Full Length Research Paper

Empirical assessment of short-term preferences of tropical forages by crossbred bull calves

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Short-term preference studies were carried out with growing calves based on diets of local grass forages found in Turiani division, Morogoro, Tanzania. Four intact crossbred male calves aged 7 - 8 months and weighing 82.75 kg were used. Four grass species were provided either singly [*Panicum maximum* (T1), *Panicum trichocladum* (T2), *Pennisetum purpureum* (T3) and *Rottboelia cochinchinensis* (T4)] or in combinations of two forages in equal proportions [*P. maximum* + *P. trichocladum* (M1), *P. maximum* + *R. cochinchinensis* (M2), *P. trichocladum* + *R. cochinchinensis* (M3) and *P. purpureum* + *P. trichocladum* (M4)]. The single grass species and mixtures were respectively fed for four days. Animals were simultaneously observed while each animal was feeding on one of the four treatments in sequential periods of 15 min each in random orders (1, 2, 3 and 4) every test-day. The amounts of herbage eaten were estimated by differences between offered and left feed. The intake rate of 15.72 gDM/min, bite rate of 5.31 bites/min and bite mass of 3.11 g/bite for T3 was significantly higher (P < 0.05) than other single grass forages. There was no significant difference (P > 0.05) between intake rate of T1 (9.78 g/min) and T2 (9.36 g/min). Total DM intake of M3 and M4 of 224.54 and 232.52 g/15 min respectively were significantly (P < 0.05) higher than that of M1 and M2. All grass mixtures had bite mass significantly different (P < 0.05) from each other although that of 3.34 gDM/bite M4 was the highest thus suggesting that whether singly or in mixture *P. purpureum* was the most preferred grass forage in the study area. It is concluded that in order to optimize DM intake farmers should consider the type of grasses and their level of inclusion in grass mixture depending on their preference by cattle

Key words: Preference, calves, *Panicum*, *Pennisetum*, bite rate, intake.

INTRODUCTION

In smallholder dairy systems of Sub-Saharan Africa, the cattle production component is integrated with other classes of livestock such as goats and crops such as maize, beans, rice or coffee; depending on the agro-ecological zone of the production systems. In most of grazing lands, roadsides or in crop fields are used for feeding. Established pastures in backyards near the dwelling and on edges of cropping fields are also found in some cases. How

However, observation on the utilization of forages in various dairy systems have indicated that when smallholder farmers harvest natural or established forages multiple factors are put in consideration. These include drought tolerance or persistence, animal preference, forage palatability and convenience in harvesting (Komwihangilo, 2005).

Forage acceptability by animals on pasture or under zero grazing conditions is a function of forage palatability and forage morphology. Palatability reflects preference of the animal based on inherent chemical traits. For example there is a general consensus that sweet sugars incr-

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ease palatability while bitter tastes may decrease pala-tability (Nombekela et al., 1994) . Similarly, cattle feeding on plants with higher contents of polyphenols showed less consumption of these materials because such plants were considered to be harder or tougher (Lizarraga-Sán-ches et al., 2001). Plant structure (morphology) inhibits or enables consumption, where for example, thorns reduce preference. Moreover, if exposed to feeding for some time animals will show little interest in fresh forages given compared to situation when they have been fasted for a considerable period (Foster et al., 2002). Therefore, pre-ference of herbage is a result of available choices, physi-cal and chemical characteristics of the plant material where measuring of voluntary intake through cafeteria trials is used to infer preferences.

