Nigerian J. Anim. Sci. 2025, 27 (1): 142 - 152

Influence of Graded Levels of Moringa oleifera Leaf Meal on Performance, Apparent Nutrient Digestibility and Economics of Production of West African Dwarf (WAD) Ewes

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Abstract

A-90 day study was carried out to determine the growth performance, apparent nutrient digestibility and economics of production of incorporating Moringa oleifera leaf meal (MOLM) in the diets of ewes. Twenty-four WAD ewes of about 10-12 months in age, averaging 12.4±0.23kg in weight, were randomly assigned to four dietary treatments (A, B, C and D) containing 0, 5, 10 and 15% MOLM inclusion levels respectively. The animals were randomly divided into four treatment groups of six ewes each and assigned the diets in a completely randomised design. Each animal was housed individually in cement floored pens provided with feeding and drinking troughs. The ewes were fed on 3% body weight on dry matter basis in addition to basal forage (Panicum maximum). Results showed that average daily feed intake and average daily dry matter intake increased significantly ($p<0.05$). Average daily weight gain differed significantly ($P<0.05$). FCR was best ($p<0.05$) for ewes fed diet C and D. Cost benefit ratio showed that the rate of returns increased as the MOLM level in the diet increased. Gross profit was higher ($p<0.05$) for animal in fed diet C and D. Dry matter, crude protein and crude fibre digestibilities were significantly ($p<0.05$) better among the treatment groups. Incorporation of MOLM in WAD sheep diets generally enhanced intakes, body weight gain, cost benefit ratio, gross profit and nutrient digestibility and hence could be included in sheep diets up to 15% without any adverse effect on intakes, weight gain, cost benefit ratio and digestibility.

Keywords: Sheep, leaf meal, alternative protein sources, weight gain, dry season supplement, Moringa.

Description of Problem

Poor nutrition is one of the major factors limiting the productivity of sheep. (1) noted the importance of sheep as a source of animal protein and its contributions to the diversification of livestock production, thus making it an integral part of the tropical agricultural system.The poor nutrition has been blamed on the non-availability of feed through the year due to prolonged dry season and change in weather as a result of climate change which has worsened the productivity

of ruminants in this region. This has resulted to poor animal protein consumption in Nigeria. (2) estimated animal protein intake in Nigeria at 8g per caput per day, which is below 67g per day recommended by the World Health Organization. This escalated animal protein inadequacy in the diets of most Nigerians is a major concern as it has increased the percentage malnutrition in Nigeria.

Locally available and non-competitive feedstuffs have been reported (3) as a better alternative to formulate a dry season concentrates for supplementing and improving the productivity of small ruminants especially during dry season. Leaf meals do not only serve as protein sources but also provide some vitamins, minerals and also oxycarotenoids (4) Leaf meal of tropical browse plants is a good source of cheap dietary protein for sheep and goats. The use of leaf meals of tropical plants such as *Moringa oleifera* to improve animal performance and optimize profit has been reported by (4;5; 6).

Moringa oleifera frequently called horse-radish, miracle tree or drum stick bee, is a good source of protein for livestock and has elicited interest in recent times (7). Moringa is established in the field, its coppicing ability is very high, and it also has good potential for forage production with minimum inputs due to favourable soil and climatic conditions for its growth (8).*Moringa oleifera* plant has the ability of being available all year round because of itsdrought resistance, persistence, vigorous growth and the ability to regrow fast (6). *Moringa* foliages are potential inexpensive protein source for livestock feeding. *Moringa* is a perennial plant popularly used as life fence in the Tropics and can be harvested several times in one growing season, and has very high potential to reduce ruminant feed cost. This study therefore presents information on growth performance, economics of production and apparent nutrient digestibility of West African dwarf sheep fed *Moringa oleifera* leaf meal. We assume that inclusion of 0–15% of *Moringa oleifera* leaf meal will have a beneficial effect on growth performance, economics of production and apparent nutrient digestibility of West African dwarf sheep fed *Moringa oleifera* leafmeal.

Materials and Methods

Experimental site

The experiment was carried out at the sheep and goat unit of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Abia state, Nigeria. The university is located on Latitude 05° 29' N and longitude 07° 33' East. It is approximately 122m above the sea level and has a maximum and minimum daily temperatures of 27-36° C and 20-29°C respectively and a relative humidity of 57-91%. It is located within the tropical rainforest zone characterized by an annual rainfall of 2177mm.

