Slovak J. Anim. Sci., 46, 2013 (2): 68-74

ISSN 1337-9984

PREFERENCE OF MUTURU CATTLE TO EITHER FRESH FORAGE OR PELLETED HAY OF *PANICUM MAXIMUM* AND *PENNISETUM PURPUREUM* CUT AT FOUR AND EIGHT WEEKS

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ABSTRACT

Short-term preference studies were carried out with growing Muturu calves based on diets of local grass forages found in South – Western Nigeria. Twelve intact pure bred muturu calves aged 9 - 12 months were used. Two grass species - guinea grass (*Panicum maximum*) and elephant grass (*Pennisetum purpureum*) at four and eight weeks of regrowth were harvested when needed either for pelleting or for fresh green chop. The diets were served to animals individually and later in group. Feed preference was assessed from the total intake at the end of 15 min cafeteria study while the chemical composition of each diet was also assessed. The CP content of the grasses ranged from 105 to 133 g/kg DM with pelleted *Panicum* at 8 weeks old having the highest CP. Pelleted grasses of 4 week old had the lowest ($P<0.05$) NDF in the trial. Green chopped *P. maximum* of 4 weeks old was most preferred by the calves. Age at harvest influenced preference as forages harvested at 4 weeks old had higher intake. Forage preference considered in terms of intake rate indicated that growing calves preferred fresh *P. maximum* of 4 week old to the other samples used in this study. Group feeding also influenced forage preference.
It is concluded that in order to optimize DM intake farmers should consider the type of grasses and their age at harvest particularly for Muturu. Pelleting improves acceptability of forages when rejected by animals in fresh forage form due to advanced age.

Key words: *Panicum*; *Pennisetum*; age at harvest; pelleting; Muturu calves

INTRODUCTION

The Muturu cattle breed is a variety of West African Shorthorn, which appears to have evolved through adaptation to the humid forest environment. Most of the Muturu cattle found in Nigeria are spread over the Benue plateau and the Southwest. This breed is also found in Southeastern coastal area of Ghana, eastern coastal areas of Maryland and Sinoe counties of southeastern Liberia (Rege *et al*., 1994). The management level where these cattle are kept is low in spite of which they maintain good body condition by grazing and browsing throughout the year. The Muturu is found in areas heavily infested with tsetse, as a result of which this breed has adapted and naturally selected to be tolerant to trypanosomosis, ticks and tick-borne diseases although it is susceptible to rinder-pest (Adeniji, 1983). The productivity of Nigerian livestock, Muturu in particular, is below its genetic potential principally due to poor nutrition and inadequacy of good quality feed produced from forages (Lamidi *et al.*, 2005).

Due to various degrees of constraints involved in the production of ruminants in Africa, such as the seasonality of pastures, this is brought about by climatic changes from season to season. Low nutritive pastures are unable to meet the nutritional requirement of these

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Received: October 22, 2012
Accepted: April 15, 2013

animals and also high capital involved in establishment of intensive systems of ruminant production. Ajayi *et al.* (2008) reported that if grass of any age is effectively managed, it can strategically be exploited to ameliorate forage scarcity in the off season. An example of these is processing it into pelleted forms, hay and silage which can be stored for feeding during the dry season. Therefore, since ruminants according to Babayemi and Bamikole (2006) are the best assessors of the nutritive value of any feed, as they always consume more of the forages that are high in protein than the high lignin containing grasses, a knowledge of the selectivity of the available forage will go a long way in increasing production and also the establishment of pasture and its conservation through various means such as silage, hay and pellet production to meet the nutritive needs of animals in periods when there is low availability of forage.

This trial is therefore aimed at evaluating the selective preference in Muturu cattle for two common tropical grasses at different ages served fresh and to evaluate their acceptability when processed (i.e. pelleted). Also, another objective was to evaluate the influence of group or individual feeding on forage acceptability by animals. Such information can aid in identifying key species, explain shifts in diet quality and animal performance (Holechek *et al*., 1981), and assist in developing grazing programmes (Gordon, 1988).

