

# ajava

Asian Journal of Animal and Veterinary Advances



Academic  
Journals Inc.

[www.academicjournals.com](http://www.academicjournals.com)

**The Nutritive Value of Silages Made from Mixtures of Pearl Millet  
(*Pennisetum americanum*) and Lablab (*Lablab purpureus*)  
as Feed for Yankasa Rams**

<sup>1</sup>J.T. Amodu, <sup>1</sup>M.S. Kallah, <sup>1</sup>I.A. Adeyinka, <sup>2</sup>J.P. Alawa and <sup>1</sup>C.A.M. Lakpini  
<sup>1</sup>National Animal Production Research Institute, Ahmadu Bello University,  
P.M.B. 1096, Shika-Zaria, Nigeria

<sup>2</sup>Department of Animal Science, Rivers State University of Science and Technology,  
Port-Harcourt, Nigeria

---

**Abstract:** A study was conducted with the field grown Pearl millet (*Pennisetum americanum*) and *Lablab purpureus*. The aim of the trial was to study the effect of the addition of Lablab legume in varying amount or the composition of daily intake and utilization of millet-silage by Yankasa sheep. Both crops were harvested separately, wilted, chopped and then mixed in four proportions (0:100, 15:85, 30:70 and 50:50% of lablab: millet, respectively) and ensiled. Silage treatments were found to be similar in concentrations of Dry Matter (DM), Organic Matter (OM) and Ether Extract (EE), while incorporation of lablab led to a small increase in Crude Protein (CP), Crude Fibre (CF) and Nitrogen Free Extract (NFE). All millet-lablab mixtures were adequately fermented with favourable aroma and colour. Comparisons of the four silage treatments revealed that, silage with 50:50 millet-lablab proportion was the most readily consumed by the rams with a mean intake of 48.4 g kg<sup>-1</sup> W<sup>0.75</sup> and lowest intake of 22.5 g kg<sup>-1</sup> W<sup>0.75</sup> for treatment with 0:100 lablab-millet proportion. Digestion coefficients declined steadily from the control (0:100% lablab-millet mixture) to 50% level legume incorporation. This investigation showed that the best performance of Yankasa rams on the basis of intake and digestibility was obtained from treatment with 50:50, lablab-millet mixtures.

**Key words:** Nutritive value, pearl millet, lablab, silages, feeding, Yankasa rams

---

## INTRODUCTION

Pearl millet (*Pennisetum americanum* syn. *P. typhoides*) is a profuse tillering annual crop cultivated over wide areas from the semi-arid to the sub-humid savannas of Nigeria. It has been used in livestock production systems over wide areas of tropics and sub-tropics as forage crop with promising results. Yield and quality attributes of early- and late-maturing varieties have been examined (Bishnoi *et al.*, 1993; Amodu *et al.*, 2001). One report indicated that good quality silage with high yields had been produced with pearl millet (Andrade and Andrade, 1985), while Nwasike (1988) reported that highest DM yields occurred at seedset stage of growth.

There are various options available in improving the nutrient concentration and utilization of low quality roughages. A method amenable to small-scale farmers is the incorporation of legume in grass/legume pastures or additions of legume to grass forage at feeding (Charmley, 2000). Legumes are usually considered superior animal feed to grasses because they contain more N than grasses of similar digestibility and therefore would provide higher voluntary intake of digested nutrients (Goering *et al.*, 1991; Thomson *et al.*, 1991). One promising legume with high fodder and grain production on the

sub-humid savanna is lablab (*Lablab purpureus*). It is a multipurpose, late season, herbaceous legume that can effectively fit into integrated livestock/crop farming pattern, providing grains for human consumption and fodder in livestock feeding practices (Karachi, 1987). In Nigeria, the crop is grown in combination with millet to produce grain as well as supplementary feed on farm.

Earlier research on fodder conservation in Shika, Northern Guinea Savanna of Nigeria showed that there are inherent problems in conservation of forages as hay. The right climatic conditions suited for hay making coincide with the time when forages are low in nutritive value while the making of good quality hay during the rainy season when they are of optimum nutrient concentration is practically impossible due to humid weather conditions (Amodu *et al.*, 2004). Ensilage offers alternative means of fodder conservation during the rainy season while retaining nutrient quality of the forage without recourse to use of fuel or solar energy for artificial hay making under wet, humid conditions (Kallah *et al.*, 1997).