Experimental animal management and design

Twenty four West African Dwarf (WAD) ewes averaging 12.44kg body weight were purchased from local farmers in Amainyi, Ihitte/Uboma local government of Imo state. The sheep were quarantined for 21days, dewormed and treated with appropriate acaricides. Each animal were housed individually in well ventilated cement floored pen equipped with feeding and

watering troughs. The animals went through a 21days preliminary period to accustom them to the environment and were fed with the control diet (Table 1) in addition to fresh *Panicum maximum* as a basal diet.

After the preliminary feeding period, the WAD ewes were randomly balanced for weight and divided into four groups of six animals each. The groups were randomly assigned the four experimental diets (A, B, C and D) in a Completely Randomized Design (CRD). Each animal received a designated experimental diet in the morning (08 hrs) for 90 days. Feed offered was based on 3% body weight of the animal per day on dry matter basis; the animals in addition were fed 2 kg fresh *Panicum maximum* later in the day (16 hrs). Regular access to fresh drinking water was made available. Records of feed offered and refused were taken on a daily basis.

Experimental diets

Experimental diets assigned A, B, C and D were formulated with diet A which served as a control containing 0% of *Moringa oleifera* leaf meal (MOLM), diets B, C, and D contained 5% 10% and 15% inclusion levels of MOLM respectively. Other constituents of the diets include maize offal, cassava peel, palm kernel meal (PKM), brewer's dry grain (BDG), bone meal and salt as shown in Table 1.

Growth trial

After the preliminary feeding period, the 24WAD ewes were randomly divided into 4 groups of 6 animals each. The groups were randomly assigned the 4 treatment diets (A, B, C and D) in a Completely Randomized Design. The animals were housed individually in well ventilated cement floored pens equipped with feeders and drinkers. Each animal received the designated treatment diet in the morning for 90 days. Feed offered was based on 3% body weight per day; the animals in addition were fed 2 kg fresh *Panicum maximum* later in the day. Fresh drinking water was made available at all time. Feed offered and refused were recorded on a daily basis. Initial weights of the animals were taken at the beginning of the trial and subsequently on weekly basis.

Apparent Nutrient Digestibility Coefficient

Four West African Dwarf sheep were selected from each treatment group, transferred and housed individually in metabolism cages with facilities for collecting faeces and urine. Each animal received one of the four experimental diets (Table 1) in a 4 x 4 Latin square design. Each animal received 1kg of one of the 4 experimental diets per day in the first phase of the experiment which lasted for 28 days. Fresh drinking water was offered *ad libitum* to each animal daily. Daily feed intake was determined by weighing the quantity offered and refused. Total faeces and urine voided by the experimental animals were collected during the last 7 days (22nd –28th) of each phase.

Faecal samples were collected and bulked for each animal. A sub sample from each animal was dried in forced draft oven at 100- 105°C for 48 hours and used for dry matter determination. Another sample was dried at 60°C for 48-72 hours for determination of proximate composition. Apparent nutrient digestibility coefficient was determined as follows:

Nutrient in feed- nutrient in faeces x 100%

Nutrient in feed

Economics of Production

The prevailing market prices of the feed ingredients at the time of the experiment were used to estimate the unit cost of the experimental diets. The variable cost of feeding the sheep considered as the cost of the feeds and all other costs (i.e. labour, capital investment and housing) were the same for all the treatments. The cost of processing the MOLM was included as the feed cost. Feed cost per kilogramme, cost per kilogramme of weight gain and cost benefit ratio were calculated.

Proximate analysis

The proximate analyses of all feeds, the test ingredient MOLM, *Panicum maximum* and faecal samples were carried out to determine the percentage composition of dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and nitrogen free extract (NFE) and ash using the method of (9).

Table 1: Constituents of Experimental Diets

	Diets (%)			
Ingredients	**A**	**B**	**C**	**D**
Maize offal	30.00	30.00	30.00	30.00
Cassava peel meal	20.00	20.00	20.00	20.00
Palm kernel cake	22.00	22.00	22.00	22.00
Brewer's dried grain	25.00	20.00	15.00	10.00
Moringa oleifera leave meal	0.00	5.00	10.00	15.00
Bone meal	2.00	2.00	2.00	2.00
Salt	1.00	1.00	1.00	1.00
Total	**100**	**100**	**100**	**100**

Experimental design and statistical analyses

For growth performance and economics of production, the experimental design was a completely randomised design (CRD). Data obtained were analysed using analysis of variance (ANOVA) as described by (10). Significant means were separated using the Duncan Multiple New Range Test (11) at $P < 0.05$. For the digestibility studies, the experimental design used was a 4×4 Latin square experiment. Data obtained were analysed using analysis of variance (ANOVA) as described by (10). Significant means were separated using the Duncan Multiple New Range Test (11) at $P < 0.05$.

