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Performance and Cost-benefit analysis of *KALAWAD* Goats fed Diets Containing Graded Levels of *Moringa Oleifera* Leaf Meal

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Abstract

The rising cost of feed ingredients had led to the development of alternative feed source for the cost effective production and management of ruminant livestock. The aim of this study was to evaluate the effect of Moringa oleifera leaf meal on performance and cost effect of the goats in terms of body weight changes, feed intake and the cost-benefit analysis. Eighty-four -day study was carried out with twelve KALAWAD weaner goats. The goats were divided into three experimental groups of four goats each using completely randomized design. Three experimental diets were formulated to include 0, 5.0 and 7.5% moringa meal. The parameters measured for performance indices were final weight (10.43 to12.46kg), metabolic weight gain (15.30 to 17.43kg), weight gain (3190 to 4100g), daily weight gain (37.63 to 48.02g), dry matter intake (628.89 to 660.74g), dry matter intake (580.14 to 614.33g) and feed conversion ratio (16.59 to 14.54). Also, the parameters measured under the cost-benefits analysis were total feed intake, total cost of feed, cost of feed/kg gain and % Reduction in cost/kg gain. The results showed that inclusion of Moringa meal as a supplement had significant ($p<0.05$) effect on the weight gain, feed intake, dry matter intake and metabolic weight gain of the animals. The Moringa leaf meal-based supplements had lowered (from N2480.92 to N2160.44) the cost of feed per kilogram of weight gain. The experimental diets were offered at 4% body weight. In this study, it was concluded that 7.5% inclusion level of Moringa oleifera leaf meal into the diet improves the performance and reduced cost of feed per kilogram weight gain.

Keywords: Goats, *performance, Moringa Oleifera,* animals and cost benefit.

Analyse des performances et des coûts-avantages des chèvres *KALAWAD* nourries avec des régimes contenant des niveaux progressifs de farine de feuilles de *Moringa Oleifera*.

Résumé

Le coût croissant des ingrédients alimentaires a conduit au développement de sources alternatives d'aliments pour une production et une gestion rentables du bétail des ruminants. Le but de cette étude était d'évaluer l'effet de la farine de feuilles de Moringa oleifera sur les performances et l'effet coût des chèvres en termes de changements de poids corporel, de

consommation alimentaire et d'analyse coût-bénéfice. Une étude de quatre-vingt-quatre jours a été réalisée auprès de douze chèvres sevrées KALAWAD. Les chèvres ont été divisées en trois groupes expérimentaux de quatre chèvres chacun selon un plan complètement randomisé. Trois régimes expérimentaux ont été formulés pour inclure 0, 5,0 et 7,5 % de repas de moringa. Les paramètres mesurés pour les indices de performance étaient le poids final (10,43 à 12,46 kg), la prise de poids métabolique (15,30 à 17,43 kg), la prise de poids (3 190 à 4 100 g), la prise de poids quotidienne (37,63 à 48,02 g), l'apport en matière sèche (628,89 à 48,02 g). 660,74g), la consommation de matière sèche (580,14 à 614,33g) et l'indice de conversion alimentaire (16,59 à 14,54). En outre, les paramètres mesurés dans le cadre de l'analyse coûts-avantages étaient la consommation alimentaire totale, le coût total de l'aliment, le coût de l'aliment/kg de gain et le pourcentage de réduction du coût/kg de gain. Les résultats ont montré que l'inclusion de farine de Moringa comme supplément avait un effet significatif ($p < 0,05$) sur la prise de poids, la consommation alimentaire, la consommation de matière sèche et la prise de poids métabolique des animaux. Les suppléments à base de farine de feuilles de Moringa ont réduit (de N2480,92 à N2160,44) le coût de l'alimentation par kilogramme de gain de poids. Les régimes expérimentaux étaient proposés à 4 % du poids corporel. Dans cette étude, il a été conclu qu'un niveau d'inclusion de 7,5 % de farine de feuilles de Moringa oleifera dans l'alimentation améliore les performances et réduit le coût de l'aliment par kilogramme de gain de poids.

Mots-clés : Chèvres, performance, *Moringa Oleifera*, animaux et coût-bénéfice.V

Introduction

Goat meat is widely accepted and consumed in Nigeria because there is no taboo against it (Peacock, 1996). The demand for goat meat is high especially in rural areas where it often commands a higher market price than beef (Odeyinka, 2000). The meat from goats is preferable to those from other animal species because of its flavour, tenderness, and palatability (Idiong and Orok, 2008). They are indispensable in marriage and religious rites and functions (Gefu *et al*., 1994) and are insurance against crop failure, especially in a rural setting (Mattewman, 1980).

