein and neutral detergent fibre. The total dry matter intake was 2.77, 2.86, 2.62 kg/100 kg live weight (LW) for *Desmodium*, *Calliandra* and *Sesbania* supplemented diets, respectively. A dry matter intake of 3.11 kg/100 kg LW was observed on the heifers fed young Napier grass. The mean daily gains were 638, 732, 606, and 1,001 g/day for *Desmodium*, *Calliandra*, *Sesbania* supplemented and young Napier grass diets respectively. Low level supplementation rate (1 - 1.5 kg DM/day) was adequate to maintain good growth rate when the heifers were fed old Napier grass.
(**Key Words:** Forage Supplementation, Intake, Growth, Napier, Heifers)

INTRODUCTION

In developing countries, feeding of dairy cattle is often based on crop residues and low quality native hay or pasture. Since these are often low both in protein and energy there is a need for supplementary feeding to meet nutrient requirements, even for maintenance. As supplies of commercial concentrate, agro-industrial by-products or domestic cereals are limited and consequently expensive, other supplementary feeds produced on-farm are needed for cattle feeding. Forage legumes are endowed with high nitrogen content and can be used as protein supplements to poor quality grasses and cereal by-products. Their use has resulted in some dramatic increases in animal performance (Stobbs and Thompson, 1975) which have encouraged their widespread adoption.

A large number of shrubs and tree legumes have been documented as useful livestock fodders (Topps, 1992). Particularly *Leucaena leucocephala* and *Gliricidia sepium*, have been used as supplements to a wide range of forages and agricultural by-products. *Leucaena leucocephala* inclusion improved performance of sheep (Kaitho et al., 1997), goats (van Eys et al., 1986), dairy heifers (Thirumalai et al., 1991), and calves (Pachauri and Pathak, 1989) on a number of different grass basal diets. *Calliandra ca lothyrsus*, *Sesbania sesban* and *Desmodium intortum* have been adopted as protein supplements to poor quality grasses and cereal by-products in the cut-and-carry feeding systems. Desmodium is intercropped with Napier grass, while *Sesbania* and *Calliandra* browses are established as hedge rows or alleys. These forage legumes are hardy and have favourable chemical composition, with a nitrogen content of 3 - 5% in dry matter (edible leaves and stem). As Napier grass matures, the nutrient content decreases, while dry matter content and yield increases. Therefore farmers can either feed young Napier if land and labour is not a constraint, or feed old Napier which requires supplementation to maintain the same level of production. Therefore this experiment was designed to investigate the effect of feeding Friesian heifers young Napier grass (7-weeks regrowth) or old Napier (*Pennisetum pupureum*) grass (16-weeks regrowth) supplemented with either wilted *Desmodium intortum*, *Sesbania sesban* or dried *Calliandra calothyrsus* leaves on intake and live weight changes.

[1] Address reprint requests to R. J. Kaitho.
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MATERIALS AND METHODS

Napier grass, *Sesbania* and *Desmodium* were grown under irrigation at the National Animal Husbandry Research Centre, Naivasha, while *Calliandra* leaves were harvested and dried at Kisii Farmers Training centre. Thirty-two heifers (271 kg, 16.8 months old) selected from the centre herd were blocked on weight and age into four groups and allocated to the experimental diets in a completely randomized block design. They were housed in cubicles with individual feeding facility and offered their corresponding diets for 67 days. The diets were either *ad libitum* young Napier grass or old Napier grass supplemented with 25% of either *Sesbania*, *Desmodium* or Calliandra. Water was provided *ad libitum*. The supplements were fed prior to feeding of Napier grass in the morning. Fresh Napier grass was harvested and transported to the stable daily and chopped to particles size of about 2 cm using a motorized chaffcutter. Feeding was such that 30, 25, 25 and 20% of the basal diet was fed in the morning, noon evening and at night, respectively. The amount of offer was adjusted daily to allow a left-over of 10-15%. The heifers were weighed weekly and underwent routine spraying and animal health care similar to all cattle in the research centre.

Four rumen-fistulated Friesian steers (451 kg; SD = 8.2) were used for degradability studies using the nylon bag technique (Mehrez and Ørskov, 1977). Each steer was fed Napier grass supplemented with 1 kg concentrate (CP = 12.6%, NDF = 46.9%). The feed samples were ground through 2.5 mm screen, weighed into nylon bags (12 cm × 14 cm; 41 μm pore size; Polymon, Swizerland) and incubated for 0, 3, 6, 12, 24, 48, 72, 96, 120 and 336 h. After incubation, the bags were washed in a washing machine (set temperature 30℃) without spining. The bags were dried in a forced-air oven at 60℃ for 48 h, cooled in a desiccator, and weighed.