Results and Discussion

Proximate composition of the experimental diets, MOLM and *Panicum maximum*

The proximate constituents of the experimental diets, *Moringa oleifera* leaf meal and *Panicum maximum* used in this

study are presented in Table 2. The proximate values for the MOLM in this study compares favourably with values reported by (12; 6). The crude protein content of MOLM in this study (23.24%) compared well with (13), thus confirming MOLM as a good source of high quality protein in animals. This further indicated the potentials of MOLM in meeting the protein needs of 16% dietary CP (14) of growing sheep.

DM contents of the test diets were similar with the control diet, though with no consistent pattern. The potential of MOLM as a good protein source for ruminants manifested with the increase in CP corresponding to increase MOLM inclusion levels. The CP of the diets were higher than 8% level recommended by (15) for optimal rumen microbial activity and also exceeded the 11.00 to 13.00% recommended by (16) to be capable of supplying sufficient protein for maintenance and moderate growth in small ruminants. The crude fibre values obtained in the diets were enough to maintain healthy rumen environment stimulating rumination and salivation and preventing digestive upset. Ether extract and nitrogen free extract declined with increasing levels of MOLM in the test diets while ash did not show any consistent trend.

Table 2: Proximate composition of the experimental diets, *Moringaoleifera* leaf meal and *Panicummaximum* (% DM basis)

	DIETS					
	A	B	C	D	MOLM	PM
Dry matter	88.15	90.47	90.92	90.61	87.90	34
Crude protein	17.07	18.79	19.38	20.20	23.24	7.21
Crude fibre	16.83	17.93	18.21	18.63	15.16	19.16
Ether extract	4.19	3.76	3.25	3.56	4.15	1.92
Ash	16.22	16.56	16.94	17.02	6.21	1.70
Nitrogen free extract	33.84	33.43	32.71	31.20	39.14	4.01
Metabolizable energy (Kcal/kg)	3075.55	3150.30	3178.05	3160.70	2606.05	555.90

MOLM = *Moringaoleifera* leaf meal
PM = *Panicum maximum*

Growth Performance

The performance characteristics of WAD ewes fed graded levels of *Moringa oleifera* leaf meal diets are shown in Table 3. The average daily feed intake (ADFI) and average daily dry matter intake (ADDMI) (g/d) were significantly ($p<0.05$) influenced by the treatment diets, with ADFI and ADDMI increasing with incremental levels of MOLM in the diets. The average feed intake in the present study is in consonance with values of 461.90 and 467.90 reported respectively for WAD goat and sheep in an earlier investigation (17). Lower DM values (291.55-313.40 g/d) have also been reported (18) for WAD goats. Diets, season and management (19) could influence differences in dry matter intake among animals of same species. Total dry matter intake as percentage of bodyweight (TDMI % BW) for the experimental animals on treatment diets were above 3% of body weight which is the recommended status for meat type sheep, but fall within 2-6% recommended by (20) for meat type sheep. The above results suggest that all the treatment groups had excellent DM status evidenced by the nourished disposition and

positive weight changes exhibited by the experimental animals. However, relatively high DM intake was observed for sheep fed MOLM diets. (4) and. (6), confirmed improved nutritive quality in in small ruminant diets incorporated with MOLM. (21) emphasized the importance of protein intake as a determinant of performance in ruminants. Consequently all treatment diets had CP level above 8% which is the minimum required for basic rumen functions. Bodyweight changes were positive for all animals within each experimental group. The total weight gain differed significantly ($P < 0.05$), increasing from 3050g in control to 4330g in diet D. The average daily weight ranged between 33.89 and 48.11g/day. The daily weight gain of ewes on diets C and D were significantly higher ($P < 0.05$) than those of animals on diets A and B. The significantly ($P<0.05$) higher weight gain observed in animals in diet C and D maybe attributed to better utilization of nutrients. The average daily weight (ADWG) recorded for treatment groups in this study fall within the range of 35-65g reported for WAD sheep (22). The present values are, however, higher than the range of 10.71-36.61 reported by (16) for ewes whose dietary proteins were supplemented. The present values were nevertheless lower than 65g/d reported by (23) for WAD sheep fed 75% grass supplementation in varying forage and concentrate ratios. The ADWG reported herein compared favourably well with the range of 46.14- 48.57g/d (12) for WAD sheep supplemented with concentrate containing MOLM. The feed conversion ratio (FCR) significantly ($P<0.05$) differed, with diets C and D having similar but better ($P<0.05$) than ewes on diets A and B. The superior feed efficiency of diets C and D compared with diet A and B was reflected in the higher growth rates observed for ewes on diets C and D.