Field observations in smallholder dairy production sys-tems of Tanzania indicated that choices in the type and amount of various grass forages used was governed by farmers' basic objectives in keeping the dairy cattle such as more and high quality milk and growth or health per-formance (Komwihangilo, 2005). However, the amount of grass forages given and eaten was a result of plant-animal relationships that would also determine whether farmers' objectives would be realised. Unfortunately, little has been done on cattle preferences of tropical grass species under zero grazing situations. Similarly, there is paucity of information on factors determining animal choi-ce of tropical grass forages equally harvested for stall-fed animals. Experiments were, therefore, conducted to investigate forage preferences by calves based on diets of tropical grass forages locally found in the paddy-sugar-cane-dairy (SPD) based farming system of Turiani divi-sion, Morogoro, Tanzania. The findings were expected to complement information on local knowledge of available resources in the view of seeking sustainable means in efficient utilization of the vast forage resources available in smallholder dairy production systems.

MATERIALS AND METHODS

Location

The experiments were conducted at the Centre for Sustainable Rural Development (SURUDE) (Latitude: 06º17'S Longitude: 37º 68'E, 372 m above sea level) located in Lungo village, Turiani division, Morogoro, Tanzania in March and April 2003. This area is within the sub-humid agro ecological zone with the prevalence of the bimodal type of rainfall. Characteristically, the short rains are between October and December whereas between March and May is the long rainy season. The two periods are marked with rainfall peaks in December and April.

Experimental design and treatments

Four crossbred bull calves aged between 7 and 8 months and weig-hing 82.75 ± 0.35 kg (Mean $\pm$ SEM) were used in 4 x 4 Latin square design to measure short-term DM intake of either four single forage grasses or four grass mixtures (TREATMENTS). The treatments were assigned in four consecutive days of the data collection period (ROWS) in four sequential orders (COLUMNS). The order of offer for the treatment was varied each day while the periods between

changes for each order were 15 min. The experiments involved 7 days of acclimatization before the start of 4 days of data collection (for the first trial). The second trial (also 4 days of data collection) followed immediately after the first trial. Each animal was confined to a pen measuring 150 x 175 cm and fed individually. The forages were put in feeding troughs measuring 70 x 40 x 23 cm. All the animals were drenched against internal parasites with a broad-spectrum antihelminthic (Tramazole 10% Albendazole, Univet Limi-ted, Tullyvin, Cavan, Ireland). Thereafter, they were sprayed fort-nightly against external parasites. They had been exposed to the feeding stalls 21 days before they were subject to any experimental work. During the acclimatization period and after each of the test-days, animals were fed with a mixture of the four grass species at approximately equal proportions on fresh weight basis. The grasses were *Panicum maximum*, *Panicum trichocladum*, *Pennisetum pur-pureum* and *Rottboelia cochinchinensis*. All grasses were harvested from communal grazing areas where they were naturally growing. All the materials were in vegetative stages (before blooming). For a-ge collections were done daily from within 8 km radius from the experimental site. The grasses were harvested in the evening prior to the test day (using sickles) and stored under shade. The follow-ing morning they were chopped to lengths of 15 – 20 cm using *machete*, thoroughly mixed and stored in polypropylene bags prior and during the feeding period.

Feeding for data collection

Single forage presentations

Two kg of chopped green grasses, *P.* maximum (T1); *P. trichocladum* (T2); *P. purpureum* (T3) and *R. cochinchinensis* (T4), were measured into a plastic bag of known weight using an electronic digital scale. The test grasses were sorted to ensure that each grass species was not mixed with other grass species or other plants. The weighed grass species was put in the feeding troughs and an animal was allowed to feed for 15 min. Two kg of the test feed were put in another plastic container (control) measuring 60 x 40 x 15 cm in order to measure evaporative weight losses. At the end of every 15 min, the amount of grass remaining in the feeding trough was carefully collected and weighed out; the feeding troughs were then cleaned and a new treatment offered. This continued until all the four species were offered for that day. The order of feeding was altered the following day and consequently in the four days of the trial. In each turn, two independent observers monitored the eating behaviours of two animals at a time. These observers were the same throughout the experimental period. Each of them was standing from a raised platform situated at a distance of appro-ximately one metre from the feeding trough. Using a score sheet and a stopwatch the observer recorded the numbers of prehension bites for the animal allocated to him within the total time of obser-vation (15 min) . This means, therefore, that the four animals were simultaneously tested with the same treatment in random orders (1, 2, 3 and 4) always at the same time of the test day. Water was avai-lable *ad libitum*. At the end of each test day (experimental day), every animal was allowed to access a freshly prepared mixture of the four grass species and a supplement for the rest of the day. The supplement was 1kg of concentrate mixture made of 53% hominy meal, 30% sunflower seed meal (SSM), 13% cottonseed meal (CSM), 3% of *Gliricidia sepium* (GSLM) and 1% mineral mix (all on DM basis). However, the supplement was offered before the rest of other feeds so as to make sure all the concentrate mixture was con-sumed. Each animal was maintained in the same pen and feeding trough throughout the experimental period. Feed was availed only during the day that is, from 8.00 a.m. until the end of the data col-lection for that day, then continued to 7.00 p.m.

