Journal of Sustainable Development in Africa (Volume 12, No.3, 2010)
ISSN: 1520-5509
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LESSER KNOWN SEED:
A RENEWABLE PATHWAY FOR SUSTAINABLE ANIMAL PRODUCTION IN AFRICA

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ABSTRACT

The study was conducted to compare the effect of soybean meal based diet and *Mucuna pruriens* seed meal on feed intake, digestibility, and body weight changes of West Africa dwarf sheep (WAD). Thirty sheep with a mean body weight of 12.30 kg (±1.45), were used in a completely randomized design model for a 112 day period. The three dietary treatments consisted of soybean meal alone (control diet, A) , 50% soybean meal +50% Mucuna seed meal (diet B) and 100% Mucuna seed meal (diet C) were randomly assigned to each sheep. The animals were fed and watered *ad-libitum* throughout the experimental period. The results revealed improvement ($p<0.05$) in the acid detergent fiber (ADF), neutral detergent fiber (NDF) , cellulose, and lignin intakes of animal fed diet B compared to diets A (control) and C. The dry matter intake (DMI), crude protein intake (CPI) and ether extract intake (EEI) were similar between diets A and B and the least was diet C. The apparent digestibility of Mucuna seed meal based diets, B and C, was significantly higher than that of the control diet A. Animals fed diet B had significantly higher body weight gain and feed efficiency. Additionally, the cost of feed per kg was cheaper in diet C, followed closely by diet B, and the least was diet A (control). It was concluded that 50% of the soybean meal can be replaced with 50% Mucuna seed meal without any detrimental effect on the animal.

Key words: Body weight, digestibility, WAD sheep, feed intake, Mucuna seed meal, soybean meal.

INTRODUCTION

Sustainable agriculture is one of the major wide spectrums of production methods that support the environment. It is also the fastest growing sector of agriculture production in the world today. This type of agriculture can be complementary to rural people's livelihood as it can increase food production at relatively low cost as well as contributing to other vital functions. Hence, Africa has the potential to feed its people and to export. For example millet, sorghum, and cassava production in Africa have increased greatly over the past 10 years and this placed Africa as the largest producer of these crops.

Therefore, Africa needs a systematic approach to ecosystem management and food production. There should be proper integration of plants and animals for positive interactions and optimize biological processes, like recycling of nutrients, biomass production, building-up of soil organic matter, and regulation of harmful organisms (Amadou, 2007).

It is noteworthy that environmental protection and good natural resource management is the key to agriculture sustainability. All the potentials of African countries have not been fully tapped since Africa is well positioned geographically between the 40^{th} parallels and is divided by the equator into two almost identical parts, in terms of land and plant diversity, making it possible for African farmers to grow all the different world crops.

Mucuna, which is a native of eastern India and southern China, is now found growing extensively all over the world. The crop has a low human preference, but with high potential as energy and /protein source in livestock diet. It is an intriguing crop which grows extremely well like a weed in various conditions and often producing high biomass (10-124DM/ha) with high seed yield. Presently, the crop is being used as a fallow crop to restore soil fertility in Nigeria. Additionally, the seed was reported as having the potential its utilization as livestock feed ingredient (Aletor & Aladetimi, 1989) . The nutritive parts of the plant are the seed, although studies have revealed presence of active principles in the stems and leaves. Becker and Siddhuraju (2003) reported significant improvement in the growth performance and feed utilization of tilapia fish fed treated mucuna seed meal. Tuleum, Carew and Ajiji (2008) opined that raw mucuna beans impaired the performance of layers while boiled mucuna beans partially reversed the impairment and the toasted mucuna beans completely reversed all the deleterious effect of the raw beans. Unfortunately, there are scanty and conflicting information on its utilization as food /feed (Pugalenthi , Vadivelm & Sddhuraju, 2005). Hence, the present study was to evaluate the efficacy of the mucuna seed meal on the performance characteristics of West African dwarf sheep.

MATERIALS AND METHODS

Sources of Mucuna seed

The Mucuna seed used for this experiment was obtained from International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria. Stones and other debris were removed before milling to form the meal. The meal was kept in a clean container and later used in the formulation of the experimental diets.

Location of the experiment

The experiment was conducted at the Animal Pavilion of the Department of Animal Production, University of Ilorin, Nigeria. Ilorin is located at the geographical and cultural confluence of the northern and southern part of Nigeria. The temperature in Ilorin is seasonally uniform.