MATERIAL AND METHODS

The experiment was carried out at the research paddock and laboratory of the Department of Pasture and Range Management, College of Animal Science and Livestock Production, University of Agriculture, Abeokuta. The research site was located in the derived savanna zone of Southwest Nigeria with monthly rainfall which ranged from 120 mm in May to195 mm in September and mean monthly temperature ranging from 22.5º to 33.7ºC. The relative humidity in the rainy (late March-October) and dry (November-early March) season ranged between 63-96 % and 55-84 %, respectively.

Guinea grass (*Panicum maximum*) and elephant grass (*Pennisetum purpureum*) at four and eight weeks of regrowth prior to flowering collected in triplicates were staged to provide forage regrowth either 4 or 8 weeks at the time needed for pelleting or for fresh green chop. The forages for pelleting were harvested with a flail cut and were chopped into 50-60 mm using a reel cutter. They were immediately dehydrated at 120ºC (*Panicum*) and 150ºC (*Pennisetum*). The temperature difference was to achieve approximately similar moisture since *Pennisetum* has larger stems than *Panicum*. After dehydration the dried forage was milled with a hammer mill fitted with 3 mm sieve and pelleted using a 6 mm mesh size to produce pelleted hay of average length of 40 mm. Water was used as the binding agent.

Cafeteria feeding study

A total of 12 pure bred Muturu calves of ages ranging from 9-12 months old were used. The cattle pens were thoroughly washed and disinfected. The animals were dewormed (using Albendazole) and dipped to destroy both internal and external parasites before the experiment. All the animals were housed in a roofed shed in well ventilated individual pens (1.5 x 3 m) for the duration of the experiment. Each pen had water and a feed trough. An initial adaptation period of 7 days was used to accustom the animals to the pen conditions as the animals were fed with *Andropogon gayanus* grass and a commercial concentrate containing crude protein (18 %), cottonseed cake (30 %), maize (16 %), common salt (2 %) and oyster shell (2 %).

Preference for forages fed individually

One kg of each sample of green chopped forage were measured and served each animal daily. Feed was delivered into cafeteria style feeders placed in a feed pen that consisted of four containers (53 dm^3) with the containers placed at each end of the pen being empty to nullify any border bias. Calves were fed at same time with containers positioned randomly in the manger at each feed delivery. At the end of 15 min, the feeding bowls were withdrawn and the left-over in the plastic feeding bowls weighed and recorded to determine the intake per 15 min. This trial was recorded for 7 days. Each day the position and order of placement of the forages before the animals was rotated throughout the trial to avoid conditioning and learning effects. After collection of the leftovers, the animals were allowed to graze. At the end of the experiment, animal were allowed to graze for a period of two weeks after which the same forage preference cafeteria method was repeated with the pelleted forms of both the grasses at 4 and 8 weeks after regrowth.

Preference for forages offered in group

In a second feeding experiment, all the animals were released in same holding yard. The animals were trained for 4 days to eat from four food boxes at equidistance in the yard using a small amount of *Andropogon gayanus* in each food box. After training (i.e., all animals learned to eat from all boxes), a 7 day trial was conducted. The four forages of known weights were placed in heaps in an enclosed yard into which animals were released. At the end of 15 min, the amount of grass remaining was weighed and recorded. The order of the presentation of the feed was altered in the following days of the trial to avoid any form of biasness. At the end of the experiment,

animals were allowed to graze for a period of two weeks after which the same forage preference cafeteria method was repeated with the pelleted forms of both grasses at 4 and 8 weeks after regrowth.

Feed preferred were assessed from the total dry matter intake throughout the experiment. A forage type was said to be preferred by animals to the others when its intake is more than others.

Laboratory Analysis

At the end of each collection, triplicate samples of green chopped forages and the pelleted forages were dried at 60ºC for 3 days, they were then milled in a Thomas-Wiley mill (2 mm sieve) and composited for subsequent analysis. The DM content was determined by drying the sample at 105ºC overnight and ash by igniting the samples in muffle furnace at 525ºC for 8 h, ether extract (EE), crude fibre (CF) and CP (N x 6.25) were determined (AOAC, 1990). Neutral detergent fibre (NDF), ADF and acid detergent lignin (ADL) were also done (Robertson and Van Soest, 1981). The samples were also digested by nitric and perchloric acids mixture (ratio = 4.1, v/v) and the concentrations of the minerals - Calcium (Ca), Potassium (K), Phosphorus (P) and Magnesium (Mg) in the samples were determined by an Atomic Absorption Spectrophotometer (Buck scientific model 200a; Buck Scientific, East Norwalk, CT 06855, USA).