Random grab samples from each of the offered forage species were taken and remixed. Two sub-samples of each were packed in

paper bags and were taken to the laboratory for drying and subsequent DM content determination. Proximate chemical composition and *in vitro* digestibility of the samples were determined using AOAC (1990) and Tilley and Terry (1963) procedures respectively.

Calculations

The amount of herbage intake (HI) was estimated by the formula:

HI = (WB$_b$ – WB$_a$) – (WC$_B$ – WC$_a$) … ……………. Equation (i).
Where:
WB$_b$ = Weight of plastic bag with forage before feeding
WB$_a$ = weight of plastic bag with forage after feeding
WC$_B$ = weight of control plastic container before feeding
WC$_a$ = weight of control plastic container after feeding

The following calculations were performed for intake rate (IR), bite rate (BR) and average bite mass (ABM):

$$IR = \frac{\text{Total DM intake (gDM)}}{\text{Time observed (min)}} \dots\dots\dots\dots\dots\dots\dots . \text{ Equation (ii)}$$

$$BR = \frac{\text{Total number of bites (bite)}}{\text{Time observed (min)}} \dots\dots\dots\dots\dots \text{ Equation (iii)}$$

$$ABM = \frac{\text{Total DM intake (gDM)}}{\text{Total number of bites (bite)}} \dots\dots\dots\dots\dots\dots \text{ Equation (iv)}$$

Mixed forage presentations

This experiment followed immediately after the single forage presentation experiment. In this test the conduct was the same except that the treatments (M1 – M4) were in a combination of two grass species in equal proportions. Forage combinations were based on local evaluation criteria of availability (abundances) and animal preferences. For example, it had been recorded previously that farmers ranked *P. maximum*, *P. purpureum*, *P. trichocladum* and *R. cochinchinensis* as the most and the least in that order based on availability in the area. Similarly, they ranked *P. purpureum*, *P. maximum*, *P. trichocladum* and *R. cochinchinensis* as the most and the least in that order in terms of preference by animals. Thus forage combinations were made so that at least one of the best ranking species in local quality criteria (that is *P. maximum* and *P. purpureum*) was combined with a moderately or poorly ranked one (*P. trichocladum* and *R. cochinchinensis*). Therefore the treatments were:

M1 = *Panicum maximum* + *Panicum trichocladum*
M2 = *Panicum maximum* + *Rottboelia cochinchinensis*
M3 = *Pennisetum purpureum* + *Rottboelia cochinchinensis*
M4 = *Pennisetum purpureum* + *Panicum trichocladum*

Calculations

All calculation for DMI, intake rate (IR), bite rate (BR) and average bite mass (ABM) in the mixed forage tests followed the same formula as ones in the single forage presentations.

