Research Journal of Animal Sciences 2 (6): 164-169, 2008
ISSN: 1993-5269

Effect of Solubilization on Corn Husk and Supplmentation with *Cassava* Leaf or *Leucaena* Leaf Meal Based Diet on Feed Intake and Digestion in Yankassa Sheep

O.O. Eniolorunda and G.A. Rowaiye
Department of Animal Production, College of Agricultural Sciences,
Olabisi Onabajo University, Yewa Campus, Ayetoro, Ogun State, Nigeria

Abstract: Sixteen growing Yankassa sheep weighing between 12.50 and 13.25 kg with age range of 8-10 months were used to evaluate the effect of solubilization on cornhusk supplemented with *Cassava* lead or *Leucaena* leaf based diets on feed intake and digestion. Some of the cornhusk were treated with Iye solution (pH 10.7) obtained from cocoa pod husk ash at 2 g ash/100 mL water kg^{-1} cornhusk. The other part of the cornhusk was treated with equivalent quantity of water as above. Both cornhusks were ensiled (biological treatment) for 28 days. For the cocoa pod husk ash treated cornhusk, CP, ND, ADF and ADL were solubilised, improvising and potential degradability and degradation rate of cornhusk. The treated cornhusks were supplemented with *Cassava* leave and *Leucaena* leave meal diets and fed to the growing sheep in the following dietary combination: cocoa pod husk ash treated Cornhusk + *Cassava* Leaf Meal based diet (CCLM), water treated Cornhusk + *Cassava* Leaf Meal based diet (CLLM) and water treated cornhusk + *Leucaena* leaf meal based diet (BLLM). The duration of the experiment was 63 days and parameters such as feed intake; weight gain, digestibility and nitrogen balance were measured. Total DMI (g/DM/day) was significant ($p<0.05$) among treatment means with the highest recorded in T_3 (485.84). Nutrient intake (g $kg^{0.75}$day) was significantly different among the treatments. Digestibility%, daily weight Gain (g) and feed efficiency were significantly ($p<0.05$) lower in animals on chemically untreated cornhusk, when compared to those on treated cornhusk. Values reported for N intake were not significantly different ($p<0.05$) between the groups of animals on the LLM diet (T_3 and T_4). It may be concluded that corn husk are potentially valuable feed resources for ruminants, but for efficient utilization it should be subjected to physic biological and chemical treatment.

Key words: Solubilisation, corn husk, cocoa pod husk, lye solution, sheep

INTRODUCTION

The browsing nature of sheep cannot be depended upon to provide adequate nutrients for optimal livestock production all year round. Hence, it is important to enhance the productivity of the stock by ensuring adequate feeding with moderate to low cost in order to maximize profits. What are readily available and cheap as feed substitutes are farm wastes such as cornhusk, corncob etc and agro-industrial by products.

Performance of small ruminants in the tropics is constrained by low voluntary intake and digestibility of the basal feed, which mainly constitute crop residues (Premaratne *et al*., 1989; Kaitho and Kairiuki, 1998). Protein is the most limiting nutrient often falling below 7%, the minimum level required for optimum microbial growth. Tree legumes, which persist during the seasons of pasture scarcity, have been shown to contribute protein-rich forage, digestible energy and minerals when used either as supplements or as sole feed (Abdulrazak *et al*., 1997). A major limiting factor in the utilization of crop residues is their low digestibility and relatively poor nutrient composition (Kiangi and Kategile, 1981). Highly lignified poor quality feed has been improved considerably by treatment with such chemicals as sodium hydroxide, calcium hydroxide, sodium hypochlorite, ammonia and urea (Adebowale, 1983). Sodium hydroxide (NaOH) treatment has been the most effective and the most extensively used for low quality roughages (Jackson, 1977). However, the problem with sodium hydroxide is the high cost of importation making it unavailable to village livestock farmers. Furthermore, the caustic nature of NaOH does not make it an ideal chemical to be handled by teeming illiterate farmers because it requires special skills. Therefore, there is a need to look for possible alternative presentation of NaOH that could be easily gotten within the reach of local farmers.

