Journal of Animal and Veterinary Advances 5 (11): 901-906, 2006
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Nutritive Value of Malted Sorghum Sprout in West African Dwarf Sheep Fed Soybean Stover Based Diets

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Abstract: The feeding value of Malted Sorghum Sprout (MSP) was investigated with West African Dwarf (WAD) sheep by feeding MSP with Soybean Stover (SBS) at different ratios of 0:100 (i.e. sole SBS), 5:95, 10:90, 15:85 (which were mixture of MSP/SBS). Feed intake, weight gain, nutrient digestibility and nitrogen utilization were monitored in 12 rams using a completely randomized design. The DM, OM and NDF intakes (g/kgW$^{0.75}$/day) increased as the level of MSP inclusion increased. Crude protein intake (g/kgW$^{0.75}$/day) was highest on 15% level of MSP inclusion (15.86) and the lowest value ($p<0.05$) was in sole SBS diet (10.13). The highest weight gain of 49.8 gd^{-1} was recorded for rams on 15% MSP supplementation while the least is from the sole SBS diet. Nitrogen balance (g/kg W$^{0.75}$) and retention (%) were highest in 15% supplementation (0.30 and 63.71) and lowest in sole SBS diet (0.11 and 56.64). The digestibility of DM, CP, NDF also followed the same trend. The result indicate that feed intake, weight gain, nutrient digestibility and nitrogen utilization can be enhanced by feeding as low as 5% MSP in mixture with SBS to WAD sheep.

Key words: Malted sorghum sprout, digestibility, soybean stover, sheep

INTRODUCTION

Malted Sorghum Sprout (MSP), a non-conventional feedstuff is relatively new in the feed industry because it is a by-product of the sorghum malting process, which is now gaining ground in Nigeria. Sorghum (*Sorghum bicolor*) is grown in many parts of the world, where it is used as food for both humans and livestock Gualtieri and Rappaccini[1]. It is ranked the fifth in importance among the world's cereal Dogget[2] but in tropical Africa, it is ranked the first with about five million tonnes produced yearly in Nigeria, this being the largest in Africa. Malting of sorghum like barley involves steeping or soaking, germination, drying and curing in kiln and polishing. MSP has a lot of prospects as a feeding stuff in the livestock industry. It is currently been turned out in large quantities by breweries, food and allied industries Ikediobi[3].

The level of usefulness of MSP as a feedstuff has generated some interest and antecedent studies using rats. Results showed that MSP nutritive value is low described by Aning[4] and Oduguwa[5]. Although there are many studies available on the use of agro-industrial by products as supplement to crop residues, there is scarcity of information in this regard. Therefore, this study was designed to provide insight into the feed intake, weight gain, nutrient digestibility and nitrogen utilization in sheep fed graded levels of Soybean Stover (SBS) and malted sorghum sprout.

MATERIALS AND METHODS

Experimental site: The study was conducted in the Small Ruminant Experimental Unit Section, of the Teaching and Research farms, College of Animal Science and Livestock Production (COLANIM) University of Agriculture, Abeokuta, South Western Nigeria,

Experimental animals and their management: Twelve (12) West African Dwarf (WAD) sheep aged between 10-15 months with a mean pre-trial body weight of 14.5 kg (range=14.2 to 14.8 kg) were purchased from villages located within about 50 km radius of the University. On arrival, the sheep were given prophylactic treatments, consisting of intra-muscular injection of oxytetracycline (LA: 1mL 10 kgBW^{-1}) and vitamin B complex. They were

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routinely dewormed with Baminth II^R wormer (12.5 g kg^{-1} body weight) and bathed with Asuntol^R powder solution (3 g litre of water) to eliminate ectoparasites. They were also administered Tissue Culture Rinderpest Vaccine (TCRV) against PPR about 2 weeks after arrival. The animals were quarantined for a period of 4 weeks.

The animals were housed individually in an open sided well-ventilated pen, which had slatted wooden flooring to prevent the animals coming in contact with their faeces. The pens were cleaned, washed and disinfected with Izal solution before the arrival of the animals. Pen clearing was done thereafter weekly. The sheep were allowed an adaptation period of two weeks during which they were fed with the experimental diets as well as with Panicum Maximum (PM) and cassava peels which were the feed they were provided at the different places of purchase. They had free access to fresh water and mineral salt lick daily.