The conservation of forage as silage should be of particular interest and value to Nigerian livestock farmer since it provides ample opportunity for harnessing wet season's excess forage growth for later use during the period of scarcity in the dry seasons. Silage can be made from variety of crops either as sole crop or cereal/legume mixtures such as maize/cowpea and maize/mucuna. Often silages from cereal/legume mixtures are preferred as they supply adequate amounts of carbohydrate and are capable of providing protein for maintenance and some growth. A study designed to examine production and preservation of forage and responses of sheep fed conserved mixed cereal/legume forage would provide some basic information with applications to small- and large-scale livestock farmers. In broad terms, this study was undertaken to evaluate: effects of levels of legume proportions on nutrient composition, intake and digestibility of ensiled millet/lablab forage mixtures.

## MATERIALS AND METHODS

The aim of the trial was to study the effect of the addition of Lablab legume in varying amount or the composition of daily intake and utilization of millet-silage by Yankasa Sheep.

In the year 2002, an experiment was conducted at the NAPRI experimental farm at Shika, 11° to 11° 13'N; 6°55' to 7°33'E in the subhumid zone of Nigeria. Mean annual rainfall varies from 800 to 1300 mm with longterm average of 1050 mm. Approximately 95% of the rainfall occurs between May to October.

The Bunkure accession of pearl millet was planted after land preparation at the rate of 5 kg ha<sup>-1</sup> in a plot of 0.5 ha, after a heavy and effective rainfall. The field was weeded at 3 and 6 weeks after sowing. Thereafter, at 10 weeks post-planting the *Lablab purpureus* cv. Highworth' was interplanted between the stands of millet at seeding rate of 10 kg ha<sup>-1</sup>. The uninterrupted growth of millet and lablab at 20 and 10 week growth, respectively, was cut and used in preparing silages. The crops were harvested separately. Forage materials of both species were allowed to wilt in the sun for 4 h, before constitution into mixtures for ensiling. The prepared millet and lablab forages were mixed together in 4 different rations as 4 experimental treatments, namely 100, 85, 70, 50% of millet with 0, 15, 30, 50% of lablab, respectively, on a dry matter basis, without any additives and designated A, B, C, D, respectively. These were immediately placed in four silage pits each accommodating a single treatment. The pits were then covered with soil for an incubation period of two months. Thereafter the pits were opened and bags removed as required during the feeding period.

The experimental animals consisted of 16 Yankasa rams allocated, according to their body weights (ranging from approximately 30.0 to 35.0 kg), to the four treatments with four rams per treatment. All the animals were kept in metabolism cages where saltlicks and fresh tap water were supplied *ad libitum*. The experimental diets were the four silage treatments A, B, C and D. The trial consisted of eleven-day preliminary period and a six-day collection period. Each animal was offered a total

of 3.0 kg of fresh silage twice daily between 07:00 and 07:30 h and 16:00 and 16:30 h. The residues of previous day's feed and faeces voided were collected daily and weighed every morning and representative samples taken for dry matter determination.

The dried ground samples were assayed for CP determined by Kjeldahl N analysis (AOAC, 1975) and of silages was determined by toluene distillation method described by Dewar and McDonald (1961). The minerals Ca, P, Mg, Na, K and S were analysed using procedures described by Ranjhan and Krishna (1980). The lactic acid content was determined using the calorimetric method of Baker and Summerson (1941). The data collected were analysed using the General linear models Procedures and the Duncan's Multiple Range Test of the Systems Analytical Statistics package (SAS, 1987).

## RESULTS AND DISCUSSION

Concentrations of DM and EE were similar ( $p>0.05$ ) in all treatments. Addition of lablab to pearl millet forage led to an increase ( $p<0.05$ ) in the silica-free ash, crude protein, crude fibre and nitrogen free extract concentrations in the pre-ensiled forage mixtures (Table 1).

Treatments resulted in silages with acceptable odour, colour, pH and lactic acid levels (Table 2). The pH levels in the silage treatments were similar (range 4.1-4.5). Lactic acid levels in the silages increased from 4.3 in the control (treatment A) to 5.8 in treatment D. Silage from treatments A, B and C were similar in aroma and colour, having a sweet aroma and being pale yellow in colour. Silage from Treatment D with 50% legume incorporation was yellowish-green and had a very sweet aroma.