Sample preparation and chemical analysis

Feed samples were obtained by regularly taking samples as the chopping progressed (6-8 kg). Subsapmpling was done by spreading the bulked sample on a polythene sheet to form a ridge and taking four segments of the ridge for each of the samples taken for dry matter and chemical analysis. The chemical analysis samples were bulked for every three consecutive days after drying at 60℃. Similarly, the individual heifer dietary feed left-overs were daily sampled for dry matter determination.

Samples of feeds and refusals were ground to pass a 1-mm screen using a Wiley mill, while rumen incubated residues were ground using a mortar and pestle. Dry matter was assayed on the offered and refused feed using the method described by the AOAC (1990). All other analyses were determined using air-dried feed samples and oven-dried (60℃) rumen incubated residues. Analyses for ash and Kjeldahl nitrogen (N) in forages were according to AOAC (1990) standard procedures. Neutral detergent fibre (NDF), acid detergent fibre (ADF) and lignin were analysed using the method of van Soest and Robertson (1985).

Data and statistical analysis

Live weight gain (LWG) over the experimental period was calculated by regressing body weight (kg) of individual animals measured weekly on time (in days). Residual DM at the various stages of incubation were expressed as fractions of original amounts incubated and the results analysed by non-linear regression (SAS, 1987) based on the following model (Robinson et al., 1986):

$$R_t = U + (1000 - S - U) + e^{-kd(t-L)}$$

where R_t = residue at time t
U = truly indigestible residue (336 h incubation)
S = water soluble fraction (0 h incubation)
Kd = rate of degradation (%/h)
L = lag phase.

Different rates of degradation were obtained by fitting the model with (Kd 1) and without (Kd 2) lag phase.

RESULTS

Chemical composition on Napier grass and supplements offered is given in table 1. These was significance difference ($p < 0.05$) on dry matter, crude protein, neutral detergent fibre and ash content on Napier and the supplements. The legume supplements had higher ($p < 0.05$) crude protein content than the Napier grass, however Napier grass had higher ash and neutral detergent fibre levels than the legumes. The old Napier was in the late vegetative growth stage and had a crude protein content of 6.4% which was significantly lower than crude protein of the young Napier grass (8.5). The young Napier grass had relatively higher solubility and degradability than the old Napier, while among the supplements, *Sesbania* had higher solubility and degradability than *Calliandra* and *Desmodium*.

Table 2 shows mean nutrient intake and live weight gain of heifers fed young Napier grass or old Napier grass supplemented with forage legumes. Significant differences ($p < 0.05$) were observed on intake of dry matter, organic matter, crude protein and neutral detergent fifre. Animals fed young Napier grass had significantly ($p < 0.05$) higher dry matter intake and live weight gain than those fed old Napier grass. The total dry matter intake was 2.77, 2.86, 2.62 kg/100 kg live weight for *Desmodium*, *Calliandra* and *Sesbania* supplemented diets respectively. A dry matter intake of 3.11 kg/100 kg live weight was observed on the heifers fed young Napier grass. The mean daily gains were 638, 732, 606 and 1,001 g/day for *Desmodium*, *Calliandra*, *Sesbania* supplemented and young Napier grass diets respectively.

Table 1. Chemical composition (%) and rumen degradability of Napier and legume supplements fed to heifers

Component (%)	Young Napier	Old Napier	*Desmodium*	*Calliandra*	*Sesbania*	SED
DM	16.6	23.7	29.6	90.9	29.0	0.82
ASH	19.8	16.5	10.8	7.8	7.3	0.37
CP	8.5	6.4	12.7	21.2	15.5	0.22
NDF	62.7	67.5	59.9	49.5	55.1	0.64
ADF	29.0	34.4	35.2	29.7	10.6	0.97
ADL	2.6	3.1	8.9	13.3	2.9	0.14
S (%)	28.4	18.5	19.3	28.7	31.6	
U (%)	17.4	23.7	28.9	22.3	3.0	
L (h^{-1})	0.2	1.6	1.5	3.4	1.5	
Kd 1 (% h^{-1})	3.5	2.6	2.9	1.6	5.8	
Kd 2 (% h^{-1})	3.1	2.5	2.7	1.2	5.3	

DM: dry matter (%); CP : crude protein (%); NDF: neutral detergent fibre (%); ADF: acid detergent fibre (%); ADL: lignin (%); S: water soluble fraction, U; undegraded residue; L: lag phase; Kd 1; degradation rate from a model including lag phase, Kd 2; degradation rate from model excluding lag phase; SED: standard error of difference (n = 20).