Experimental feed preparation: The soybean (*Glycine max* Merrill) stover (mixed varieties) used in the study was procured from the University of Agriculture, Abeokuta (UNAAB), model extension villages at Lanlate, Ilewo Orile and Boodo. They were threshed with Vogel type mechanical thresher obtained from International Institute for Tropical Agriculture, (IITA), Ibadan. The stover was thereafter subjected to further deseeding process, to ensure the pods were properly stripped off the raw seeds which is detrimental to the animals. Furthermore, the stover was packed into jute bags and immersed into boiling water for 10 min to detoxify any cracked or whole seed which may be remaining. It was spread out on a concrete slab and sun dried for 7 days. After drying they were baled into bundles with jute bags and stored in a well -ventilated room till required for feeding. All stover collected were fed to the sheep as threshed.

Malted sorghum sprout was purchased from Growell Industries, Limited, Abeokuta, Nigeria. The experimental diet consisted of three replications of four graded levels of malted sorghum sprout diet with soybean stover as the basal. Each diet consisted of 100:0, 95:5, 90:10, 85:15% soybean stover offered as collected from the thresher and graded levels of MSP, respectively. Sheep were offered the diet at 3.0% of BW split into two instalments per day (09.00 h and 14.00 h).

Digestibility and nitrogen balance trials: These were carried out immediately after the growth trial by transferring the animals into wooden metabolic crates fitted with facilities for separate collection of urine and faeces. The quantity of feed offered, feed refused, faeces and urine voided was determined for 7 days, after 7 days of adjustment to the cages. Ten percent of the faeces and urine collected daily were kept and pooled over the 7 days period. Nitrogen loss from the urine by volatilization was prevented by introducing 20 mL of 10% H_2SO_4 into the well-labeled urine collection container and stored in a refrigerator. All other samples were frozen until subsequent laboratory analysis.

Data collection: The quantity of the daily feed provided and the residue of the previous days' feed were weighed to determine the feed intake of each animal to compute feed intake on daily basis. Samples of experimental diet were collected during the experiment for Dry Matter (DM) determination and chemical analysis. The samples were weighed and dried in an oven at 60°C to constant weight. The dried samples were weighed and ground to pass through a 2 mm sieve. They were properly bulked and stored for proximate and fibre component analyses. To monitor the growth pattern of the animals in response to the experimental treatment, the animals' weight were taken once a week before the morning feed was offered using a hanging scale. Weights achieved were recorded for subsequent growth analysis.

Chemical analysis: The dried ground and bulked experimental diet and faecal samples were analysed for total ash, Organic Matter (OM) and Nitrogen (N) according to the official method of analysis. A.O.A.C[6]. The concentration of Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF) and lignin in both feed and faecal samples were determined by methods of Van Soest and Robertson[7]. Hemicellulose content was estimated as the difference between NDF and ADF while cellulose was estimated as the difference between ADF and ADL. Gross energy of feeds was determined with adiabatic bomb calorimeter (Parr Instrument Company, 1966).

Tannin content of samples was measured by the modified vanillin-hydrochloric acid method of Price[8]. Mineral analysis was by wet digestion of samples in $HNO_3/HClO_3$ and concentration of the element Ca and P was read in an atomic absorption spectrophotometer (Bulk Scientific model 200a, East Norwalk, USA).

Statistical analysis: Data generated from parameter investigated were analysed in a completely randomized design using the procedure of Statistical Analysis System SAS[9] and treatment means were differentiated using Duncan's Multiple range Test Duncan[10].

RESULTS AND DISCUSSION

The nutrient composition of soybean stover and Malted Sorghum Sprout (MSP) fed to West African dwarf

Table 1: Chemical composition of Soybean Stover (SBS) and Malted Sorghum Sprouts (MSP) ($g\ kg^{-1}$) fed in graded levels to west African dwarf sheep

Constituent	SBS	MSP
Dry matter	942.6	844.7
Organic matter	919.0	914.7
Crude protein	91.7	226.0
Crude fibre	353.1	48.1
Ash	81.0	58.3
Neutral detergent fibre	703.0	431.0
Acid detergent fibre	569.8	299.0
Hemicellulose	133.2	132.0
Cellulose	324.8	174.5
Acid detergent lignin	245.0	124.5
Gross energy (kcal g DM)	4.51	5.78
Tannin	2.8	1.0
HCN	0.13	0.10