Inclusion of lablab in the ensilage forage mixture resulted in increases ( $p<0.05$ ) in OM, CP, CF, NFE and lactic acid content with increments of legume proportion in the forage mixture. Level of calcium (Ca) and phosphorous (P) increased ( $p<0.05$ ) as level of lablab in the mixture increased,

Table 1: Nutrient composition (%DM) of fresh lablab and pearl millet forage mixtures before ensiling

Parameters	Silage treatment				SEM
	A	B	C	D	
Dry matter (%)	23.1	24.0	24.5	25.1	2.10
Silica-free ash (%DM)	1.8 <sup>a</sup>	2.1 <sup>a</sup>	2.0 <sup>a</sup>	2.6 <sup>a</sup>	0.33
Crude protein (%DM)	10.1 <sup>b</sup>	10.7 <sup>a</sup>	11.0 <sup>a</sup>	11.9 <sup>a</sup>	0.51
Ether extract (% DM)	1.0 <sup>b</sup>	1.1 <sup>b</sup>	1.3 <sup>a</sup>	1.5 <sup>a</sup>	0.20
Crude fibre (% DM)	27.5 <sup>b</sup>	27.7 <sup>b</sup>	29.2 <sup>a</sup>	30.5 <sup>a</sup>	1.15
Nitrogen-free extract (% DM)	48.7 <sup>b</sup>	50.4 <sup>b</sup>	51.7 <sup>a</sup>	52.2 <sup>a</sup>	0.51

Within rows, values followed by different letter(s) are significantly different ( $p<0.05$ ). Treatments A, B, C and D are 100% pearl millet, 15:85, 30:70 and 50:50% lablab and pearl millet forage mixtures, respectively

Table 2: Characteristics of silages made from pearl millet and lablab forage mixtures grown in the sub-humid savanna of Nigeria

Parameters	Silage treatment				SEM
	A	B	C	D	
Corrected DM (%)	26.4	26.0	26.8	25.4	1.50
Organic matter (% DM)	86.8 <sup>b</sup>	88.0 <sup>a</sup>	88.7 <sup>a</sup>	90.2 <sup>a</sup>	1.10
Crude protein (% DM)	5.4 <sup>b</sup>	5.8 <sup>b</sup>	6.5 <sup>ab</sup>	6.8 <sup>a</sup>	0.70
Ether extract (% DM)	1.2	1.4	1.5	1.8	0.35
Crude fibre (% DM)	27.4 <sup>b</sup>	31.0 <sup>a</sup>	32.5 <sup>a</sup>	34.1 <sup>a</sup>	1.50
Nitrogen-free extract (% DM)	48.0 <sup>c</sup>	50.0 <sup>b</sup>	52.5 <sup>a</sup>	53.4 <sup>a</sup>	0.80
Lactic acid (% DM)	4.3 <sup>d</sup>	4.5 <sup>c</sup>	4.6 <sup>b</sup>	5.8 <sup>a</sup>	0.03
pH	4.3	4.4	4.5	4.1	0.40
Colour	PY	PY	PY	YG	
Aroma	S	S	S	VS	

Within rows values followed by different letter(s) are significantly ( $p<0.05$ ) different. Treatments A, B, C and D are 100% pearl millet, 15:85, 30:70 and 50:50% lablab and pearl millet forage mixtures, respectively. PY = Pale Yellow, YG = Yellowish Green, S = Sweet, VS = Very Sweet. All values expressed as percentage of corrected dry matter

Table 3: Mineral composition (% DM) of silages made from pearl millet and lablab forage mixtures, grown in the sub-humid savanna of Nigeria

Mineral	Silage treatment				SEM
	A	B	C	D	
Ca	0.25	0.27	0.28	0.30	0.02
P	0.27 <sup>b</sup>	0.28 <sup>b</sup>	0.32 <sup>b</sup>	0.41 <sup>a</sup>	0.03
Mg	0.28 <sup>a</sup>	0.25 <sup>b</sup>	0.24 <sup>b</sup>	0.21 <sup>c</sup>	0.01
Na	0.13 <sup>ab</sup>	0.15 <sup>a</sup>	0.12 <sup>ab</sup>	0.10 <sup>b</sup>	0.01
K	1.70 <sup>a</sup>	1.43 <sup>b</sup>	1.20 <sup>b</sup>	1.00 <sup>c</sup>	0.14
S	0.13 <sup>a</sup>	0.09 <sup>b</sup>	0.05 <sup>c</sup>	0.02 <sup>d</sup>	0.01