Corresponding Author: O.O. Eniolorunda, Department of Animal Production, College of Agricultural Sciences, Olabisi Onabajo University, Yewa Campus, Ayetoro, Ogun State, Nigeria

However, the high lignocelluloses content of maize residues requires a source of readily available carbohydrate and nitrogen to optimize their utilization particularly when treated. Hence, the look for a low cost and readily available supplement within the reach of peasant farmers ensues. Some of the forages with good supplementing potentials among others are including Siam weed, *Cassava* leaves, *Leucaena* foliages etc. This study was, therefore, carried out to find the effects of cocoa pod husk ash treatment of corn husk on the digestibility and nutrient intake in growing Yankassa sheep when supplemented with diets formulated using *Cassava* leaf meal and *Leucaena* leaf meal, respectively.

MATERIALS AND METHODS

Feedstuffs and diets: Corn husk and cocoa pod husk used were collected from a farm 3 km away from the experimental location. The cocoa pod husk was dried and burnt to ashes. This ash served as the alkali used in treating the cornhusk and a source of mineral nutrients to animals. *Cassava* and *Leucaena* leaves were collected fresh from the plants at the college teaching and research farm. They were air-dried to about 80-90% dry matter level in order to reduce the anti-nutritional factors like cyanide and mimosine, respectively. The dried corn husk was chopped (physical treatment) into bits (5-7 cm long). A part of the corn husk was treated with Iye solution obtained from dried cocoa pod husk ash (2 g ash/100 mL water kg^{-1} cornhusk), while other part was only treated with water (100 mL, water kg^{-1} cornhusk). They were both ensiled (biological treatment) separately in airtight metallic tanks for 28 days. The physico-biological and chemically treated corn husk © and the physico-biologically treated corn husk (B) were the 2 groups of cornhusks fed to the animals in the morning (8:00 am) at 2% body weight, while *Cassava* and *Leucaena* leaves were used separately to formulate a concentrate that contains maize offal, rice husk, brewers-dry grain, with fixed levels of premix, salt, oyster shell and bone meal, respectively (Table 1) and were supplied in the evening (4:00 pm) at 3% body weight.

The formulated leaf meal based which gives 4 dietary treatment combinations as summarized below:

- T_1 : CCLM-Cocoa pod husk ash treated cornhusk + *Cassava* leaf based diet.
- T_2 : BCLM-Water treated cornhusk + *Cassava* leaf based diet.
- T_3 : CLLM-Cocoa pod husk ash treated cornhusk + *Leucaena* leaf based diet.
- T_4 : BLLM-water treated cornhusk + Leucaena leaf based diet.

Table 1: Composition of leaf meal based diets

Ingredient (kg)	*Cassava* Leaf Meal based (CLM)	*Leucaena* Leaf Meal based (LLM)
Cassava leaf meal	23.73	-
Leucaena leaf meal	-	16.15
Rice husk	24.42	27.75
Maize offal	27.89	29.44
Brewers dry-grain	20.00	22.66
Premix	0.50	0.50
Bone meal	2.00	2.00
Oyster shell	1.00	1.00
Salt	0.50	0.50
Total	100.00	100.00

Animals and experimental design: Sixteen growing (8-10 months) Yankassa sheep weighing between 12.50 and 13.25 kg were used for this study. The animals were treated for internal parasites (Levamisol®; Kepro B.V. Holland) and for external parasites (Diazintol®; Alfasan International B.V. Holland). These sheep were assigned to 4 dietary treatment in a complete randomized design with each treatment having 4 animals, period of acclimatization was 2 weeks during which the experimental diet were gradually introduced to them. Water was supplied ad libitum. Animals were housed individually in a pen of 1.2×1.0×1.2 m inside a well ventilated shed. Wooding shaving was supplied as beddings to absorb waste materials and these were changed weekly. Each pen was equipped with feed and water troughs.