SBS=Soybean stover, MSP=Malted sorghum sprout

Table 2: Nutrient intake of West African dwarf sheep fed graded levels of MSP supplement to a basal diet of soybean stover

	% Inclusion of MSP				
	0	5	10	15	SEM
LW gain (kg)	0.67^c	0.80^b	1.01^a	1.03^a	0.20
Daily weight gain ($g\ d^{-1}$)	31.9^c	38.04^b	48.09^{ab}	49.80^a	7.05
DM intake SBS ($g\ d^{-1}$)	679.14	633.33	637.19	655.60	26.30
DM intake MSP ($g\ d^{-1}$)	-	78.82^c	149.11^b	196.49^a	18.67
Total DM intake ($g\ d^{-1}$)	679.17	712.15	786.07	862.11	37.64
DM intake ($g\ kg^{-1}\ W^{0.75}$/day)	93.03	93.28	107.38	116.98	5.64
OM intake ($g\ kg^{-1}\ W^{0.75}$/day)	85.49	89.34	98.11	106.93	9.03
CP intake ($g\ kg^{-1}\ W^{0.75}$/day)	10.13^b	11.87^{ab}	14.06^{ab}	15.86^a	0.84
NDF intake ($g\ kg^{-1} W^{0.75}$/day)	65.4	65.35	69.95	75.06	2.30
ADF intake ($g\ kg^{-1}\ W^{0.75}$/day)	53.01	55.73	59.67	59.42	2.07
Feed conversion ratio	21.85	18.69	16.34	17.31	

a,b,c: Means on the same row with different superscript are significantly ($p<0.05$) different

sheep is shown in Table 1. The dry matter and organic matter content of the MSP and SBS were similar. The value of crude protein in MSP was more than twice that in SBS. MSP had a lower NDF, ADF and lignin. Crude fibre value for MSP was 48.1 $g\ kg^{-1}$ while that of SBS was 353.1 $g\ kg^{-1}$. The energy concentration of the feed-stuff as depicted by the gross energy values were 4.51and 5.78 kcal g^{-1} DM for SBS and MSP, respectively.

DM intake increased as the inclusion of MSP increased, there were however no significant difference ($p<0.05$) among the diets (Table 2). These values were 93.03, 107.38 and 116.98 $g\ kg^{-1}\ W^{0.75}$/day, respectively. Organic matter intake also had a similar trend as the dry matter intake while the crude protein intake varied significantly ($p<0.05$), ranging from 10.13 $g\ kg^{-1}\ W^{0.75}$/day in 0% MSP and 15.86 $g\ kg^{-1}\ W^{0.75}$/day in 15% MSP. The values for ADF intake ranged between 53.01-59.42 $g\ kg^{-1}\ W^{0.75}$/day.

Live-weight changes of WAD sheep (Table2) indicated that there were significant differences among the treatments. The sheep fed on 15% MSP exhibited the highest weight gain. This also reflected in the daily weight gain values, which ranged from 31.90 to 49.80 $g\ d^{-1}$. Feed conversion ratio was best in the animals fed 10% MSP (16.34) and worst (21.85) in SBS sole fed animals.

Table 3: Digestibility coefficient of major nutrient by West African dwarf sheep fed graded levels of Malted Sorghum Sprout (MSP) and Soybean Stover (SBS)

	Levels of inclusion				
Nutrients	0	5	10	15	SEM
Dry matter	0.574	0.607	0.624	0.664	1.90
Organic matter	0.593^b	0.612^b	0.675^{ab}	0.716^a	2.45
Crude protein	0.538	0.577	0.616	0.648	2.26
Crude fibre	0.592	0.621	0.653	0.707	2.23
Neutral detergent fibre	0.598	0.601	0.616	0.665	2.03
Acid detergent fibre	0.575	0596	0.607	0.612	1.56
Lignin	0.625	0.578	0.552	0.509	2.07
Cellulose	0.611	0.595	0.591	0.621	2.58
Hemicellulose	0.518	0.546	0.734	0.841	5.90

a,b,ab,b: Means on the same row with different superscript are significantly ($p<0.05$) different