Within rows, values followed by different letter(s) are significantly ( $p < 0.05$ ) different. Treatments A, B, C and D are 100% pearl millet, 15:85, 30:70 and 50:50% lablab and pearl millet forage mixtures, respectively

while levels of magnesium (Mg), sodium (Na) and sulphur (S) decreased ( $p < 0.05$ ) (Table 3). The level of potassium (K) fluctuated, but the lowest level resulted from the 50% lablab in the forage mixture. Sodium concentrations (0.10-0.15%) were similar to the levels recommended for beef cattle (0.06-0.10%; NRC, 1984), below those for dairy cattle (0.18%; NRC, 1978) and above those for sheep (0.04-0.10%; NRC, 1976). Lactating dairy cows would certainly require a salt supplement if fed a ration containing high level of these silages.

The Ca concentrations in our silages ranged from 0.25-0.30%, while the critical level of Ca in the diet has been set at 0.30% Ca (NRC, 1976). Similarly, the concentrations of P in the silages ranged from 0.27-0.41% P, which exceeded the critical values of 0.25% P, recommended by Bourn and Milligan (1984), while all silages would supply adequate K to meet the requirements of various classes of ruminants (0.05-0.12% K).

#### Proximate Composition of Various Treatments Before and after Ensiling

A range of 23.0 to 25.4% dry matter was obtained in the oven-drying, while the toluene distillation techniques resulted in values between approximately 25.4 and 26.8%. These values obtained in the toluene distillation are higher than those obtained by oven-dried method. The proportion of losses from dry matter in oven temperature might be a result of volatile fatty acids, lactic acid, ammonia and amines (Coward-Lord *et al.*, 1974). Wilkinson (1990) observed the volatile constituents lost during oven drying to be very digestible hence it is necessary to correct for losses of volatile constituents during oven drying. In the present study, the corrected dry matter ranged from 25.4 to 26.8%, which resulted in about 3-4% under estimation of the true dry matter. Both the silage composition and digestibilities reported in this study were expressed on the corrected dry matter basis. It was observed in this study that the silage treatments are of low dry matter content. This might be due to the moisture content of both millet and lablab forages.

Generally, there were differences between the chemical composition of the fresh forage at harvest and the silage treatments. The differences between the chemical composition of the fresh forage at harvest and the silage treatments in this study were similar to what was obtained by Olubajo (1981) in silages made from grass and grass-pineapple.

The Organic Matter (OM) of the silages has been observed to be of high values, which might be due to the high content of soluble carbohydrate and Crude Fibre (CF) in millet and lablab respectively. It has been reported that wilting herbage in the field before ensiling concentrates the sugars (Kaiser, 1984). Wilting also increases the osmotic pressure of the herbage as a result of which butyric acid production in silage ceases even at relatively high pH values (Kaiser *et al.*, 1993). It is thus, possible, that the wilting of millet and lablab mixtures before ensiling in this study has probably increased the sugar content and osmotic pressure. These might have accounted for better preservation and fairly good silage obtained in the study.

The crude protein and ether-extract of the silages were observed to be low. This is probably because the millet is composed chiefly of soluble carbohydrates with very low protein. There are poor fermentation patterns in silages from tropical pastures. The silages do not compare favourably with those in temperate species. In the tropical pastures, acetate fermentation is often associated with high ammonia-N concentrations, which appear to be more prevalent than the desired lactate fermentation (Jarrige *et al.*, 1982; Kaiser, 1984).

The desirable silage quality is judged by its physical characteristics and chemical composition. Earlier studies show that a good silage should have pH less than 4.5, lactic acid more than 6%, butric acid less than 1%, ammonia nitrogen less than 1% on dry matter basis and ammonia nitrogen as percent of total nitrogen less than 8%. A good silage is also characterized by its yellow or green colour, mild sweet smell and palatability to livestock (Patel and Mudgal, 1968).

From the above discussion, all the four silage treatments could be classed as good silages, while the silage with 50% legume incorporation (treatment D) could be rated as the best silage treatment in this study. Treatment D, with 50% lablab incorporation was characterized by yellowish-green colour sweet aroma with pH of 4.1 and 5.8% lactic.