Measures and samples: Daily feed refusals collected at 7:45 am and 3:45 pm for cornhusk and concentrate, respectively, were weighed and deducted from the daily feed supply ascertain daily feed consumption. The feeding trial was carried out for 63 days include the first 14 days for adaptation and subsequent 49 days for measurements. Daily voluntary intake and weekly BW of all the animals were recorded before feeding in the morning through out the study. Digestion and nitrogen balance trial was conducted after 39 days of feeding. During the metabolism trial, the sheep were housed in individual metabolism cages (90×75×90 cm) made of welded wire-mesh fitted with removable feeders and arranged for quantitative collection of feaces and urine separately. The trial lasted for 10 days with a 3 day adaptation period of accustom the sheep to cages prior to a 7 day collection and measurement period. Daily fecal outputs for each animal were weighted, sub-sampled (10%) then bulked with samples taken on previous days and stored frozen. Daily urinary excretion for each animal was collected into 10 mL of 10% concentrated H_2SO_4 and after measuring the volume, sub-samples were bulked and stored frozen until analyzed. Feed and fecal samples were analyzed for their proximate compositions, urine sample was analyzed for nitrogen and the various fiber components were also determined.

Statistical analysis: The data obtained from these analyses were used to calculate the digestibility, nutrient intake and nitrogen balance by the growing Yankassa sheep. Data were subjected to analysis and variance of complete randomized design using SAS (1990).

RESULTS AND DISCUSSION

Feedstuff composition: Water treated corn husk had 6.97% crude content, while cocoa pod husk ash treated corn husk crude protein content was lower (6.08%) due to the effect of solubilization (Table 2). The values obtained for the CP content of these residues did not conform to that reported by Orskov (1991). The corn husk in this experiment had relatively high crude protein levels as a result of treatment. In the cocoa pod husk ash treated corn husk, CP, NDF, ADF and ADL were solubilised, improving the potential degradability and degradation rate of cornhusk. Orskov (1991) made similar conclusion. The above author also confirmed that corn husk is characterized by high cell wall components, which will lead to partial degradation of all structural polysaccharides when fed to ruminant as a result, slow and low digestibility was recorded, supported by Chesson (1981). Cocoa pod husk ash treated corn husk ash content (12.58%) was higher due to the addition of Iye solution. It was supported by Adebowale (1985) in his study that ash content of straw increased sharply from 11.7% for the untreated to 20.9% for the palm bunch ash treated maize straw.

The 2-leaf meal based diets had crude protein content of 14.70 and 14.85% for LLM and CLM diets, respectively. CLM diet had higher nutrient content than the LLM diet except for DM, CF, ADL and ash content which were lower in the CLM diet than LLM diet. Norton (1994) reported that the foliage of leguminous trees is usually high in protein and minerals and has been used as either a supplement of low quality hay and straw or as a sole source of feed. The relatively low ash content of the feed materials suggests that the energy content is quite high. The concentrates crude protein that is relatively higher than that of the treated cornhusk, makes it suitable for supplementing these treated cornhusks. The formulated diets have a crude protein content of 14.7 and 14.85% and gross energy levels of 3.08 and 3.15 Kcal g^{-1}, respectively.

Performance and digestion: Four groups of animals were used in this study, fed with different combinations of the experimental diets, with the 2 corn husk groups on each of the leaf meal based diets (CLM and LLM). Significant ($p<0.05$) treatment effect occurred among treatment means for all parameters except concentrates intake (g/DM/day) and initial live weight (kg) of animals (Table 3). Animals on T_3 consumed the highest ($p<0.05$) DM intake (g/DM/day) of corn husk followed by T_2 and T_4 that were not significantly different from each other and lowest in T_4. The total DMI were highest in T_3, next to it was T_2 and lowest in T_4 due to the low consumption of cornhusk. The high total DMI observed in this study, was comparable with the value reported by Osakwe (2006). Supplementation generally increased the total DM intake. This may be attributed to ability of the forage supplements to provide N and energy for the cellulolytic microbes upon degradation in the rumen.