The trials were arranged in 2 x 2 x 2 factorial completely randomized design. The statistical analysis was completed using all the data generated from the experiment in analysis of variance (ANOVA) using General Linear Model (GLM) procedures of SAS 2001 and separation of treatment means was done using Duncan Multiple Range Test.

RESULTS AND DISCUSSION

The chemical composition of either chopped or pelleted *Panicum* and *Pennisetum* harvested at 4 or 8 weeks regrowth is presented in table 1. There was a significant (P<0.05) three-way interaction among grass species, age at harvest and processing methods on the DM, CP, CF, EE, Ash, P and Ca content of the grasses.

The CP content of the grasses ranged from 105 to 133 g.kg^{-1} DM with pelleted *Panicum* at 8 weeks regrowth having the highest CP. The interaction effect of

Table 1: Chemical and mineral composition (g.kg^{-1} DM) of both green chopped and pelleted *P. maximum* and *P. purpureum* harvested at two stages of growth

Interaction	DM	CP	CF	EE	ASH	K	P	Mg	Ca
P. maximum									
4 Pelleted	947a	105b	160c	24a	171a	33.4	4.09a	1.67	14.7 b
8 Pelleted	936a	147a	150c	20ab	110bc	31.6	3.25bc	1.50	23.0a
4 green chopped	722b	129ab	330b	24a	125b	30.0	2.69c	1.58	16.5b
8 green chopped	722b	115ab	400a	12c	95bc	26.5	2.79	1.33	13.3c
P. purpureum									
4 Pelleted	951a	129ab	150c	16bc	90bc	27.6	1.82b	1.38	13.4c
8 Pelleted	932a	115ab	160c	18abc	80c	26.5	3.94a	1.33	17.7b
4 green chopped	702c	133ab	380ab	21ab	125b	26.5	3.93ab	1.33	17.5b
8 green chopped	707c	115ab	370ab	12c	110bc	26.8	2.56ab	1.29	17.2b
SEM	1.88	0.41	2.36	0.37	0.65	1.64	3.29	0.08	1.21
Interaction									
S	*	**	**	**	NS	*	**	NS	**
A	NS	NS	NS	*	**	*	*	**	**
P	**	NS	*	NS	NS	NS	**	NS	NS
S x A	NS	NS	NS	**	**	NS	*	**	**
S x P	**	NS	**	NS	**	NS	NS	NS	**
A x P	**	NS	**	**	NS	NS	NS	NS	**

abc: means in the same column with different superscripts are significantly different (P < 0.05), ** *P* < 0.01, * *P* < 0.05
DM: Dry matter; CP: Crude protein; CF: Crude fibre; EE: Ether extract; K: Potassium; P: Phosphorus; Mg: Magnesium; Ca: Calcium
S: Species; A: Age at harvest; P: Processing

species and age at harvest, species and processing was not significant (P>0.01) on the CP content of the grasses, however, the main effect of species showed that *Panicum* had higher (P<0.01) CP than *Pennisetum* in this trial.

DM values were higher (P<0.01) in *Panicum* when green chopped at both 4 and 8 weeks than in *Pennisetum* of similar ages, while the DM remained similar when the forages were pelleted at both ages.

The CF contents of the grasses were influenced by the interaction of species, processing and age at harvest of the forages. Among the treatments, green chopped *Panicum* at 8 weeks regrowth had greater (P<0.05) CF content compared to others. The main effect of processing and species significantly (P<0.01) reduced the values of CF in both species.

The EE contents of the grasses were influenced by the interaction of species, processing and age at harvest of the forages. The effect of age and processing was similar (P>0.05) within each species of grasses while the 8 weeks old green chopped forages recorded the lowest EE content.

Interaction of grass species, processing and age at harvest influenced the ash content of the grasses. The ash content ranged from 90 and 171 g.kg^{-1} DM with 4 weeks old pelleted *Panicum* having the highest ash content. Species interaction with age, harvest and processing influenced (P<0.01) the ash content of both grasses while age at harvest with processing did not.

The Phosphorus (P) content of *Panicum* and *Pennisetum* were dependent on the interaction between species and age at harvest, and the main effect of each of the factors.