Diet Preparation

The Mucuna seed meal, which was used as protein source, was included in a total ration to replace Soybean meal at 50 and 100% levels (Diets B and C
respectively, while Diet A (control) was soybean meal based diet)

Table 1 : Composition of the Experimental Diets

Ingredients (%)	Diet A	Diet B	Diet C
Soybean meal	20.00	10.00	-
Mucuna seed meal	-	10.00	20.00
Rice husk	23.00	23.00	23.00
Cassava waste	55.00	55.00	55.00
Vitamin –mineral premix	1.00	1.00	1.00
Salt	1.00	1.00	1.00
Total	100.00	100.00	100.00

Animals, Experimental design and Management

Thirty (30) male West African dwarf sheep (mean initial body weight, 11.30 kg(±0.36)) used for this study were bought from a local market in Ilorin, metropolis, Nigeria. The animals were housed in individual pen under a common roof and treated against ecto and endo parasites using Ivomec containing ivermectin and clorsulon (manufactured by Merck and Dohme, B.V, Netherlands). The animals were fed *ad libitum* twice daily (09.00 and 16.00hr). Ort was removed daily before the fresh diet was given to the animals. During this period, the sheep also had free access to fresh clean water. Samples of the experimental diets and the orts were taken weekly for dry matter and other proximate determination. The experiment lasted for 112 days.

Body weight gain was determined on the first day of the experimental period and the last day of the period, while body weight gain was calculated by the difference between mean body weights at the start and end of the experimental period. Hence, average body weight gain was calculated as the difference between the initial body weight gain and final body weight gain, divided by the number of the experimental days (112days).

Feed intake was calculated as feed offered minus feed ort, multiplied by nutrient composition of the experimental diets.

Digestibility trial

The digestibility trial was conducted during the last two weeks of the experimental period. The animals were housed in metabolic cages with a slatted floor, covered with a fine wire netting that allows the passage of only urine. A collecting tray was used to collect the feces daily before feeding. Total feces voided by each sheep were weighed daily and only about 25% of the sample was taken for dry matter determination at 100^{o}C for 24 hours. The remaining was dried at 70^{0}C for 48 hours.

Feces of each sheep was bulked and milled with a simple laboratory milling machine and later stored in airtight containers until needed for the analysis. The experimental diets given and the orts (left over) were also analyzed for proximate composition. Apparent digestibility coefficient was calculated as thus:

$$\frac{\text{Feed intake} - \text{Fecal output}}{\text{Feed Intake}} \times 100$$

Analyses

The proximate analysis of the diets, orts, and the feces were done in triplicate using the method of A.O.A.C (2000). Dry matter was determined by drying the sample at 100^{0}C for 24 hours. The metabolic energy of Mucuna seed meal and Soybean meal was determined by using the method of Capenter and Clegg (1956). The calcium and phosphorus contents were determined by using atomic absorption spectrophotometer. All data collected were subjected to analysis of variance (ANOVA) of a completely randomized design model, while the means were separated using the Duncan (1955) multiple range test.

RESULTS AND DISCUSSION

Proximate composition

The dry matter content of Mucuna seed meal seems consistent with most leguminous seeds (Leucana leucocephala seed, Glyricidia sepium seed, and Glycine max seed) (Giral, Sotelo, Lucas, & De La vega, 1978). The crude protein (CP) content of Mucuna seed meal was higher than the value reported for most leguminous seeds *(Leucana leucocephala, Glyricidia sepium , Etanda Africana, stylosanthes guyanensis, etc.),* which are used as supplement in the diet of ruminant animals in the tropics . The CP of the seed was consistent with the report of Belewu, Fagbemi , Dosumu and Adeniyi, (2007) and Iyayi, Taiwo and Fagbohun, 2005. The amount of protein is more vital than quality of protein and legumes are good source of protein for sheep. The crude fiber content of the seed meal, which fell between 20 and 23 percent, reported for some leguminous seeds *(Leucana leucocephala and Glyricidia sepium)* agreed with the work of Belewu et al. (2007), who used similar seed. Additionally, the meal was found to be rich in most of the mineral contents. This agreed with the reported values of Iyayi et al . (2005) and Belewu et al. (2007). However, the value for the mineral content was higher than values reported for some leguminous seeds. The high mineral content of the mucuna seed meal shows that it can satisfy the mineral needs of growing sheep (NRC, 1985). The fiber fractions (ADF, NDF, and lignin) are consistent with the work of Belewu et al. (2007) .Mean with similar superscripts are not significantly different from each other (p>0.05)