Nutrient intake (g $kg^{-0.75}$ day^{-1}) was significantly lowest ($p<0.05$) in T_1 except for the NDF intake value. Reverse was the case in T_4. Generally, the trend observed in nutrient intake (g $kg^{-0.75}$ day^{-1}) in this study showed that animals fed on cocoa pod husk ash treated corn husk (i.e., T_1 and T_3) had significantly ($p<0.05$) lower values for all nutrients observed than those group of animals fed on water treated corn husk (T_2 and T_4) in the respective concentrate groups (CLM and LLM diets) except for the

Table 2: Chemical composition of the experimental diets

Composition (%)	B	C	CLM	LLM
Dry matter	92.58	92.14	92.22	92.07
Organic matter	80.20	80.16	83.33	83.72
Crude protein	6.97	6.08	14.85	14.70
Crude fiber	18.11	16.34	12.84	13.52
Ether extract	0.86	0.50	2.01	1.96
Ash	10.25	12.58	6.55	8.78
Nitrogen free extract	63.81	64.50	63.75	61.24
Neutral detergent fiber	38.95	34.10	35.17	28.50
Acid detergent fiber	49.15	47.53	50.50	48.25
Acid detergent lignin	21.17	20.62	12.11	15.85
Gross energy (kcal g^{-1})	2.42	2.85	3.15	3.08

B = Water treated corn husk; C = Cocoa pod husk ash treated corn husk; CLM = *Cassava* Leaf Meal based diet; LLM = *Leucaena* Leaf Meal based diet

Table 3: Performance characteristic of growing yankassa sheep fed the experimental diets

Parameters	T_1	T_2	T_3	T_4	SEM
Intake (g/DM/day)					
Residue	73.84^b	78327^a	88.67^a	64.86	4.85
Concentrate	397.21	397.89	397.17	397.95	1.81
Total	471.05^c	467.16^b	485.84^a	462.81^d	4.19
Nutrient intake (g $kg^{-0.75}$ day^{-1})					
Dry matter	61.02^c	63.77^b	63.28^b	65.29	0.77
Organic matter	50.43^c	52.76^b	52.52^b	54.33^a	0.65
Crude fiber	8.21^c	8.49^b	8.30^c	8.90^a	0.12
Ether extract	0.87^c	1.15^a	1.07^b	1.18^a	0.02
Nitrogen free extract	34.13^b	34.29^b	35.47^a	35.07^a	0.51
Neutral detergent fiber	21.39^b	22.58^a	18.67^d	19.44^c	0.39
Acid detergent fiber	30.62^b	32.02^a	30.42^b	31.58^a	0.47
Acid detergent lignin	8.17^c	8.71^b	10.57^a	10.82^a	0.26
Initial wt (kg)	13.00	13.00	12.75	12.75	0.26
Final wt (kg)	17.53^a	16.60^b	17.85^a	14.50^c	0.26
Wt gain (g day^{-1})	92.25^b	73.50^c	95.50^a	35.75^d	0.01
Metabolic wt	7.72^a	7.55^b	7.68^a	7.09^c	0.08
Feed efficiency	0.20^a	0.15^b	0.20^a	0.08^c	0.01

Values in the same row with different superscripts differ ($p<0.05$)

NFE intake that showed no significant differences between the groups in different concentrates diet. Hence, the trend observed suggested that solubilisation of cornhusk leads to reduction in the level of nutrient intake of animals. Significant different ($p<0.05$) was also noticed on nutrient intake (g $kg^{-0.75}$ day^{-1}) between the animals on the different leaf meal based diets (CLM and LLM). Nutrient intake (g $kg^{-0.75}$ day^{-1}) for group of animals on LLM diet was significantly better ($p<0.05$) than those on CLM diet except for NDF intake that proved better ($p<0.05$) in animals on CLM diet. This could be attributed to the higher NDF content in CLM diet (35.17%); then the LLM diet (28.50%). The better nutrient intake (g $kg^{-0.75}day^{-1}$) observed in animals on LLM diet could be attributed to the higher DMI (g $kg^{-0.75}day^{-1}$) of animals on this supplement and the good interaction of the supplement with the treated cornhusk.