### Nutrients Content and Daily Intake of Silages by Rams

Legumes are considered a superior animal feed to grasses because of a higher voluntary intake of digested nutrients (Goering *et al.*, 1991; Thomson *et al.*, 1991). In this study average intake of silage increased with increasing addition of lablab legume. This might be due to increased CP and digestibility of the rations as a result of the addition of lablab legume. Earlier study with dolichos lablab (*Lablab purpureus*) produced silages with a crude protein content of approximately 190 g kg<sup>-1</sup>DM, but the digestibility in sheep was low OMD<60% (Morris and Levitt, 1968). Higher *in vitro* digestibilities were observed in soybean forage (Desborough and Ayres, 1988).

Aston *et al.* (1974) reported that intake of silage based diets is not always consistently and closely related to digestibility as in fresh or dried forage. This was attributed to the confounding influences of fermentation quality and the various fermentation products on intake (Thomas *et al.*, 1981; Gill *et al.*, 1988). The OM digestibility values observed in this study increased as the dry matter intake increased. An attempt to increase the proportion of lablab in the diet by 15% in every treatment appeared to improve acceptability of the diets to the animals.

Thomas *et al.* (1982) suggested that differences in dry matter content of silage may be a factor in determining the rate of voluntary consumption of the silage showing that consumption was linearly and positively related to dry matter content of silage.

The dry matter content of silage partly determines the degree of fermentation during the ensiling process and this in turn probably determined the voluntary silage consumption by the rams.

It was observed in this study that when concentration of lactic acid was 5.8% (treatment D), intake was 48.8 g kg<sup>-1</sup> W<sup>0.75</sup> which was depressed to 27.5 g kg<sup>-1</sup> W<sup>0.75</sup> when lactic acid concentration was 4.5% (treatment B) (Table 4). This supports the suggestion by Olubajo (1981) that silage acidity may be an indicator of its quality and voluntary intake.

Table 4: Average daily intake of forage and nutrients from silages by Yankasa rams

Treatments	Silage treatments				SEM
	A	B	C	D	
Fresh feed (g day <sup>-1</sup> )	1839.5 <sup>c</sup>	2278.8 <sup>b</sup>	2445.4 <sup>b</sup>	2606.4 <sup>a</sup>	211.10
Dry matter (g day <sup>-1</sup> )	365.3 <sup>d</sup>	450.0 <sup>c</sup>	504.7 <sup>b</sup>	671.5 <sup>a</sup>	12.44
Organic matter (g day <sup>-1</sup> )	319.4 <sup>e</sup>	391.2 <sup>b</sup>	398.8 <sup>b</sup>	598.1 <sup>a</sup>	20.12
Crude protein (g day <sup>-1</sup> )	18.0 <sup>e</sup>	32.5 <sup>b</sup>	44.0 <sup>a</sup>	50.3 <sup>a</sup>	5.30
Crude fibre (g day <sup>-1</sup> )	80.2 <sup>e</sup>	93.4 <sup>b</sup>	90.1 <sup>b</sup>	120.2 <sup>a</sup>	6.50
Dry matter intake (g kg <sup>-1</sup> W <sup>0.75</sup> )	22.5 <sup>d</sup>	27.5	39.1 <sup>b</sup>	48.4 <sup>a</sup>	1.35

Within rows, values followed by different letter(s) are significantly (p<0.05) different. Treatments A, B, C and D are 100% pearl millet, 15:85, 30:70 and 50:50% lablab pearl millet forage mixtures, respectively

Table 5: Apparent digestion coefficients (% DM) of the components of silage fed to Yankasa rams