Statistical analysis

The GLM procedures of SAS (1999) were used to analyse the data whereby days and order of offer represented rows and columns respectively of the Latin Square design. The multiple squares approach was followed in the analysis whereby calves represented the squares. The general model used for the analysis was written as shown (model i):

$$\gamma_{ijkl} = \mu + \alpha_{i(k)} + \beta_{j(k)} + \delta_k + \tau_l + e_{ijkl} \dots\dots\dots\dots\dots\dots\dots(\text{model i})$$

Where

$i = 1, \dots 4$; $j = 1, \dots 4$; $k = 1, \dots 4$; $l = 1, \dots, 4$.
γ_{ijkl} = Observation on the ith row (day) associated with the jth column (order) under l^{th} forage species replicated k^{th} times.
μ = Overall mean for the tth forage species associated with the jth order

α = day
β = Order of offer
δ = Calf
τ = Forage species
e = the residual error term which was assumed to be independent and normally distributed.

The Tukey option of SAS (1999) was used to compare the least square means (LS Means). Correlations of forage preference as expressed in DM intake in the 15 min observation period and forage chemical and nutritive values were also performed.

RESULTS

Mean dry matter (DM) content on as fed basis for the grass materials offered was 25.81 ± 1.98, 32.54 ± 1.27, 18.88 ± 1.75 and 23.83 ± 2.29 g/100gDM for T1, T2, T3 and T4 respectively while M1, M2, M3 and M4 had DM content of 30.67 ± 0.41, 27.46 ± 0.22, 24.74 ± 0.45 and 27.85 ± 0.82 g/100gDM respectively. There was a wide variation in CP composition with minimum and maximum CP content ranging from 6.7 to 12.17 g/100g DM. The mean CP content of individual grasses varied from 7.83 ± 0.60 to 9.65 ± 0.80 g/100gDM (Table 1). The CP content was within the minimum threshold level of 6.5 – 7 g/100g DM required for microbial activity initiation in the rumen. Mean ADF and NDF varied from 46.54 ± 1.64 and 84.25 ± 2.53 (for T4) to 49.82 ± 1.19 and 88.28 ± 1.19 (for T2) respectively. The chemical compositions of these tropical pasture species were within the range of values earlier reported (Minsonss, 1990).

Least square means (LS Means) of quantities consumed and feeding behaviour of calves offered single forage species are shown in Table 2. The overall consumption of 235.76 ± 10.27gDM/15min for T3 was significantly higher ($P < 0.05$) than that of the other three species offered singly and T2 was the least consumed 140.46 ± 10.27 gDM/15 min. Intake rate of 15.72 ± 0.68 g/min was equally the highest and significantly ($P < 0.05$) different from that of T1, T2 and T4. The bite rate of T2 (4.04 ± 0.18 bites/min) was significantly lower ($P < 0.05$) than the rates for T1, T3 and T4 therefore rendering the lowest intake at the end of the trial. However, the bite mass for T2 (2.57 ± 0.22 g/bite) was not different ($P > 0.05$) from T4 that attained the highest intake level.

The relationship between chemical content of forage and intake of the single forage species was as shown in Table 3. DM intake (g/kgLW$^{0.75}$) was negatively correlated with DM content (r 0.45, $P < 0.001$). The correlation between DM intake and ME content was poor and insignificant (r 0.13 $P>0.05$). DMI was positively correlated with

Table 1. Mean composition and nutritive value (g/100g) of grass species used in the preference study (standard error in parentheses).

	g per 100g DM								
Species	**DM[1]**	**DM**	**Ash**	**CP**	**ADF**	**NDF**	**IVDMD**	**IVOMD**	**ME MJ/kgDM**
P. maximum	25.81	92.61	11.23	7.83	48.22	87.54	42.74	47.63	5.57
	(1.98)	(0.31)	(1.40)	(0.60)	(0.75)	(0.44)	(0.91)	(5.53)	(0.13)
P. trichocladum	32.54	92.33	9.58	9.65	49.82	88.28	39.10	40.36	5.03
	(1.27)	(0.34)	(0.56)	(0.80)	(1.19)	(1.19)	(1.33)	(1.41)	(0.20)
P. purpureum	18.88	91.95	10.68	9.62	46.73	86.15	41.65	49.19	5.40
	(1.75)	(0.20)	(0.14)	(1.09)	(2.67)	(1.44)	(0.97)	(1.91)	(0.14)
R. cochinchinensis	23.83	92.00	12.18	9.61	46.54	84.25	43.22	48.63	5.63
	(2.29)	(0.63)	(0.62)	(0.81)	(1.64)	(2.53)	(1.65)	(2.25)	(0.24)