The final weight (kg) and feed efficiency of animals in T_3 and T_1 were significantly ($p<0.05$) higher than those in T_2 and T_4 having the lowest values. The trend observed in T_4 and T_3 implies that the animals utilized the concentrates supplemented better when combined with solubilised corn husk. More so, with the cocoa pod husk ash treated corn husk having higher energy content (2.85 Kcal g^{-1} DE) than water treated corn husk with energy content of 2.42 Kcal g^{-1} DE would possibly have permitted the utilization of other nutrients for the synthesis of body tissues than for energy requirement of the body. The weight gain values obtained in this study compared favourably with the range of values 70.58-90.58 g day^{-1} reported by Bawala *et al.* (2008) for sheep fed sugarcane tops supplemented with *Leucaena* foliage. Although, weight gain was better ($p<0.05$) for animals on T_3 than those on T_4 which is possibly due to the low DMI of corn husk observed within animals on T_4, but still it is significantly higher ($p<0.05$) than those animals on T_2 and T_4, which are fed with water treated corn husk.

Animals fed cocoa pod husk ash treated corn husk i.e., T_1 and T_3 had higher digestibility values (Table 4) for all the nutrients except for CF in T_1, when compared with the corresponding animals on the same group of concentrate i.e., T_2 and T_4, respectively. This result conforms to that reported by Taiwo *et al.* (1992) in their study of the effect of urea treated and untreated maize husk. This could be due in part to the reduction in the lignin content of corn husk by chemical treatment (cocoa pod husk ash), which increased its surface area for microbial colonization (Leng, 1990). This made available more energy for microbial growths. The high crude protein and nutrient digestibility values observed in animals on the cocoa pod husk ash treated corn husk might be due to the alkali treatment as a result of high pH (10.7) in the Iye solution, which caused the ruminal pH to tend towards neutral (pH 7) and according to Church (1993), at a neutral pH proteolytic bacteria may be more prevalent or greater degradation of cellulose and cell wall exposes more protein to microbial attack. The above author also confirmed that effect of solubilisation is to allow soluble compounds due in part to differences in microbial access.

Table 4: Apparent nutrient digestibility by growing Yankassa sheep fed the experimental diets

Nutrient	T_1	T_2	T_3	T_4	SEM
Dry matter	67.61^a	66.14^b	68.15^a	63.85^c	2.18
Crude protein	86.41^a	85.96^a	82.12^b	80.56^c	1.53
Crude fiber	60.76^c	64.41^b	70.19^a	66.83^b	2.68
Ether extract	86.70^a	86.59^a	80.18^b	76.09^b	1.94
Ash	50.51^c	39.27^d	66.12^a	60.77^b	2.11
Nitrogen free extract	74.63^c	73.80^a	75.53^a	64.66^b	2.37
Neutral detergent fiber	74.16^a	70.53^b	64.43^c	62.36^d	1.79
Acid detergent fiber	73.95^{bc}	72.94^c	76.22^a	73.70^{bc}	1.67
Acid detergent lignin	51.70^c	47.60^d	68.87^a	66.68^b	1.83

Values in the same row with different superscripts differ ($p<0.05$)

The low and high nutrient digestibility observed in animals on cocoa pod husk ash treated corn husk supplemented with CLM diet could be attributed to high (CP, NDF and EE) and low (ADL, CF and Ash) nutrient content observed in the chemical composition of CLM diet (Table 2). However, in the present study, digestibility value was made by the Coleman *et al.* (2003). Similar trend was also observed between animals on water treated corn husk except for DM and NFE values that were significantly ($p<0.05$) lower in animals on LLM diet. The improvement in digestibility observed in the present study for animals on the CLM diet were similar to that reported, which could be attributed to the ability of the supplement to provide fermentable nitrogen for microbial propagation in the rumen. It could also be due to high proportion of bypass protein reportedly (Wanapat, 1995) present in *Cassava* leaf meal, Leng (1990) had observed that both factors would enhance the utilization of poor quality feedstuff for ruminant particularly under tropical conditions.