Performance of small ruminants is influenced by the appropriate nutrients in their daily feed intake to meet the requirement for both maintenance and production. Protein and energy are major determinants of performance in small ruminant feed that can alter the animal's productivity. However, in developing countries goats are often fed on crop residues generally receiving only 6.2% of their crude protein (CP) requirements (Sarwar *et al*., 2002). Feeding small ruminants according to their CP requirements not only ensures sufficient protein availability to grazing animals but also reduces the hazards associated with excess and deficiency of this nutrient.

The use of concentrates as supplements to low-quality hay is known to improve the intake and digestibility of roughage (Nurfeta, 2010). However, the supplementation with concentrates is restricted under smallholder livestock production systems as a result of inadequacy and the high price of concentrates. Thus, there is a search for alternative unconventional and cheap feed sources that may contain valuable components of animal diets and can easily be produced and be readily available to farmers. The use of fodder trees and shrubs could be a potential approach for increasing the quality and availability of feeds for resource-limited livestock farmers during

the dry season. According to Moyo *et al*. (2012), *Moringa oleifera* serves as a good and cheap source of protein and micronutrients. Improvement in the intake, digestibility, and body weight gain was reported when tree leaves were used as a supplement for low-quality grass (Manaye *et al.,* 2009). One of such trees is the Moringa (*Moringa oleifera*) tree which is a multipurpose tree that is cost-effective with numerous industrial and livestock feed formulation uses.

Moringa is a slender, deciduous, perennial evergreen tree that originated from India but has spread to other parts of the world (Foidl *et al*., 2001). Among all trees in the world, it is one of the fastest-growing trees with high biomass yield, high crude protein of about 25%, and a balance of other nutrients in the leaves (Makkar and Becker, 1996; Foidl *et al*., 2001).

Several research findings have been investigating the use of Moringa leaves as a protein source and feed components in animal production especially in goats (Asaolu *et al*., 2012; Babeker and Bdalbagi, 2015; Sultana *et al*., 2015) was found to be effective. The use of Moringa foliage as a protein source has several advantages which include: the ability to be harvested several times per growing season; a small difference in the intake of both fresh or dried Moringa form and the ability to store its dried leaves for longer periods without deterioration in nutritive value (Mendieta-Araica *et al.*, 2011). Moringa also contains natural antioxidants like vitamin C, tocopherols, flavonoids, and other phenolic compounds (Laandrault *et al.,* 2001; Iqbal and Bhanger, 2006). Moringa leaves are rich in nutrients such as protein, fatty acid, minerals, and vitamins and have the potentials to be used as a feed additive for multiple purposes (Moyo *et al*., 2013). Considering the myriad of benefits of the Miracle tree called Moringa. It can be used as a supplement for crude protein in the diets of goats.

Materials and Methods

Location of the experiment

The study was conducted at the Livestock Production Research Program farm of the Institute of Food Security, Environmental Resources, and Agricultural Research (IFSERAR), Federal University of Agriculture, Abeokuta (FUNAAB). This `is in the humid zone of south-western Nigeria at latitude 7o13' 47" and longitude $3^0$24'04". It gets 1,112.7mm of precipitation on average, with 110.9mm in the late dry season (January-March), 462.1mm in the early wet season (April-June), 376.6mm in the late wet season (July-September) and 163.1mm in the early dry season (October-December). Throughout the year, the relative humidity averages 82 percent. The elevation here is 76 meters above sea level (Google Earth, 2022).

Sources and preparation of feed ingredients

The *Moringa oleifera* leaves was sourced from the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, air-dried and milled. Maize, wheat offal, palm kernel cake (PKC), bone meal, salt (NaCl) and premix were among the other feed materials obtained and milled at a reputable feed mill. The concentrate was blended on a clean floor using the floor mixing method, then bagged and stored in a cool-dry and well-ventilated area.

Management of experimental animals

A total of 12 weaner '*KALAWAD'* goats between 12 and14 weeks of age were used for the study. The animals were selected at the livestock production research program goat farm at the Institute of Food Security, Environmental Resources, and Agricultural Research (IFSERAR), FUNAAB. The *KALAWAD* goat is the crosses between the Kalahari red goat male and the West African goat female. The management system was intensive system with the goats receiving

feed and water on-site. The goats were housed in cross-ventilated pens on the slated floor. Three treatments with four goats per treatment in a completely randomized design (CRD) experimental format. To determine the weight changes: the goats were weighed individually at the start of the experiment and then bi-weekly using a sensitive hanging weighing scale before feeding in the morning.