[1]DM as fed. This was 30.67 (0.41); 27.46 (0.22); 24.74 (0.45) and 27.85 (0.82) g/100g for M1, M2, M3 and M4 respectively, where:
M1 = *P. maximum* + *P. trichocladum*; M2 = *P. maximum* + *R. cochinchinensis*
M3 = *P. purpureum* + *R. cochinchinensis*; M4 = *P. purpureum* + *P. trichocladum*

Table 2. Quantities consumed and feeding behaviours by growing bull calves fed single forage species.

	Treatment				
Amount (gDM)	**T1**	**T2**	**T3**	**T4**	**SEM**
Total intake (g/15 min)	146.77[b]	140.46[b]	235.76[a]	171.55[b]	10.27
Intake rate (g/min)	9.78[b]	9.36[b]	15.72[a]	11.44[b]	0.68
Intake rate (g/kgLW$^{0.75}$)	0.36[b]	0.34[b]	0.57[a]	0.41[b]	0.03
Bites					
Total (bites/15 min)	70.19[b]	60.63[c]	79.69[a]	80.81[a]	2.72
Bite rate (bites/min)	4.68[b]	4.04[c]	5.31[a]	5.38[a]	0.18
Bite mass (g/bite)	2.23[b]	2.57[ab]	3.11[a]	2.14[b]	0.22

T1 = *P. maximum*; T2 = *P. trichocladum*; T3 = *P. purpureum*; T4 = *R. cochinchinensis*. SEM = standard error of mean [a,b,c]Means within a row with different superscripts differ significantly (P < 0.05).

Table 3. Pearson correlation coefficients of chemical composition and palatability estimates of forages offered singly to bull calves.

	ME	**NDF**	**IVDMD**	**IVOMD**	**Intake[a]**	**BM[b]**	**IR[c]**
DM	-0.47***	0.18[NS]	-0.13[NS]	-0.37**	-0.45***	-0.08[NS]	-0.28*
ME		0.07[NS]	0.79***	0.64***	0.13[NS]	-0.10[NS]	0.08[NS]
NDF			0.11[NS]	-0.25*	0.01[NS]	0.29*	-0.02[NS]
IVDMD				0.46***	-0.07[NS]	-0.23[NS]	-0.09[NS]
IVOMD					0.08[NS]	-0.23[NS]	-0.01[NS]
Intake[a]						0.72***	0.36**
BM[b]							0.18[NS]

DM = Dry matter (as fed), g/100g; ME = Metabolizable energy, MJ/KgDM; NDF = Neutral detergent fibre g/100g ; [a]Intake (g/kgLW$^{0.75}$); [b]BM = Bite mass, gDM/bite; [c]IR = Intake rate gDM/minute *** Significant at 0.001 level ; ** Significant at 0.01 level ; * Significant at 0.05 level ; [NS] = Non significant

bite mass and this relationship was strong (r 0.74 P< 0.001). The relationship between intake (g/kgLW$^{0.75}$) and DM as fed was described by the equation (v): Intake (g/kgLW$^{0.75}$) = 10.34(±0.97) – 0.15(±0.04) DM as fed (g/ 100g) (P = 0.0002, F = 15.4, R^2 = 0.20)……. Equation (v) LSMeans of intake and feeding behaviour of calves on mixed forages is shown in Table 4. LSMeans (±SEM) for intake of mixed forage species ranged from 160.20 to 232.52 g/15min. The intake rate of M4 (232.52 ± 5.71 g/15min) was significantly higher than that of M1 and M2 but not significantly (P < 0.05) different from that of M3. The bite rates for M1, M2, M3 and M4 were respectively

Table 4. Quantities consumed and feeding behaviours by growing bull calves fed mixed forage species.