Treatments	Silage treatments				SEM
	A	B	C	D	
Dry matter (%)	77.5 <sup>a</sup>	73.4 <sup>a</sup>	70.1 <sup>b</sup>	67.2 <sup>c</sup>	2.20
Organic matter (%)	82.5 <sup>b</sup>	88.8 <sup>a</sup>	70.1 <sup>f</sup>	80.2 <sup>b</sup>	1.70
Crude protein (%)	59.8 <sup>d</sup>	70.2 <sup>b</sup>	65.0 <sup>e</sup>	74.1 <sup>a</sup>	1.40
Crude fibre (%)	70.0 <sup>b</sup>	74.6 <sup>a</sup>	68.4 <sup>e</sup>	72.0 <sup>a</sup>	1.70
Ether extract (%)	37.1 <sup>f</sup>	41.2 <sup>b</sup>	35.3 <sup>c</sup>	58.2 <sup>a</sup>	2.10
Nitrogen-free extract (%)	82.5 <sup>a</sup>	73.1 <sup>b</sup>	61.4 <sup>d</sup>	67.5 <sup>e</sup>	1.50
Total Digestible Nutrient (TDN)	66.1 <sup>b</sup>	63.2 <sup>c</sup>	57.2 <sup>d</sup>	75.3 <sup>a</sup>	1.20

Within rows, values followed by different letter(s) are significantly ( $p < 0.05$ ) different. Treatments A, B, C and D are 100% pearl millet, 15:85, 30:70 and 50:50% lablab pearl millet forage mixtures, respectively

#### Apparent Digestion Coefficient of Silages Fed to Rams

Treatment A, with the least dry matter intake of 22.5 g kg<sup>-1</sup>W<sup>0.75</sup> had digestion coefficient of 77.5%, whereas treatment D, with the highest dry matter intake of 48.4 g kg<sup>-1</sup>W<sup>0.75</sup> had a coefficient of 67.2% (Table 5). The crude protein digestibility was generally high probably due to the addition of lablab legume. The fibre content of the diet were very high and could also increase the excretion of the faecal nitrogen. The high apparent crude protein (CP) digestibility could also be due to low production of volatile bases as suggested by Olubajo (1981). Total digestible nutrient was affected by the addition of lablab to the diet. The higher the percentage of lablab in the diet, the higher the total digestible nutrient.

In this experiment, all the rams used in the investigation performed satisfactory during the trial, with no visible adverse effects due to consumption of the silages.

#### CONCLUSION

The study showed that satisfactory silage can be made from mixtures of millet and lablab. Although nutrient content were slightly improved by legume addition in the forage ensiled the protein concentrations in the resultant silage were low for production. Silage of the quality made could be used only as a roughage source. Further studies are recommended to investigate the low protein concentrations of silages found in this study. Furthermore, long duration feeding trials are needed to define the value of millet-lablab silages in feeding systems of the region.

#### REFERENCES

- Amodu, J.T., M.S. Kallah, O.S. Onifade, A.T. Omokanye and I.A. Adeyinka, 2001. The effect of harvesting at different growth stages on yield and quality of three late-maturing pearl millet accessions in Northern Nigeria. *Trop. Grasslands*, 35: 175-179.
- Amodu, J.T. and S.A. Abubakar, 2004. Forage conservation practices. In: Proceedings of Training Workshop on Forage Production and Management in Nigeria. Held at The National Animal Production Research Institute, Ahmadu Bello University, Zaria. 10-14 October, 2004.
- Andrade, J.B. and P. Andrade, 1985. Silage production from pearl millet (*P. americanum* L.). (*K. schum*). *Sorghum and Millet Abstracts*, 7: 42-43.
- AOAC (Association of Official Analytical Chemists), 1975. Official Methods of Analysis. 12th Edn., Association of Official Analytical Chemists, Washington DC., USA.
- Baker, S.B. and W.H. Summerson, 1941. The colorimetric determination of lactic acid in biological material. *J. Biol. Chem.*, 137: 535-554.
- Bishnoi, U.R., G.M. Oka and A.L. Fearon, 1993. Quantity and quality of forage and silage of pearl millet in comparison to sudax, grain and forage sorghum harvested at different growth stages. *J. Trop. Agric. (Trinidad)*, 70: 78-102.