Interaction effect between species and processing resulted in higher (P<0.01) Ca content in pelleted *Panicum* compared with *Pennisetum* but lower (P<0.05) Ca content in green chopped *Panicum* compared to *Pennisetum*.

The Magnesium (Mg) content of *Panicum* and *Pennisetum* were dependent on the interaction between species and age at harvest, and the main effect of age at harvest.

The neutral detergent fibre (NDF) values, which constitute the cell wall of the grasses, were influenced by the interaction of grass species, processing and age at harvest. The NDF values ranged between 400 and 590 g.kg^{-1} DM. Pelleted grasses of 4 week old had the lowest (P<0.05) NDF in the trial. The main effect of species and processing as well as their interaction

Table 2: Fibre fraction (g.kg^{-1} DM) of both green chopped and pelleted *P. maximum* and *P. purpureum* harvested at two stages of growth

Treatment	ADF	NDF	ADL	HEM	CELL
P. maximum					
4 Pelleted	130e	420c	105	211c	198d
8 Pelleted	260d	527ab	120	272a	238c
4 green chopped	310c	530ab	100	227b	303b
8 green chopped	410a	560b	91.0	227b	433a
P. purpureum					
4 Pelleted	130e	400c	105	131b	340abc
8 Pelleted	270d	550b	101	239b	351ab
4 green chopped	380b	590a	75.1	236b	419a
8 green chopped	380b	590a	115	216c	419a
SEM	2.13	1.89	1.03	1.06	4.68
Interactions					
S	NS	NS	NS	**	NS
A	**	**	NS	NS	**
P	**	**	NS	NS	**
S x A	NS	NS	NS	**	**
S x P	NS	NS	NS	NS	NS
A x P	NS	**	NS	NS	NS

abc: means in the same column with different superscripts are significantly different (P < 0.05), ** P < 0.01, * P < 0.05
ADF: Acid detergent fibre; NDF: Neutral detergent fibre; ADL: Acid detergent lignin; HEM: Hemicellulose; CELL: Cellulose
S: Species; A: Age at harvest; P: Processing

influenced the NDF content of the grasses. The NDF content of both species pelleted at 4 weeks regrowth were lower than those pelleted at 8 weeks regrowth.

Interaction of grass species, processing and age at harvest affected the ADF content of the grasses as well as their single effect. Pelleted *Panicum* of 8 weeks age had greater (P<0.05) ADF content compared to others. The interaction of species and age at harvest on the ADF of the grasses were similar (P>0.01). The ADF content of both species pelleted at 4 weeks age were lower than those pelleted at 8 weeks age while pelleting also lowered (P<0.01) the ADF content of each species.

Preference was observed using intake from the cafeteria method as recorded in figure 1. Green chopped *P. maximum* of 4 weeks age was most preferred by the calves. *P. maximum* was more preferred than *P. purpureus* either green chopped or pelleted at both ages. Intake was influenced most by individual feeding method for all categories except green chopped *P. purpureum* of 8 weeks age where intake increased in group feeding than individual feeding method. Group feeding method increased preference for pelleted samples than that served individually. When served in group calves preferred green chopped to pelleted forages except in 4 weeks old *P. purpureum* where pelleted forage had similar intake with green chopped ones. Age at harvest influenced preference as forages harvested at 4 weeks age had higher intake when served individually than forages harvested at 8 weeks age. However, when served in group, calves' preference for fresh forages at 8 weeks old was higher than forages at 4 weeks old.

The assessed quality parameters of the grasses were dependent on the interaction of species, processing and age at harvest. The CP content of the grasses ranged from 105 to 133 g.kg^{-1} DM and these values fall within the range reported for tropical grasses (Topps and Oliver, 1993) and well above 8 % suggested by Norton (1994) for ruminal function. The interactions of species, processing and age at harvest, CP content of the grasses were similar irrespective of method of processing.