Amount (gDM)	Treatment				
	M1	**M2**	**M3**	**M4**	**SEM**
Total intake (g/15 min)	160.20[b]	172.47[b]	224.54[a]	232.52[a]	5.71
Intake rate (g/min)	10.68[b]	11.50[b]	14.97[a]	15.50[a]	0.38
Intake rate (g/kgLW$^{0.75}$)	5.84[b]	6.29[b]	8.21[a]	8.49[a]	0.21
Bites					
Total (bites/15 min)	58.75[d]	77.63[b]	80.06[a]	70.31[c]	1.36
Bite rate (bites/min)	3.92[d]	5.17[b]	5.34[a]	4.69[c]	0.09
Bite mass (g/bite)	2.76[b]	2.26[c]	2.85[b]	3.34[a]	0.08

M1 = *P. maximum* + *P. trichocladum*; M2 = *P. maximum* + *R. cochinchinensis*
M3 = *P. purpureum* + *R. cochinchinensis*; M4 = *P. purpureum* + *P. trichocladum*
SEM = Standard error of mean ; [a,b,c,d]Means within a row with different superscripts differ significantly (P < 0.05).
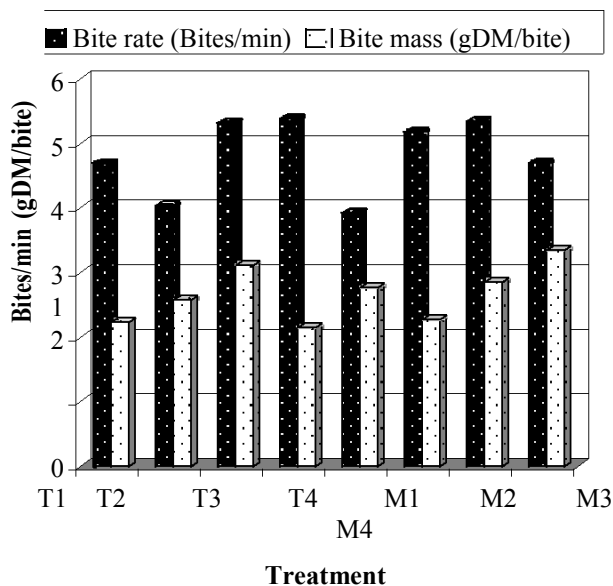
Figure 1. Comparison of forage preferences by calves: Relationship between bite rate and bite mass of single and mixed tropical grasses

3.92, 5.17, 5.34 and 4.69 (±0.09). These were significant-ly (P < 0.05) different from each other. Generally, the hig-her intake rate of M3 and M4 (14.97 and 15.50 (± 0.38) gDM/min) and subsequently high bite mass (2.85 - 3.34 (±0.08) gDM/bite) rendered the mixture containing *P. purpureum* as the most preferred. On the other hand, there was a general observation of proportionate decrease in bite mass with an increase in bite rate particularly for grass species offered singly (Figure 1).

DISCUSSION

Forage preference considered in terms of intake rate indicated that growing calves preferred *P. purpureum* to the other three species used in this study. The DM content of forages at the time of feeding may have had an