Table 2: Proximate and Mineral Composition of *Mucuna* seed meal and Soybean meal (Dry matter basis)

Parameters (%)	*Mucuna* seed meal	Soybean meal	±SEM
Dry matter	92.00	90.10	NS
Crude Protein	39.00	42.00	NS
Crude fiber	19.30^{a}	7.50^{b}	*
Ether extract	7.50^{a}	4.00^{b}	*
Metabolizable energy M.cal/kg	4.20^{a}	2.70^{b}	*
Acid detergent fiber	36.50	10.58	*
Neutral detergent fiber	66.20	15.90	*
Calcium	0.14^{a}	0.20^{b}	*
Phosphorus	0.49^{a}	0.65^{b}	*

Experimental Diets

The CP and ether extract contents of the Mucuna based diets was slightly lower than that of soybean meal based diet (control). The fiber fractions (ADF, NDF, cellulose, and lignin) increased in Mucuna meal based diets, while the CP and ether extract decreased with the incremental levels of Mucuna seed meal in the mixed ration. However, the CP value of every dietary treatment was above the minimum requirement needed for moderate growth in sheep (NRC, 1985). Additionally, the energy able to be methabolized was adequate for animal of this age (NRC, 1985).The concentration of the minerals (macro and micro) were higher than the minimum requirement (NRC , 1985) due probably to the fact that legumes have been implicated as an excellent source of calcium and phosphorus (NRC, 1985).

Table 3: Proximate Composition of the Experimental Diets (Dry matter basis)

Parameters (%)	Diet A (Control)	Diet B	Diet C
Dry matter	95.66	93.75	93.30
Crude Protein	18.06	16.33	13.84
Crude fibre	6.64	6.21	6.70
Ether extract	4.39	3.25	3.11
Ash	8.31	10.45	10.48
Acid detergent fiber (ADF)	20.14	25.01	30.24
Neutral detergent fibre (NDF)	50.48	52.43	54.37
Lignin	5.85	4.68	3.97
Cellulose	14.29	20.38	28.85
Hemicellulose	30.34	27.41	24.14

Feed intake

There was a significant intake in most of the parameters evaluated (Table 4) (CP, EE, ADF, NDF, Lignin, Cellulose and Hemicellulose). This observation was consistent with the work of Belewu, et al. (2007), who reported higher intake and utilization of *Etanda africana* (Leguminous seed) seed meal in a total mixed ration for goat fed *ad libitum*. However, the CP intake of diets A and B were similar. It is noteworthy that leguminous seeds have a more rapid digestion rate than grass (Buxton, 1996) hence they are consumed more than grass (Aregheore, 2004). The higher dry matter intake of diet B could be due to the complementary effect of both soybean meal and Mucuna seed meal.

Table 4: Nutrient intake, Feed efficiency and Body weight gain of the Experimental animals

Parameters (%)	Diet A (control)	Diet B	Diet C	±SEM
Dry matter	3501.10^{a}	3642.18^{a}	3214.09^{b}	116.52*
Crude Protein	632.31^{a}	594.77^{a}	444.83^{b}	18.90*
Crude fibre	232.48^{b}	226.18^{b}	275.93^{a}	83.21*
Ether extract	153.70^{a}	118.37^{b}	87.09^{c}	11.33*
ADF	290.95^{b}	380.61^{a}	335.87^{a}	29.52*
NDF	705.14^{b}	910.91^{a}	971.94^{a}	18.74*
Lignin	204.82^{a}	168.63^{b}	127.60^{c}	5.65*
Cellulose	462.81^{c}	742.28^{b}	844.35^{a}	77.58*
Hemicellulose	1063.45^{a}	998.33^{b}	775.89^{c}	31.98*
Feed efficiency	7.46^{b}	8.94^{a}	6.74^{b}	0.17*
Weight gain(g/d)	230.00^{b}	281.50^{a}	176.23^{b}	10.17*

Mean followed by different superscripts are significantly different ($p<0.05$)