Table 4: Nitrogen utilization by West African dwarf sheep fed graded levels of Soybean Stover (SBS) and Malted Sorghum Sprout (MSP)

	Treatments				
Parameters	0	5	10	15	SEM
Nitrogen intake ($g\ d^{-1}$)	1.38^a	2.35^b	2.87^{ab}	3.38	0.01
N intake ($g\ d^{-1}\ W_{kg}^{0.75}$)	0.19^c	0.32^b	0.39^{ab}	0.45^a	0.01
Faecal N output($g\ d^{-1}$)	0.58^b	0.69^{ab}	0.71^{ab}	0.87^a	0.02
UrinaryN output($g\ d^{-1}$)	0.02^b	0.22^{ab}	0.40^a	0.34^a	0.01
Total N output ($g\ d^{-1}$)	0.59^b	0.19^{ab}	1.11^a	1.21^a	0.11
N retained ($g\ d^{-1}$)	0.77^c	1.44^b	1.77^{ab}	2.17^a	0.12
N balance ($g\ d^{-1} Wkg^{0.75}$)	0.11^c	0.19^b	0.24^{ab}	0.29^a	0.71
N retention (%)	56.64	61.28	61.92	63.71	4.32

a,b,ab,c: Means on the same row with different superscript are significantly ($p<0.05$) different

An increasing inclusion of MSP in the diet significantly ($p<0.05$) increased the intake of nitrogen by the sheep (Table 3). These values were generally low. It also followed the trend in crude protein intake by the animals. Similarly, faecal and urinary N outputs were significantly ($p<0.05$) different among the diets. However, the percentage N retention values were not significantly ($p>0.05$) different among the treatments. The N retention also showed similar with that observed for N intake.

Apparent nutrient digestibility values were not significantly ($p>0.05$) different except for organic matter with values ranging from 0.593 to 0.7160 (Table 4). A trend was also observed in which the digestibility values of all the nutrients gradually increased with increase in the level of MSP except for lignin where the values decreased with increasing MSP levels.

The dry matter composition of the malted sorghum sprout used in this study was expectedly so as it was collected in a dry form. The dry matter content ranged favourably with that of wheat offal Nsahlai[11]. Also the dry matter content of soybean stover in this study compares favourably with an earlier reported range of 975.7-987.6 $g\ kg^{-1}$ for four different varieties of soybean stover Dada[12]. The high content of OM, ADF, cellulose and GE of the soybean stover were identical to those of SBS reported by Soofi[13], Felix[14] and comparable to reports by Ngwa and Tawah[15] on groundnut haulms and cowpea vines. Crude protein content of MSP was higher than 189.0 g kg^{-1} reported by Fafiolu[16] and Akinola[17].

A very important finding in this study was that MSP was found acceptable when fed to sheep. On the average, the animals consumed more of the diet as the inclusion level increased. This also led to increased SBS intake by the sheep, as well as increased DM Intake (DMI). Organic Matter (OM) intake followed DMI pattern as well. Crude Protein Intake (CPI) was highest in diet 4 having the highest inclusion level of MSP, effect of treatment significantly influenced the intake of crude protein, the sole fed soybean stover sheep had a lowered mean CPI. Lowest CP intake of diet 1 could be ascribed to the low CP content of SBS compared with the supplemented diets. However, mean CP intake of sheep fed the experimental diets was higher than 0.79 kg^{-1} $W^{0.75}day^{-1}$ recommended for maintenance and growth in the tropics Akinsoyinu[18].

Mean NDF intake values of the four diets were not different though the NDF content of SBS was about 40% higher than that of MSP. Higher inclusion of MSP did not override the intake of NDF in the other diets especially the sole fed diet. Similarly, high NDF content of the SBS may be responsible for the observed non-significant NDF intake in four diets Dada [12] Cellulose is a potential source of carbohydrate, one of the major nutrients supporting microbial growth in the rumen Dhinan and Saltter[19]. It was observed during feeding that the animals in each dietary group consumed more of all the MSP provided as well as the SBS. The haulms had greater percentage of empty pods and stems and very negligible portion of leaves.