The neutral detergent fibre (NDF) values, which constitute the cell wall of the grasses, were influenced by the interaction of grass species, processing and age at harvest. The NDF values ranged between 400 and 590 g.kg^{-1} DM. The values were comparable to values reported by Minson (1990) as typical of tropical grasses. In all the treatments, the NDF content increased with increasing plant maturity irrespective of the species difference. Mtui (2009) reported no difference in NDF content between *Panicum*, *Pennisetum* and certain forage grass species and the type of season. The increase in NDF with age of regrowth is related to physiological changes that occur as plant ages, that lead to a decrease in cell cytoplasm's highly soluble components (cell contents), accompanied by an increase in cell wall fibre components (Nogueira *et al*., 2000). Pelleting resulted in decreased NDF content within species and age with greater reduction in the NDF content of *Pennisetum* than *Panicum*. Since reduction in forage particle size greatly influences the effectiveness of fibre (Allen, 1995), this implied that intake of *Pennisetum* with high NDF content could be improved through pelleting. West (1998) reported that a major factor which could enhance intake of forages by cattle is to simply lower the cell wall content.

A similar trend to that of NDF was observed with the ADF content of the grasses with advancing maturity. These changes are due to increased secondary thickening in cells associated with plant support and water transport (Buxton, 1989). ADF contents of pelleted *Pennisetum* were comparable with *Panicum* at similar age but were higher than ADL content of *Panicum* in

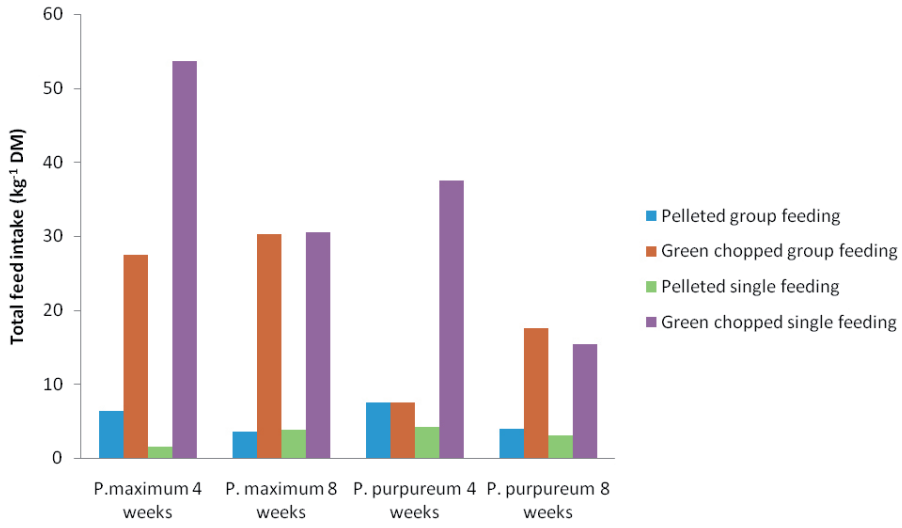

Fig. 1: Feed preference as assessed from the total intake

green chopped samples. Thus pelleting reduced the ADF content.

The effect of species on ether extract was pronounced with *Panicum* having higher content of EE than *Pennisetum*. Preference can be calculated either as the proportion of time spent grazing each species or as the proportion of total intake derived from each species (Parsons *et al*., 1994). Given that total intake is more important than grazing time in terms of the animal's energy balance (and, therefore, growth and production), preference should ideally be calculated using total intake, especially when there are significant differences in the rate at which the animals eat the different herbage species.

Forage preference considered in terms of intake rate indicated that growing calves preferred fresh *P. maximum* at 4 week old to the other samples used in this study. For a given plant, ingestibility, like digestibility, is dependent on the vegetation stage and the number of the vegetation cycle (Demarquilly *et al*., 1981). The decrease in ingestibility with age of forage is the consequence of the increase in its fill effect. As the plant ages, its morphological and histological development decreases the amount of cell content, which is soluble, rapidly degraded and has almost no fill effect, and increases the amount of cell walls. Consequently, forage retention time in the rumen and thus fill effect increases. In addition, tissue lignification increases the undegradable fraction of the cell walls and decreases the degradation rate of the degradable fraction (Grenet and Demarquilly, 1987).

The DM content of forages at the time of feeding may have had an influence on the relatively higher preference of fresh *P. maximum* both singly or in group. 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 CP and NDF concentrations of diets are the most important factors affecting DMI. Intake of grass species declines when the NDF concentration of the consumed forage increases. 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 by Turiani (Komwihangilo *et al.*, 2007) indicated that farmers consider *P. maximum*, *P. purpureum* and *R. cochinchinensis* to be eagerly eaten by animals in a similar manner or vice versa.