Nutrient digestibility

The nutrient digestibility of West African dwarf ewes fed *Moringa oleifera* leaf meal is presented in Table 4. The apparent nutrient digestibility coefficient showed that dry matter digestibility (DMD), crude protein digestibility (CPD), crude fibre digestibility (CFD) and ash digestibility (AD) differed ($P<0.05$) significantly. The DMD ranged between 55.62and 61.99%indicated that the diets were well digested since the values were above 50% DMD. DMD increased as the level of MOLM increased from diet A – D, suggesting, that incorporation of MOLM in sheep ration enhanced digestibility. Dry matter of the test diets (B, C and D) were digested better than the control diet. In a similar study (24), obtained DMD ranging from 55.74 – 70.80%for sheep fed supplemental diets containing MOLM and basal diet comprising mostly *Panicum maximum*. Diets are known to influence DMD (18). DMD is positively correlated to dry matter intake (DMI), it is presumed that nutrient density and not DMD maybe the overriding factor influencing DMI in animals (25).

Crude protein digestibility coefficient also followed similar pattern as dry matter, it increased significantly ($P<0.05$) from diets A-D. With respect to dry matter, CPD coefficient for the control diet differed significantly ($P<0.05$) from those of diet B, C and D. Digestibility coefficients of animals fed diet B did not differ significantly ($P>0.05$) from that of C neither did the value for diet C differ ($P<0.05$) from that of diet D.

Table 3: Growth performances of WAD ewes fed diets containing graded levels of *Moringa oleifera* leaf meal diets.

Parameter	A	B	C	D	SEM
Initial weight (kg)	12.50	12.63	12.17	12.47	0.12
Final weight (kg)	15.55^{b}	16.03^{ab}	16.37^{ab}	16.80^{a}	2.00
Total weight gain (kg)	3.05^{b}	3.40^{b}	4.20^{a}	4.33^{a}	0.18
Average daily weight gain (g/day)	33.89^{b}	37.78^{b}	46.67^{a}	48.11^{a}	1.95
Total feed intake (kg)	41.73	42.18	43.33	44.27	1.27
Average daily feed Intake (g/day)	463.70^{b}	468.70^{b}	488.89^{ab}	491.85^{a}	8.80
Average daily DMI conc. (g)	408.75^{b}	424.03^{b}	444.50^{ab}	445.67^{a}	8.53
DMI % BWT Concentrate	2.63	2.65	2.71	2.65	0.05
DMI % BWT Forage	0.58	0.66	0.66	0.68	0.05
Total DMI % BWT	3.21	3.31	3.37	3.33	0.04
FCR	13.68^{a}	12.41^{b}	10.48^{c}	10.22^{c}	0.40

$^{a-b}$, means on the same row with different superscripts are significantly different at ($p<0.05$)
Average daily DM intake =Average daily dry matter intake
DMI%BWT concentrate = Dry matter intake as percentage body weight of concentrate
FCR =Feed conversion ratio

The apparent digestibility values obtained for crude protein in the study compared favourably with the range of 64.69-84.96% reported by (24) for sheep fed MOLM containing diets. The higher CP digestibility coefficients reported in the treatment groups indicated that dietary protein was better utilised by the ewes fed the treatment diets relative to the control. It is possible that MOLM improved the amino acid profile of the treatment diets, a view earlier confirmed by investigations of (9) and (26). The crude protein contents of the treatment diets were positively correlated with CF digestibility. This supports the submission by (27) that CF digestibility decreases as the level of CP in the diet decreases. In management of farm animals, synchronisation of nutrients, particularly protein and energy, should be of crucial consideration for nutrient utilisation. Improved digestibility at higher nitrogen levels (diet D) had previously been linked to low fibre levels (28).