Experimental diets

Treatment 1(Control): 0% inclusion level of Moringa leaf meal
Treatment 2: 5.0% inclusion level of Moringa leaf meal
Treatment 3: 7.5% inclusion level of Moringa leaf meal

Feeding trial

The experiment lasted for twelve (12) weeks. During this period, the animals were allotted into three treatments with four animals per treatment and three animals per replicate. The animals were fed at 4% of their body weight and water provided *ad libitum*.

Data collection

Initial weight

The goats were weighed individually at the beginning of the experiment in the morning before the commencement of the feeding trial. The following data were collected:

Statistical analysis

Analysis of Variance on the data of feed intake, daily weight gain, Metabolic weight gain, growth rate was conducted based on a completely randomized design (CRD) using the general linear model procedure of SAS (SAS,2002), released version 19.3. Means were separated by Duncan Multiple Range Test (DMT) of the same statistical package. The differences in the means were compared by Least square means (LSM) at 5% level ($P<0.05$)

Feed intake

Data on feed intake for the feed offered was collected daily. The weight of the leftover feed was deducted from the weight of the feed offered to get the value of feed intake per treatment and replicate.
Feed intake = feed offered – feed leftover

Weight changes

The goats were weighed every 14 days from the commencement of the feeding trial to determine the weight differences.

Final weight gain

The goats were weighed at the end of the feeding trial to determine final weight gain.

Total weight gain

The initial live weight was subtracted from the final liveweight to determine the weight gained by each animal at the end of the study.
Total Weight gain (g) = final weight gain (g) – initial weight gain (g)

Metabolic weight gain

Metabolic weight depends on the amount of metabolically active tissue in the body, rather than total body weight; it was calculated as weight gain ($wgt^{0.75}$)

Feed conversion ratio

The feed conversion ratio (FCR) or feed conversion rate is a ratio or rate measuring of the efficiency with which the bodies of livestock convert animal feed into the desired output.
Feed conversion Ratio = feed intake (g) Weight (g)

Cost benefit analysis

i. Cost of feed purchased
   Cost of feed per kilogram (kg) was determined using the initial market price.

ii. Cost of feed consumed per goat
The data obtained on feed cost per kg and feed intake (kg/goat) was used to estimate the cost of feed consumed per goat in naira (N)

iii. Cost of feed consumed per goat (N): Cost of feed consumed per kg feed x Total feed intake (kg/goat)

iv. Cost of feed consumed per kg weight gain Cost of feed consumed per goat (N) and weight gain (kg/goat) was used to determine cost of feed consumed per kg weight gain (N)

v. Cost of feed consumed/kg weight gain (N) = Cost of feed consumed per goat (N)Weight gain (kg/goat)

vi. Reduction in feed cost/kg weight gain

Results

Table 1: Proximate Composition of the Experimental Diets

Ingredients Inclusion Levels	MLM 0.0%	MLM 5.0%	MLM 7.5%
Maize	15.0	15.0	15.0
Wheat offal	50.0	50.0	50.0
PKC	30.0	25.0	22.5
Bone meal	3.5	3.5	3.5
NaCl	1.0	1.0	1.0
Premix	0.5	0.5	0.5
MLM	0.0	5.0	7.5
Total	100	100	100

MLM = *Moringa oleifera* leaf meal

Table 2: Chemical composition (%) of the experimental diets at different inclusion levels

	EXPERIMENTAL DIETS			
Parameters(%, DM)	**MLM0%**	**MLM5.0%**	**MLM7.5%**	**SEM**
Dry matter	92.43^{a}	92.23^{b}	92.43^{a}	0.03
Crude protein	14.55^{c}	17.46^{b}	21.42^{a}	0.02
Ether extract	4.82^{a}	4.22^{b}	4.22^{b}	0.01
Ash	12.02^{a}	12.02^{a}	9.36^{b}	0.01
Crude fibre	8.87^{a}	8.87^{a}	7.52^{b}	0.01
Moisture	7.59^{b}	7.75^{a}	7.59^{b}	0.01
Nitrogen free extract	59.74^{a}	57.43^{c}	57.48^{b}	0.01

^{abc} means of the same row with different superscripts are significantly different($p>0.05$)