However, Muturu calves showed more preference for fresh *P. maximum* than *P. purpureum* in this trial. This could be as a result of the coarse and hairy morphology of *P. purpureum* because the sense of touch plays a role in the response of the animal to the feed. Physical characteristics of the forage such as hair, thorns, coarseness and resistance to fracture are known to affect ease of apprehension and thus intake rate (Inoue *et al*., 1994). Higher leaf to stem ratio in guinea grass may also have influenced its preference over elephant grass. 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).

Group feeding tended to show increased intake as preference for pelleted samples increased than when served individually. Mustafa *et al.* (2009) reported that cafeteria calves show more eating behaviour and less idle standing, licking object and drinking behaviour which led to increased ruminating and intake in comparison to individually fed calves The instinct for completion invariably decreased idle standing which could probably result to increased intake of fresh forages at 8 weeks old as observed in the present trial than forages at 4 weeks old when served in group.

CONCLUSION

Intake rates observed in the present study represent 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 small-holder farmer who harvests forages on daily basis or one planning to establish one pasture species from among the choices available.

Forage acceptability by animals on pasture or under zero grazing conditions is a function of forage, inherent chemical traits, forage morphology as was ascertained by the observed intake and also the influence of group feeding. Therefore, 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.

REFERENCES

ADENIJI, K. O. 1983. Review of endangered cattle breeds of Africa. *Animal Genetic resources in Africa*. OAU/STRC/IBAR, Nairobi, Kenya. Second OAU Expert Committee Meeting on Animal Genetic Resources in Africa. 24-28 November 1983: Bulawayo, Zimbabwe.

AJAYI, F. T. 2008. Nutritional evaluation of Guinea grass (*Panicum maximum* cv Ntchisi) intercropped with some legumes for West African dwarf goats. *Thesis*, University of Ibadan, Nigeria.

ALLEN, M. 1995. Fiber requirements: Finding an optimum can be confusing. *Feedstuffs*. May 8.

AOAC, 1990. Association of Official Analytical Chemists. *Official Methods of Analysis*, 15th ed. Arlington, VA, USA, p. 125.

BABAYEMI, O. J. – BAMIKOLE, M. A. 2006. Nutritive value of *Tephrosia candida* seed in West African dwarf goats. *J. Central Eur. Agric.*, vol. 7 (4), 2006, p. 731-738.

BUXTON, G. W. 1989. African grasses. http://www.hort.purdue.edu.newcrop/proceedings 1993/V2-294. html

DE ROSA, G. – FEDELE, V. – NAPOLITANO, F. – GUBITOSI, L. – BORDI, A. – RUBINO, R. 1997. Dietary preferences in adult and juvenile goat. *Anim. Sci*., vol. 65 (3), 1997, p. 457.

DEMARQUILLY, C. – ANDRIEU, J. – WEISS, P. 1981. L'ingestibilite des fourages verts et des foins et sa prevision. *Prevision de la Valeur Nutritive des Aliments des Ruminants*, INRA Publications, Versailles, 1981, p. 155-157.

GIBB, M. J. – HUCKLE, C. A. – NUTHALL, R. 1998. Effect of time of day on grazing behavior and intake rate by lactating dairy cows. *Grass and Forage Sci*., vol. 53, 1998, p. 4146.

GORDON, F. J. – COOPER, K. M. – PARK, R. S. – STEEN, R. W. J. 1998. The prediction of intake potential and organic matter digestibility of grass silage by near infrared spectroscopy of undried samples. *Animal Feed Sci. and Techn.*, vol. 70, 1998, p. 339-351.

GRENET, E. – DEMARQUILLY, C. 1987. Rappels sur la digestion des fourrages dans le rumen (parois) et ses consequences. Demarquilly, C. (Ed.), Les Fourrages Secs: Recolte, Traitement, Utilisation, INRA Editions, Paris, 1987, p. 141-162.

HOLECHEK, J. L. – PIEPER , R. D. – HERBA, C. H. 1998. Range Management. Principles and Practices. 3rd Edition. Prentice Hall, Upper Saddle River, New Jersey, 07458.