Nitrogen utilization: Significant difference ($p<0.05$) occurred in al the parameters except for the urinary nitrogen (Table 5). The trend observed shows that animals fed with CLM diet have better ($p<0.05$) nitrogen intake than those fed with LLM diet. The fecal nitrogen and total nitrogen excreted was significantly ($p<0.05$) lower in T_1 and T_2, when compared to T_3 and T_4, the higher nitrogen losses as feaces/unit N intake might be due to the increased passage rate of the feed materials. However, the lower N loss as urine and lower total N losses showed a higher absorption of N that resulted in a higher retained N/unit N intake. Nitrogen balance and nitrogen retained values were best ($p<0.05$) in animals

Table 5: Nitrogen utilization by growing Yankassa sheep fed the experimental diets

Nutrient	T_1	T_2	T_3	T_4	SEM
Nitrogen intake	14.35^a	14.20^a	13.79^b	13.70^b	0.19
Nitrogen excretion					
Feacal	1.96^c	1.99^b	2.49^a	2.67^a	0.48
Urinary	0.36	0.43	0.38	0.39^b	0.13
Total	2.32^b	2.43^b	2.87^a	3.05^a	0.29
Nitrogen balance	12.30^a	11.78^a	10.93^b	10.65^a	0.26
Nitrogen retained (%)	83.87^a	82.92^a	72.42^c	77.74^b	1.88

Values in the same row with different superscripts differ ($p<0.05$)

placed on T_1 and T_2 and this could be ascribed to higher protein intake and digestibility of CLM diet, which led to the better utilization of nitrogen for microbial protein. Chwalibog *et al.* (1994) supported that the increase retained protein in the body was not only by an increase in the digested protein but also by the improved utilization of the absorbed proteins i.e., using more protein for anabolism and less for oxidation.

Though values reported for N intake were not significantly different ($p<0.05$) between the groups of animals on the LLM diet (T_3 and T_4). T_4 had the least N balance value resulting from high fecal N excretion. This reveals the inadequate energy intake resulting in mobilization of tissue proteins to provide the needed energy. The positive nitrogen balance observed in all treatment groups suggested that all the nitrogen absorbed was well tolerated and utilized by the animals. In general the percentage nitrogen retention values were on the high side for all the treatments, which is in agreement with the assertion that nitrogen increased with protein supplementation (Mupangwa *et al.*, 2000).

CONCLUSION AND RECOMMENDATIONS

The above results indicated that cornhusk is a potentially available feed resource for ruminants but for efficient utilization, it should be subjected to physical (chopping), biological (ensiling) and chemical (alkali) treatments. More so, it should be adequately combined with green forage or browse plant based concentrates such as *Cassava*, *Leucaena* or agro-industrial by-product. In Nigeria these farm residues are abundant and ware discarded as wastes. It may also be necessary to provide simple machines (similar to corn mills found in some villages in the country) for shredding straws before feeding to animals.

The extension service department of the ministry of agriculture should be strengthened to advise farmers on the proper treatments and feeding of straws and other agricultural by-products. The study has shown that the utilization of cocoa pod husk ash as alkali sources for improving digestibility and intake can boost small ruminant production in Nigeria.

REFERENCES

Abdulrazak, S.A., R.W. Muinga, W. Thrope and E.R. Orskov, 1997. Supplementation with *Gliricidia sepium* and *Leucaena leucocephala* on voluntary food intake, digestibility, rumen fermentation and live-weight gain of crossbred steers offered *Zea mays* stovers. Livest. Prod. Sci., 49: 53-62.

Adebowale, E.A., 1983. Efficient utilization of feed resources for animal production in Nigeria. Proc. The 5th World Conference on Animal Production, pp: 603-604.