The CFD coefficient of diet A differed ($P<0.05$) significantly from those of the test diets (B, C and D) even though this nutrient was fairly equally digested ($P>0.05$) among the diets B, C and D. (25) observed that increase in crude fibre digestibility coefficient with incremental crude fibre of the diets increased. The crude protein and crude fibre are components of dry matter of same feed. This probably explains why digestibility coefficient of CP and CF increased from A-D, in the same pattern with dry matter.

Economics of production

The economics of feeding West African Dwarf ewes diets containing graded levels of *Moringa oleifera* leaf meal are presented in Table **5**. The cost of producing a kilogram of treatment diets significantly ($P<0.05$) reduces as the level of MOLM inclusion level increases which is as a result of low cost of sourcing and processing MOLM, thereby validating the choice of MOLM as an alternative source of protein for ruminant animals. Ewes on treatment diet D (15% MOLM) recorded the lowest feed cost per kg

Table 4: Apparent digestibility of nutrients WAD ewes fed diets containing graded levels of *Moringa oleifera* leaf meal diets.

PARAMETERS	Diets A	B	C	D	SEM
Dry matter digestibility	55.62[d]	58.17[c]	60.82[b]	61.99[a]	0.65
Crude protein digestibility	71.61[c]	75.67[b]	77.18[ab]	78.79[a]	0.81
Crude fibre digestibility	66.93[b]	71.00[a]	72.06[a]	74.31[a]	0.85
Ether extract digestibility	93.00	92.44	91.62	92.84	0.29
Ash digestibility	36.49[b]	39.48[b]	47.71[a]	46.67[a]	1.39
NFE digestibility	48.71	46.68	48.51	47.79	0.63

[a-d]Means on the same row with different superscripts differ significantly (P<0.05); NFE = Nitrogen free extract.

weight gain (N348.04), this unit cost differed significantly (P<0.05) from that of diet A (N486.39) and B (N434.83) but did not with C (N356.44). The result of this study showed that incorporating MOLM in the diets of ewes generally reduced cost of production and increased gross profit among ewes fed the test diets; a view corroborated by (29). Diet D with highest MOLM inclusion (15%) had the least cost of production and the highest gross profit. This observation is also buttressed by the cost benefit ratio analysis which was the highest for ewes fed diet D. MOLM by this study has shown to be able to improve the farmer's income by using least input to achieve higher output, this is in consonance with (3) assertion that locally available and non-competitive feedstuffs can be used to formulate concentrates for supplementing and improving the diets of animals. The potentials of *Moringa* for optimization of the farmer's income by using it as alternative feedstuff both for feeding and fattening sheep and small ruminants are still very possible since the current research did not exceed 15% MOLM inclusion level (diet D). More efforts should be done to increase the inclusion levels for the benefits of the farmers.

Table 5: Economics of feeding WAD ewes diets containing graded levels of *Moringa oleifera* leaf meal

INGREDIETS	A	B	C	D	SEM
Cost/100kg feed (₦)	3555.00[a]	3505.00[b]	3455.00[c]	3405.00[d]	17.03
Cost/kg feed (₦)	35.55[a]	35.05[b]	34.55[c]	34.05[d]	1.24
Total feed consumed (g)	41.73	42.18	43.33	44.27	1.27
Total cost of feed (₦)	1483.50[b]	1478.41[b]	1497.05[ab]	1507.39[a]	4.22
Total weight gain (kg)	3.05	3.40	4.20	4.30	0.29
Feed cost/weight gain (₦)	486.39[a]	434.83[b]	356.44[c]	348.04[c]	17.11
Cost/kg live weigh (₦)	730	730	730	730	0.00
Cost benefit ratio	1:1.50	1:1.68	1:2.04	1:2.10	
Gross profit	243.61[c]	295.17[b]	373.56[a]	379.44[a]	9.82

[a-d], means on the same row with different superscripts are significantly different at (P<0.05)

Conclusion

Moringa oleifera leaf meal incorporation in WAD ewe's diets generally improved feed and dry matter intake, digestibility, average daily weight gain and feed conversion ratio. Diet D that contains 15% MOLM could be recommended for sheep fattening programmes without any detrimental effect owing to the fact that it recorded better apparent nutrient utilization which is in concomitance to the highest weight gain and the best cost benefit ratio. The intensive system of sheep rearing can be encouraged using *Moringa oleifera* leaf meal, it is therefore suggested that extension services should be improved to enlighten rural dwellers who keep 95% of small ruminants. *Moringa oleifera* can be used to fatten sheep all year round since it survives drought and is available all year round.

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