INOUE, T. – BROOKES, I. M. – JOHN, A. – KOLVER, E. S. – BARRY, T. N. 1994. Effects of leaf shear breaking load on the feeding value of perennial ryegrass (*Lolium perenne*) for sheep. 2. Effects on feed intake, particle breakdown, rumen digesta outflow and animal performance. *J. Agric. Sci*., vol. 123, 1994, p. 137-147.

KOMWIHANGILO, D. M. – LEKULE, F. P. – MGHENI, D. M., – PETERSEN, P. H. – MTENGA, L. A., KAJEMBE, G. C. – KURWIJILA, R. L. 2007. Empirical assessment of short-term preferences of tropical forages by crossbred bull calves. *African J. of Agricult. Res*., vol. 2 (11), 2007, p. 558-564.

LAMIDI, O. S. – JIBRIL, A. – ADEYINKA, I. A. 2005. Preference studies and short – term intake of Browse mixtures by cattle. *Asset Journal,* Series A 5, 2005, (1), p. 45-52.

LU, C. D. 1988. Grazing behavior and diet selection of goats. *Small Rumin. Res.,* 1988*,* 1, p. 205.

MINSON, D. J. 1990. Forage in Ruminant Nutrition. Academic Press Inc. Toronto, 483 pp.

MTUI, D. J. – LEKULE, F, P. – SHEM, M. N. – ICHINOHE, T. – FUJIHARA, T. 2009. Comparative potential nutritive value of grasses, creeping legumes and multipurpose trees commonly in sub humid region in the Eastern parts of Tanzania. *Livestock Research for Rural Development*, vol. 21 (10), 2009.

MUSTAFA, B. – UNAL, K. – MURAT, G. – AHMET, S. 2009. Behavioural responses of dairy calves to cafeteria feeding vs. single feeding. *J. of Anim. and Vet. Advances*, vol. 8 (9), 2009, p. 1723-1728.

NOGUEIRA, J. C. M. – FONDEVILA, M. – BARRIOS, U. A. – GONZÁLEZ, R. M. 2000. *In vitro* microbial fermentation of tropical grasses at an advanced maturity stage. *Animal Feed Sci. and Technol.*, vol. 83, 2000, p. 145-157.

NORTON, B. W. 1994. Tree legumes as dietary supplements for ruminants. Gutteridge, R. C. and H. M. Shelton (editors). *Forage tree legumes in tropical agriculture*, CAB International, 1994, p. 192-201.

PARSONS, A. J. – NEWMAN, J. A. – PENNING, P. D. – HARVEY, A. – ORR, R. J. 1994. Diet preference of sheep: effects of recent diet, physiological state and species abundance. *J. Anim. Ecol*. 63 (2), 1994, p. 465-478.

REGE, J. E. O. – ABOAGYE, G. S. – TAWAH, C. L. 1994. Shorthorn cattle of West and Central Africa. I. Origin, distribution, Classification and population statistics. FAO Corporate Document Repository – Identification and characterization of West African Shorthorn Cattle. *World Animal Review*, 78 (1), 1994, p. 2-13.

ROBERTSON, J. B. – VAN SOEST, P. J. 1981. The detergent system of analysis and its application to human foods. James, W. D. T., Thender, O. (Eds.), *The Analysis of Dietary Fiber in Foods*. Marcel Dekker, New York, NY, 1981, p. 123-158.

SAS (2001): The SAS System for Windows. Release 9.1. The SAS Institute, Cary, NC, USA.

TOPPS, J. H. – OLIVER, J. 1993. (Eds) Animal Food of Central Africa. *Zimbabwe Agricultural Journal Technical Handboo*k, No. 2, Modern Farming Publication, Harare, Zimbabwe, 1993, p. 76-105.

VOLLBORN, E. M. 1998. Amazing graze. *A publication of The Ohio State University Extension*. http://www.ag.ohio-state.edu /~rmoore/ag/ama- zegrazesep98.html.

WANDERA, J. L. 1996. Review of Kenyan Agricultural Research Vol. 23: Pasture and Fodder Crops. Kenya Agricultural research Institute, Nairobi.www.bangor.ac.uk /~azs80f/projects/ kard/Vol 23 Pasture.doc

WEST, J. W. 1998. Factors Which Influence Forage Quality and Effectiveness in Dairy Rations http://www.wcds.ca/proc/1998/