The highest average daily weight gain obtained in sheep fed 15% inclusion of MSP might be attributed to high intakes of DM, OM and CP and cellulose. As the level of MSP increased, the gain per day also improved in the sheep. Active growth could be obtained in animals fed grainless (wheat bran) concentrate as reported by Giri[20]. The lowest weight gain by animals in the unsupplemented diet was in agreement with earlier reports by Dada[12]. This depicts that leguminous crop residues can sustain animals on maintenance level. This is opposed to weight loss of -33.30 to -50 g d^{-1} reported by Adamu[21] with unsupplemented sorghum stover. The live-weight gain (g/day) observed in this study was however lower than the range of 47.60-107.15 in sheep fed chopped sorghum stover and cotton seed cake concentrate supplements reported by Olaleru and Adegbola[22].

The feed conversion ratio of sheep fed supplemented diet were similar but lower than the unsupplemented diet implying that diet 1 had a very high and efficient conversion of feed to body tissue. The available nutrients were judiciously utilized. The Feed Conversion Ratio (FCR) obtained in this study is higher than 9.2-11.9 FCR values obtained by Adu and Brinckman[23] with sheep fed varying concentrate levels though their basal diet was grass hay. Furthermore, better feed conversion of sheep fed diet 1 could be ascribed to the cellulose digestibility. Reports of Minson[24] and Givens[25] corroborates the fact that feed efficiency is improved through a reduction in dry matter intake.

Digestibility of DM, CP, NDF and ADF followed the same pattern observed in DMI. Digestibility of DM, OM, CP and fibre fraction in the diets increased with increasing level of MSP. Several workers have reported on the influence of substitution level of hay or crop residue on digestibility El Hag and El Sharg[26] Kraiem[27]; Aregheore[28]. The values obtained in this study compared favourablv with these values earlier reported. There was an increasing CP Digestibility (CPD) with increasing MSP level. Animals on 15% MSP diet gave better CPD than those on the other diets. This may be due to the ability of the supplement to effectively stimulate additional microbial protein synthesis. Also the additional crude protein from the legume crop residue plus additional fermentable energy could have resulted in better digestibility. There was an increase in NDF digestibility probably due to the level of supplementation of MSP, higher levels of supplementation would have hindered the activity of cellulolytic bacteria. Kraiem[27] reported that digestibility of fibre fraction increased slightly with low level of supplementation with concentrate (20%) but decreased with higher levels (40 and 60%).

Also, this depicts the ability of the MSP to synchronize better release of nitrogen and fermentation energy (carbohydrate) to the rumen in the form of available cellulose and hemicellulose which stimulate fibre digestion. Hemicellulose digestibility observed in this study can be attributed to the high hemicellulose intake by the sheep in the supplemented diets. Previous workers Wilson[29], Dada[12] also commented that hemicellulose intake play a major role in hemicellulose digestion although this is equally controlled by other factors because its digestion is not accomplished by enzymes of the animal body but depends upon the enzymes of symbiotic microorganisms that inhabit the digestive tracts of the animals.

SBS contain about twice the amount of lignin in MSP. There might not be any phenolic constituents such as cutin in the ADL fraction of MSP. The malting process of sorghum grain might have removed part of the cutin originally found in the grains Miron[30]. Ho[31] also suggested that cutin rather than lignin plays an important role in protecting wheat bran from microbial degradation in the rumen. On the other hand, for SBS the lignin content resembles the core lignin which is difficult to degrade Van Laar[32].

Nitrogen balance indicated that the sheep fed supplemented diets showed higher intake than those on unsupplemented SBS. Faecal N output also followed the same trend. The urinary N output was highest for 10% MSP diet. The retention and utilization of dietary nitrogen can be influenced by the type and quality of carbohydrate present Alli Balogun[33]. Protein retention as a percentage of N intake also followed the same trend. Lowered retention value for the sole fed sheep could be as a result of reduced utilization of dietary protein by microbes Antoniou and Hadjipanayiotou[34]. The positive nitrogen balances obtained however signified that the diets were adequate in their supply of nitrogen to the rumen.

The results of this study reveal that the feeding value of this unconventional supplement, malted sorghum sprout, can be fed with soybean stover to improve the performance of sheep. The level of the supplement in combination with soybean stover to achieve substantive improvement in performance could be as low as 5% and as high as 15%.

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