Average daily gain and feed efficiency

Average daily gain of sheep on diets A, B and C was 2.30, 2.81 and1.76 g, respectively. (Table 4). Average daily gain (ADG) was higher for diet B compared to the average of diets A and C, which were similar. The weight gain may show changes in rumen fill as much as changes in body tissue (Aregheore , 2007). Feed efficiency [gain (g)/feed intake (kg)] was 7.46 (A), 8.94(B), and 6.74(C). The CP content of all the diets was higher than the level recommended as adequate for animal of this age for moderate weight gain in sheep. NRC (1985) reported a minimum of between 6 and 8% CP for maintenance purpose in ruminant animals. Hence, all the diets had above this level of CP content. The difference in ADG might be due probably to the higher intake of nitrogen and energy, as observed in diet B (Aregheore, 2007). The feed efficiency followed a similar trend as the body weight gain. The improvement in the body weight gain and feed efficiency could be explained by the fact that feed intake by sheep, in relation to its weight gain, tends to increase as it grows rapidly with improved feed efficiency.

Digestibility coefficient

There was no significant difference in the dry matter digestibility and crude protein digestibility among the diets, although the diets had different nutrient concentrations, mostly crude protein and energy. Nutrient digestibility increased with the increasing inclusion of Mucuna seed meal (Table 5). The ether extract content of Mucuna seed meal based diets was higher and this may be implicated for its higher digestibility. Additionally, the digestibility of the fiber fractions of the Mucuna seed meal based diets was significantly higher than soybean meal based diet (control), due, probably, to its higher content before inclusion in the diet.

Nutritive value index (NVI) and Economic analysis

Nutritive value index was similar between diets B and C, followed by diet A, which was the least; hence inclusion of Mucuna seed meal improved NVI of the total ration. NVI is one of the indices used to evaluate the quality of diet since it is a measure of the voluntary intake of digestible dry matter. Animals on diet B had the highest digestible dry matter intake, coupled with higher ADG. Also, the feed cost of diet C was lower than that of A and B by 84.6 and 42.4%, respectively. This revealed that Mucuna seed meal can be used as a cheap source of protein supplement in the diet of growing sheep up to 100% level without detrimental effect on the health status of the animal. However, the 50% level of inclusion of Mucuna seed meal was the best.

Table 5: Apparent digestibility coefficient and Nutritive value index of the Experimental Diets

Parameters	Diet A (control)	Diet B	Diet C	±SEM
Dry Matter	55.98	60.88	64.19	2.76NS
Crude Protein	80.04	75.53	82.53	4.16NS
Crude fiber	70.63	69.43	71.78	3.02NS
Ether extract	361.58^{b}	329.71^{c}	423.31^{a}	12.69*
Acid detergent fiber	61.53^{b}	69.29^{b}	76.36^{a}	2.06*
Neutral detergent fiber	63.78^{b}	73.36^{a}	72.94^{a}	2.18*
Lignin	76.14	71.54	74.19	1.64NS
Cellulose	63.35^{b}	71.18^{ab}	78.88^{a}	1.95*
Hemicellulose	65.26^{b}	72.75^{a}	68.07^{b}	1.39*
Nutritive value index	1959.92	2217.36	2063.12	

Mean with same superscripts are not significant ($p>0.05$)

Table 6: Economics analysis of Feeding *Mucuna s*eed meal based diets to West African dwarf sheep

Parameters	Diet A (control)	Diet B	Diet C
Total feed consumed(kg)	392.12	407.92	359.98
Total Feed[a] cost(#)	6612.00 ($41.85)	3812.00 ($24.13)	1012.00 ($6.41)
Feed cost(#) /kg	66.12 ($0.42)	38.12 ($0.38)	10.12 ($0.10)
Total weight gain[b](kg)	44.80	47.04	33.60
Feed cost/kg weight gain[(a/b)]	147.59 (9.34)	81.04 (5.13)	30.12 (1.91)
% Cost of saving	-	42.35	84.69

CONCLUSION AND IMPLICATIONS

The use of mucuna seed meal the diet of sheep, as reported in this study, will assist African farmers to restore its ecosystem and produce enough animal protein sustainably for its people. It will also provide a resilient system that builds on traditional management technique over a costly, high technical production system.

The results of this study revealed that Mucuna seed meal is a promising source of cheap protein in the diet of growing sheep with better weight gain (increasing tissue deposition). Another point of concern is that the meal has no nutritional value in the diet of human, hence; its cultivation should be encouraged among farmers in Africa since the seed may be an economically, socially, and nutritionally acceptable preposition.

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ACKNOWLEDGEMENT

The authors are grateful to Dr and Dr(Mrs) K.S. Olorunmaiye , University of Ilorin, Nigeria for supplying the Mucuna seed.

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