influence on the relatively higher preference of *P. purpureum* both singly or in mixture. This is in agreement with Gibb et al. (1998) and Vollborn (1998) who reported that DM content and surface moisture content of grazed forages raise bite rates and bite mass on fresh weight basis though on DM basis are the lowest. The results are also in agreement with farmers' arguments that *P. purpureum* could be consumed more because of higher water content than other species like *P. trichocladum*. Contrary to observations that a decrease in DM content could decrease intake rate in sheep (Kenney and Black, 1984), results of the present study revealed that there was no such direct relationship. Similarly, the present results were different from those of Dougherty et al. (1988) who demonstrated that when beef cattle grazed alfalfa of DM content of 160 - 280 g/kg DM, the bite mass ranged from 0.86 - 1.17 (gDM/bite). This was probably because the animals were under zero grazing and fed to grass for a-ges with higher leaf to stem ratio than alfalfa. However, the ME content may not have a direct influence on tropical forage preference although both DM and ME have a significant contribution to total DM intake and overall performance of livestock on a long term. Mayland et al. (2000) have indicated that non-structural carbohydrates such as sucrose that are readily fermentable could play a role in diet preferences for hungry animals. *P. purpureum* is also reported to have a relatively higher sugar content (FAO, 2004), a fact that may have also contributed to more consumption of this forage than the other forages used in the present study. It was reported by Wandera (1996) that *Pennisetum* species were more palatable than *Panicum*, *Cynodon* and other grass species. Similarly, earlier work in the SPD system of Turiani (Komwihangilo, 2005) indicated that farmers consider *P. maximum*, *P. purpureum* and *R. cochinchinensis* to be eagerly eaten by animals in a similar manner or *vice versa*.

Intake rates observed in the present study are representing some of the key factors in understanding palatability and voluntary feed intake. The high intake rate for any forage may have significant implication to a smallholder farmer who harvests forages on daily basis or one

planning to establish one pasture species from among the choices available. Alternatively, this implies associative effects on rumen (physical) fill animal satisfaction and performance if the respective forage was to be supplied *ad libitum*. Unlike in studies where bite rates declined with increasing bite mass (Forbes, 1988) and where prehensing bite rate doubled when intake rate declined (Black and Kenney, 1984), such a direct relationship was not found in the present study (Figure 1). This relationship could be because the practice of harvesting the feeds daily was inevitably associated with the use of species with varying characteristics. Kenney and Black (1984) and De Rosa et al. (1997) also demonstrated that factors such as particle size, fibre content, and phonological stage, grazing environments or animal body weight may influence intake. De Rosa et al. (1997) reported that in short-term trials, intake rate was determined by bite mass and bite rate whereby these two variables depend on each other. However, Forbes (1988) maintained that bite mass (bite size) varies widely with type and stage of growth of forage under investigation including the differences in leaf to stem ratio.

An increase on bite rate, intake rate and bite mass was observed with grass species fed in mixtures compared to single species. Associative effects emanating from two individual forages could have influenced the trend of observed parameters with these mixed grasses. This is in agreement with Bwire et al. (2003) who reported an increase in DM intake and milk yield when combining different grass species. In both single and mixed forage cases, other factors such as physical feel, taste or odour also play a part. Plant characteristics determining ingestibility such as easiness to chew and swallow were reported to influence preference (Boumont et al., 2003) especially when contrasting forages are combined. In the present study, however, the higher bite mass noted where *P. purpureum* was combined with other grass forages reflected that the highly preferred species could also be determined by considering specific forage species included in the mixture. This would also be an important strategy for improving DM intake and increased production with diets based on these local forages.

Digestibility had been indicated to influence forage preference such that the highly digestible forages would be more favoured (Lu, 1988). However, in such short-term trials like those in the present study, it is unlikely that digestibility of materials would have influenced preferences. On the other hand, tastes and odour of the feeds could also have applied in the observed situation, as was the case in studies of De Rosa et al. (1997).

Conclusion

In smallholder zero grazing conditions where daily harvesting of green materials is practiced, mixing of different species of green grasses (e.g. mixing of more palatable species with less palatable ones) increases total DMI of the forages. This was ascertained by the observed improvements on bite rate, intake rate as well as on bite mass for grass species fed in mixtures compared to single species. Therefore, dairy extension effort should encourage farmers to establish and maintain the forage species which are locally available that are also adapted to social and environmental conditions of respective areas.

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