- Bourn, D. and K. Milligan, 1984. The dynamic of cattle distribution in the Nigeria subhumid zone. Report to ILCA's Subhumid Zone Programme, Kaduna.
- Charmley, E., 2000. Toward improved silage quality. A review. *Can. J. Anim. Sci.*, 81: 157-168.
- Crowder, L.V. and H.R. Chheda, 1977. Forage and Fodder Crops. In: *Food Crops of the Lowland Tropics*. Leaky, C.L.A. and J.B. Wills (Eds.), Oxford Univ. Press, pp: 127-159.
- Desborough, P.J. and J.F. Ayres, 1988. Cultivar and growth stage effects on the nutritive value of soyabean hay. *Proc. Aust. Soc. Anim. Prod.*, 17: 388.
- Gill, M., A.J. Rook and L.R.S. Thiago, 1988. Factors Affecting the Voluntary Intake of Roughages by Dairy Cow. In: *Nutrition of Lactation in the Dairy Cow*. Garnsworthy, P.C. (Ed.), Butterworths, London, pp: 262-279.
- Goering, H.K., D.R. Waldo, H.F. Tyrrell and D.J. Thomson, 1991. Composition of formaldehyde and formic acid treated alfalfa and orchardgrass silages harvested at two maturities and their effects on intake and growth by Holstein heifers. *J. Anim. Sci.*, 69: 4634-4643.
- Jarrige, R., C. Demarqilly and J.P. Dulphy, 1982. Forage Conservation. In: *Nutritional Limits to Animal Production from Pastures*. Hacker, J.B. (Ed.), CAB. Slough, UK., pp: 363-387.
- Kaiser, A.G., 1984. The Influence of Silage Fermentation on Animal Production. In: *Silage in the 80's*. Proceeding of a National Workshop. Kempton, J.T., A.G. Kaiser and T.E. Trigg (Eds.), Armidale, NSW, 8-9 August 1984, pp: 106-135.
- Kaiser, A.G., E.J. Havilah, G.D. Chopping and R.G. Walker, 1993. Northern dairy feed base 2001. 4. Feeding systems during winter and spring. *Trop. Grasslands*, 27: 180-211.
- Kallah, M.S., M. Baba, J.P. Alawa, I.R. Muhammad and R.J. Tanko, 1997. Ensiling quality of Columbus grass (*Sorghum almum*) grown in Northern Nigeria. *Anim. Feed Sci. Technol.*, 68: 153-163.
- Karachi, M., 1987. Yield and Quality of *Lablab purpureus* Ecotypes in High Altitude Semi-arid Lands in Kenya. In: *African Forage Plant Genetic Resources, Evaluation of Forage Germplasm and Extensive Livestock Production Systems*. Dzowela, B.H. (Ed.), Proc. 3rd. Workshop Held at the International Conf. Centre, Arusha, Tanzania, 27-30 April, 1987, pp: 121-126.
- NRC (National Research Council), 1978. *Nutrient Requirements of Dairy Cattle*. 5th Edn., National Academy of Sciences, Washington DC.
- NRC (National Research Council), 1984. *Nutrient Requirements of Beef Cattle*. 6th Edn., National Academy of Sciences, Washington DC.
- Nwasike, C.C., 1988. Progress in millet improvement in Nigeria. Paper Presented at the Regional Pearl Millet Workshop Held at Zaria, Nigeria, August 15-19, 1988.
- Olubajo, F.O., 1981. The feeding value of two tropical grass and grass-pineapple pulp silages. *World Review of Anim. Prod.*, 17: 37-42.
- Patel, B.R. and V.D. Mudgal, 1968. Studies on silage making from Berseem (*Trifolium alexandrinum*). *Indian. J. Dairy Sci.*, 27: 251-257.
- Ranjhan, S.K. and C. Krishna, 1980. *Laboratory Manuals for Nutrition Research*. Vikas Publishing House DVT Ltd., New Delhi, India, pp: 134.
- SAS, 1987. *Statistical Analysis System*. SAS Institute Inc., Cary, USA., pp: 967-978.
- Thomas, C., S.R. Daley, K. Aston and P.M. Hughes, 1981. Milk production from silage. 2. Relationships between silage digestibility and milk production among Holstein cows. *Anim. Prod.*, 33: 7-13.
- Thomas, C., B.G. Gibbs and J.C. Taylor, 1982. Beef production from silage. 2. The performance of beef cattle given silages of either perennial ryegrass or red clover. *Anim. Prod.*, 32: 149-153.
- Thomson, D.J., D.R. Waldo, H.K. Goering and H.E. Tyrrell, 1991. Voluntary intake, growth rate and tissue retention by Holstein steers fed formaldehyde and formic acid-treated Lucerne and orchardgrass-silage. *J. Anim. Sci.*, 69: 4644-4659.
- Wilkinson, J.M., 1990. *Silage*. 6th Edn., Chalcombe Publications: Marlwo, UK.