Diets: MLM 0%: Control diet; MLM5.0%: 5.0% inclusion of *M. oleifera leaf* meal; MLM7.5%: 7.5% inclusion of *M. oleifera leaf* meal; MLM: *M. oleifera leaf* meal
Ingredients: PKC: Palm kernel cake
SEM: Standard Error of Mean

Table 3: Effect of *Moringa oleifera* leaf meal on feed intake and growth performance of *KALAWAD* weaner goats

Parameters	Diets			
	MLM 0%	MLM 5.0%	MLM 7.5%	SEM
Initial weight (kg)	7.73	7.21	8.5	0.10
Final weight (kg)	9.85^{c}	10.43^{b}	12.46^{a}	0.09
Metabolic weight gain (kg)	11.42^{c}	15.30^{b}	17.43^{a}	0.16
Weight gain (g)	2167.5^{c}	3190^{b}	4100.0^{a}	82.22
Weight gain (kg)	2.17^{c}	3.19^{b}	4.1^{a}	0.08
Daily weight gain (g)	25.60^{c}	37.63^{b}	48.02^{a}	0.32
Feed intake (g/day)	582.11^{c}	628.89^{b}	660.74^{a}	0.40
Dry matter intake (g)	541.23^{c}	580.14^{b}	614.33^{a}	0.38
Feed Conversion Ratio	22.83^{a}	16.59^{b}	14.54^{c}	0.23

^{abc}= means of the same row with different superscripts are significantly different($p>0.05$)
Diets = MLM 0: Control diet; MLM5.0%: 5% inclusion of*M. oleifera leaf* meal; MLM 7.5% inclusion of *M. oleifera leaf* meal; MLM *M. oleifera leaf* meal

Table 4: Effects of *Moringa oleifera* leaf meal on cost-benefit analysis of *KALAWAD* goats.

	Levels of Moringa leaf meal inclusion (%)		
Parameters (₦)*	MLM0%	MLM5.0%	MLM7.5%
Total feed intake (kg)	48.90	52.83	55.50
Feed cost/kg	110.10	143.10	159.60
Total cost of feed	5383.59	7559.97	8857.80
Cost of feed/kg gain	2480.92	2369.90	2160.44
% Reduction in cost/kg gain	-	4.47	12.92

* Naira = Nigerian currency (100 kobo = 1 naira)

Table 1 showed the samples from the experimental diets for each treatment and analyzed for proximate composition.
Table 2 shows the proximate chemical composition of experimental diets of different groups on a dry matter basis. The moisture, dry matter, crude protein, ether extract, crude fibre was analyses and it reveals crude protein (21.42% DM) was recorded in MLM7.5% with the lowest (14.55%DM) in MLM0%. Moisture content is higher in MLM5.0% (7.75%DM). Dry matter was the same for both MLM0% and MLM7.5% (92.43%DM). Ether extract was higher at MLM0% (4.82% DM). Ash and crude fibre

were higher at both MLM0% and MLM5.0% (8.87% DM) and has the least value at MLM 7.5% (7.52% DM)

The table 3 showed the effect of MLM inclusion on feed intake and growth performance of *KALAWAD* goats. All the parameters observed were significant (p>0.05). The results showed significant (P>0.05) difference in feed intake across the treatment group. The feed intakes are 582.11, 628.89 and 660.74g/d for MLM0%, MLM5.0% and MLM 7.5% respectively. Dry matter intake was also significant (p>0.05) with MLM 7.5% having the higher value of 614.3g than those fed MLM 0%.

There were also significant (p>0.05) differences in the final weight, and weight gain. MLM 7.5% influences the weight gain more with a value of 4.10kg than other treatment group with MLM 0% having the least value of 2.17kg.

Weight gain, daily weight gain and metabolic weight gain increased with increasing level of *Moringa oleifera* leaf meal inclusion. Weight gain varied from 2.17 to 4.1kg while daily weight gain ranged from 25.60 to 48.02g/d in animals fed diets with 0% to 7.5% *Moringa oleifera* leaf meal respectively. Feed conversion ratio was also significant (p>0.05) across the treatments. The feed conversion ratio was higher in animals fed at 7.5% (14.54) followed by 5.0% *Moringa oleifera* leaf meal inclusion levels.

Table 4 showed the results of the cost-benefit analysis of experimental diets fed to KALAWAD goats. The total feed cost ranged from N5383.00 at MLM 0% to N8857.80 at MLM7.5%. Feed cost/kg gain ranged from N2480.92 followed by N2369.90 and N8857.80 at 0%, 5%, and 7.5%, respectively.