Adebowale, E.A., 1985. Organic waste ash as possible source of alkali for animal feed treatment. Anim. Feed Sci. Technol.,13: 237-248.

Bawala, T.O., A.B.J. Aina, C.F.I. Onwuka, A.O. Oni, Y. Adebisi and M.A. Alli, 2008. Studies on performance of sheep fed sugarcane tops supplemented with varying levels of *Leucaena Leucocephala* foliage In: Proc. 33rd Annual Conference of NSAP held 17-20th, March 2008. Printed by Unique concept, Ibadan, Nigeria, pp: 583-586. ISBN: 1596-5570.

Chesson, A., 1981. Effect of sodium hydroxide on cereal straw in relation to the enhanced degradation of structural polysaccharides by rumen microorganisms. Sci. Food Agric., 32: 745-758.

Church, D.C., 1993. The Ruminant Animal Digestive Physiology and Nutrition. 1st Edn. Waveland Press, Inc. Prospects Heights, Illinois, pp: 239-240.

Chwalibog, A., K. Jensen and G. Thorbek, 1994. Effect of heat stress on the efficiency of utilization of metabolisable energy for lactation. Euro. Ass. Anim. Prod. Pub., 76: 213.

Coleman, S.W., S.P. Hart and T. Sahlu, 2003. Relationships among the forage chemistry, rumination and retention time with intake and digestibility of hay by goats. SRR, 50: 129-140.

Jackson, M.G., 1977. Review article: The alkali treatment of straws. Anim. Feed Sci. Technol., 2: 105-130.

Kaitho, J.R. and J.N. Kairiuki, 1998. Effects of Desmodium, Sesbenia and Calliandra supplementation on growth of dairy heifers fed Napier grass basal diet. Asian-Aust. J. Anim. Sci., 11 (6): 680-684.

Kiangi, E.M.I. and J.A. Kategile, 1981. Different sources of ammonia for improving the nutritive value of low quality roughages. Anim. Feed Sci. Technol., 6: 377-386.

Leng, R.A., 1990. Factors affecting the utilization of poor quality forage by ruminants particularly under tropical conditions. Nutr. Res. Rev., 3: 277-303.

Mupangwa, J.E., H.T. Ngongon, J.N. Topps and H. Hamndikwanda, 2000. Effects of supplementing a basal diet of *Choris gayana* hay with one of 3 protein rich legume hays of *Cassia rotunda*, *Lablab purpureus* and *Macroptiulum atrpurpureus* forage on some nutrition parameters in goats. Trop. Anim. Health Prod., 32 (4): 245-248.

Norton, B.W., 1994. The Nutritive Value of 3 Legumes. 2nd Edn. Cab International, Wallingford, Oxford, UK, pp: 177-191.

Orskov, E.R., 1991. Use of ash of cocoa pod husk as a source of alkali for upgrading agricultural residues with or without hydrogen peroxide. Trop. Agric., 68: 27-32.

Osakwe, I.I., 2006. Effects of *Leucaena leucocephala* supplementation to basal hay on energy and protein metabolism in West African Dwarf sheep. Nig. J. Anim. Prod., 33 (1): 94-101.

Premaratne, S., J. Van Bruchem and H.G.D. Perera, 1989. Effects of type and level of foliage supplementation on voluntary intake and digestibility of rice straw in sheep. Asian-Aust. J. Anim. Sci., 10: (2): 223-228.

SAS, 1990. Statistical Analysis Software. SAS/STAT users Guide. Version 6. 4th Edn. SAS Inst. Inc. Cary, N.Y.

Taiwo, A.A., E.A. Adebowale, J.F.D. Greenhalgh and A.O. Akinsoyinu, 1992. Effects of urea treatment on the chemical composition and degradative characteristics of some crop residues. Nig. J. Anim. Prod., 19: 26-35.

Wanapat, M., 1995. The Use of Local Feed Resources for Livestock Production in Thailand. Proceeding of the International Conference on Increase Animal Production with Local Resources. China Forestry Publishing House Ministry of Agriculture, China.