Table 2. Nutrient intake (kg/100 kg LW) and live weight gain (LWG, g/day) of heifers fed young Napier grass or old Napier grass supplemented with forage legumes

	Young Napier	Old Napier supplemented with			SED
		Desmodium	*Calliandra*	*Sesbania*	
DMI Napier grass	3.11	2.31	2.43	2.28	0.037
DMI supplement	–	0.46	0.43	0.34	0.017
Total DMI	3.11	2.77	2.86	2.62	0.039
CPI	0.24	0.21	0.25	0.20	0.005
NDFI	1.95	1.83	1.85	1.73	0.065
OMI	2.49	2.34	2.43	2.22	0.033
LWG	1,001	638	732	606	154.8

LW: live weight; DMI: dry matter intake (kg/100 kg LW); CPI: crude protein intake (kg/100 kg LW); NDFI: neutral detergent fibre intake (kg/100 kg LW); OMI: organic matter intake (kg/100 kg LW); SED: standard error of difference (n = 8).

DISCUSSION

The pattern of growth and nutrient intake observed in this study indicate that supplementation of poor quality Napier grass with legumes had a positive impact on daily gains. Legume supplementation of grass diets with less than 7% CP has been shown to increase dry matter and animal performance (Minson and Milford, 1967). In many parts of tropics, there are regular feed shortages and droughts and therefore under such conditions subsistence feeding, mainly poor quality grasses and crop byproducts, results in reduced live weight and perpetual low productivity of livestock. The severe nutritional limitations are further associated with delayed age at first calving, increased interval between parturitions, increased non-productive life of animals and herd wastage. Therefore, during times of feed shortage, forages from shrubs and especially trees have a great value as they supply dietary nitrogen, energy, minerals and vitamins.

Most investigations of intake response to protein supplementation have been conducted with concentrate supplements. Previous research indicates that browses will support similar level of animal performance when fed to provide similar amounts of CP (Khalili and Varvikko, 1992; Varvikko and Khalili, 1993; Richards et al., 1994). In this study, animals on young Napier grass gained more weight than those fed old Napier grass and supplemented with the forage legumes. In a previous study, Kaitho and Kariuki (1990), heifers fed old Napier grass sustained a growth of 400 g/d while those fed young Napier grass gained over 750 g/d. Legume supplementation of grass-only diets has been observed to improve animal performance (Chadhokar and Kantharaju, 1980; Reed et al., 1990). These responses have typically been attributed to the legume overcoming the depressing effect that the low N concentration grass has on intake (Minson and Milford, 1967), and by the legume providing ruminally degradable N (Van Eys et al., 1986) or ruminally escape N (Flores et al., 1979).

Most of the forage legumes contain biochemically active materials, such as cyanogenic glycosides, tannins, goitrogenic and allergenic substances that affect metabolism. When livestock are on free range pasture, as in an extensive production systems, they are hardly affected. This may be because of the animals have a variety of forage material to select from. Under zero grazing system, the farmer hardly provides variety, hence incidences of toxicity are more likely. It is known that high levels of tannin are present in *Calliandra* and *Desmodium*, and both have a low digestibility (Kaitho et al., 1992) while *Sesbania* has high levels of saponins (Kaitho et al., 1997). Legumes forages with moderate levels of phenolic compounds are promising protein supplements (Kaitho et al., 1997). Although the phenolics in these species reduce nitrogen availability, the negative effect is partially offset by lower urinary loss of nitrogen, allowing adequate animal performance (Woodward and Reed, 1989).

Increased attention must be given to include potentially important shrubs and trees into native pastures, alley farming and agroforestry systems. Research on management and use of shrub and tree fodders is limited, although their potential is increasingly being recognized. There are however outstanding gaps in present knowledge concerning browse productivity and its measurement. The most important problem that urgently requires solution is how to increase the availability of browse to grazing and stall fed animals through improved management taking into considerations seasonal changes in plant productivity and the feed requirements of the animals. The nutritional value of browse has long been underestimated with the result that only limited data on intake, digestibility, utilization and the value of shrubs in dry seasons have been reported. Well designed studies need to be carried out to establish optimum levels of supplementation with various combination of forages and by-products typical of particular areas.

CONCLUSION

It is clear that forage legumes have a distinct advantage over tropical grasses in terms of their superior nutritional value, particularly as supplements to poor quality roughages. A low level supplementation rate (1-1.5 kg DM/day) was adequate to maintain good growth rate (> 600 g/day) when basal feed quality was poor (dry season feeding).

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