The feed cost/kg was increased with the inclusion of MLM with N2481.28, N3404.70 and N3831.31 in goat fed 0%, 5.0% and 7.5% respectively. Reduction in feed cost/kg gain was 4.47% and 12.92% in treatment group fed 5% and 7.5% *Moringa oliefera* leaf meal.

Discussion

Moringa oleifera is one of the alternative forage protein sources. It compares well in nutrient composition, especially crude protein (Daramola *et al*., 2005; Owusu *et al*., 2008). *Moringa oleifera meal* supplement has been reported to improve the growth performance of ruminants when supplemented as fresh fodder, hay, or as part of a concentrate diet (Sultana *et al*., 2015; Kholif *et al*., 2016; Jiwuba *et al*., 2016). This is in agreement with the result of the present study because the inclusion of MLM influenced the growth parameters.

Crude protein content of experimental diets obtained in this study was in line with the report of Sultana *et al*. (2014). Makkar *et al*. (1996) and Kakengi *et al*. (2005) reported that the CP in goat diet supplementation can vary from 15 to even more than 30% depending on the physiological status and respective proportions of leaves to stems. The protein content of MLM used in this study was comparable with the values reported by Sànchez *et al*. (2006) and Soliva *et al*. (2005) for *M. oleifera* meals, but lower than the value reported by Fadiyimu *et al*. (2010). The crude protein of the Moringa meal is higher than the minimum microbial activity requirements to support acceptable ruminal microbial activity and the maintenance requirement for a protein of the host ruminant (McDonald *et al*., 2002). This is suggested better performance of the animals that fed the meal. The crude fibre content obtained in this study for MLM which ranges from 14.55–21.45% was higher than 6.49% and 7.10% reported by Aderinola *et al*. (2013) and Adegun (2013), respectively. Results obtained from the study revealed high dry matter content of Moringa leaf meal (94.85%) and was higher to the values obtained by Adegun (2013) who reported

92.22 % DM. The high dry matter and ash contents of MLM may lead to increase in activity of cellulolytic rumen microflora, and this can result in rapid degradation of the diet and passage of digesta in the rumen. The nutritional quality of animals fed with leaf meal of *Moringa oleifera* may increase due to the high ether extract content of the diet that can supply essential fatty acids and calorie needed. The differences in the chemical composition of feed ingredients may be due to natural variations because of environment, cultivation method, season of harvest, variations due to sample preparations and analysis (Brisibe *et al*. 2009; Njidda, 2010).

The numerically higher values in the group supplemented with Moringa showed that *Moringa oleifera* could contribute towards better livestock performance in terms of body weight changes and high yield of good-quality products (Nouman *et al*., 2014) as it contains an appreciable level of essential nutrients. Improved feed intake in animals fed moringa leaf meal may be a result of the acceptability and digestibility of the feeds. The results of the feed intake (582.11-660.74 g/d) of the current study were higher compared with those of Asaolu *et al*. (2012) who reported a feed intake of 278-289 g/d when Moringa leaves were fed as sole forage or combined with legume tree leaves to grow goats. The feed conversion ratio (14.54-22.83) observed in this study showed that *Moringa oleifera* leaf meal inclusion influences feed utilization. This finding was in line with the reports of Nagalakshmi *et al*. (2010) who observed that complete diets increased nutrient utilization, palatability and reduced cost of feeding in ruminants.

Moringa leaf meal inclusion in the experimental diets of goats has been observed to reduce the cost of production more than the diet without the inclusion of MLM. Okafor *et al*. (2012) stated that inclusion of *Moringa oleifera* leaves in goat diet decreases the cost of feed. Plant leaf meal and tree foliage have been reported to be cost effective protein source that can be used in ruminant feeding (Kholif*et al.*, 2015). The results obtained in present study are also in agreement with Adegun and Aye, (2013); Ahmad*et al.*(2017), the authors observed significant reduction in cost per kg live weight gain with increasing level of supplementation. Ammar *et al*. (2011) which proved that supplementation is economically feasible and is necessary to ensure farm viability because of large difference in terms of average daily gain between supplemented and non-supplemented animals.

Conclusion

Study showed that inclusion of Moringa leaf meal into the diets of the KALAWAD goats, reduce the feed conversion ratio thereby improving performance characteristics (body weights, daily weight gain) of the. *Moringa oleifera* leaf meal supplementation at 5.0% and 7.5% levels of inclusion reduced the cost of production per kilogram of weight gain.

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