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Performance and cost-benefits of weaner rabbits fed graded levels of *Moringa oleifera* leaf meal

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Abstract

Moringa has been acclaimed to be beneficial especially in livestock production. Its leaves and green fresh pods are said to be rich in carotene and ascorbic acid with a good profile of amino acids while its twigs are reported to be very palatable to ruminants and have appreciable crude protein levels. However, *Moringa oleifera* leaf meal (MOLM) has been observed to contain higher pepsin and total soluble protein than other parts of the plant which makes it more suitable to monogastric animals. MOLM has been widely used in poultry production but with limited use in rabbits' diets; hence this study was conducted to determine the performance of weaner rabbits fed graded levels of MOLM. A total of 48 unsexed weaner rabbits of mean initial weight of 744.56±29.25 g were assigned to 4 experimental diets, namely T1, T2, T3 and T4 containing 0%, 15%, 30% and 45% MOLM, respectively, having 3 replicates and 4 animals per replicate. The results showed that the dry matter intake of T1-T4 ranged 53.17 - 55.31g/day. Though not significant, highest crude protein digestibility coefficient was recorded for experimental animals on diet T4 (71.36%) followed by diets T1 (69.67%), T2 (69.17%), T3 (68.25%), respectively. The keel length for T1, T2, T3, and T4 rabbits were 225.39, 201.64, 246.66 and 217.26cm, respectively Rabbits fed 30% MOLM were found to be most profitable numerically (₦1320.10) while the least profit was obtained with 0% MOLM with ₦1305.40. Hence, it can be concluded that *Moringa oleifera* leaf meal (MOLM) can replace soya bean meal up to 45% in the nutrition of weaner rabbits.

Keywords: Moringa oleifera leaf meal, feed intake, weaner rabbit, cost.

Introduction

Animal protein sources are becoming inadequate in developing countries in terms of quality and quantity as larger percentage of human population depends mostly on plant sources of protein which are deficient in essential amino acids needed for growth and development. Odunsi (2003) reported that rapid growth of human and livestock population has led to increasing need for food and feed in less developed countries. Hence, rabbits which fall into the category of underutilised livestock species in developing countries, have been seen as one way of meeting the animal protein requirement of the Nigeria populace (Iyeghe-Erakpotobor *et al.*, 2002). This is because rabbits are renowned for their fecundity and prolificacy (Biobaku and Dosunmu, 2003), ability to utilize forage (Aduku and Olukosi, 1990) and low in fat and cholesterol levels (Biobaku and Oguntona, 1997). The rapid rate of reproduction and short gestation period of 28 – 32 days has made its production a wise choice as a means of alleviating food shortage. However, rabbit breeding is facing enormous constraints such as diseases, feeding, acceptability which consequently lead to high cost of production, of which feed cost is highly significant since nutrition accounts for about 70 -80% of production cost (Akinmutimi, 2001). This has been linked to the escalating prices of conventional feed ingredients such as soybean meal, maize and sorghum (Akinmutimi, 2006). The conventional feed ingredients, particularly the protein sources used in feed formulation such as fish meal, groundnut cake and soybean meal are very expensive. This is why it is urgent to find economical, beneficial, endogenous alternative feedstuffs to produce rabbit in quantity and quality (Ijaiya and Awonusi, 2001; Dougnon *et al.*, 2012). Recently, there has been interest in the utilization of Moringa (*Moringa oleifera)* commonly called horse radish tree or drum stick tree, as potentially inexpensive protein source for livestock feeding. The nutritional qualities of *Moringa oleifera* are excellent, which constitutes a source of high quality forage for animals. Also, these leaves are browsed by ruminants and poultry because of its high protein and minerals (Foidl *et al*., 2001), by guinea pigs (Tedonkeng *et al*., 2005) and by rabbits (Nuhu, 2010). Studies on *M. oleifera* showed that the leaves are rich in energy and vitamins (Ayssiwede *et al.*, 2011).Therefore, a partial replacement of soybean meal with *Moringa oleifera* leaf meal would be a cost-saving step in the right direction. It is against this background that this study was designed to assess the performance of weaner rabbits fed diets containing graded levels of *Moringa oleifera* leaf meal and its economic implication.

Materials and Methods

Experimental site

The study was conducted at the Directorates of University Farms (DUFARMS), Federal University of Agriculture, Alabata Road, Abeokuta, Ogun State which is in the sub savannah region with an average temperature of 30^0C, relative humidity of 80%, Latitude 6.25^0 and 9.25^0 on the Equator and Latitude 2.70^0E and 5.0^0E on the Greenwich meridian (Google earth, 2014).

Experimental animals and management

Forty eight mixed breeds weaner rabbits, with initial weights range of 711.00-782.00g±29.25, were used in the feeding trial for a duration of 70 days. They were randomly allocated to four treatments with three replicates per treatment and four animals per replicate while feed and clean water were supplied *ad libitum*.

Preparation of Moringa oleifera leaf meal

Fresh *Moringa oleifera* leaves were sourced around the University community. The leaves were air-dried, milled and sieved using 1-mm mesh to form Moringa leaf meal (MOLM). About 12 kg of *Moringa oleifera* leaves produced 1 kg of MOLM. Four experimental diets were formulated to include MOLM at 0% (control), 15%, 30% and 45% levels for Diets 1, 2, 3 and 4, respectively as shown in Table 1.

Table 1: Composition (%) of the experimental diets

Ingredients	T1	T2	T3	T4
Maize	39.00	39.00	39.00	39.00
Rice bran	20.00	20.00	20.00	20.00
Moringa oleifera leaf meal	0.00	1.50	3.00	4.50
Soybean meal	10.00	8.50	7.00	5.50
Groundnut cake	10.00	10.00	10.00	10.00
Palm kernel cake	10.00	10.00	10.00	10.00
Wheat offal	4.80	4.80	4.80	4.80
Bone meal	3.00	3.00	3.00	3.00
Oyster shell	2.00	2.00	2.00	2.00
Salt	0.30	0.30	0.30	0.30
Vitamin-mineral premix	0.30	0.30	0.30	0.30
Lysine	0.30	0.30	0.30	0.30
Methionine	0.30	0.30	0.30	0.30
TOTAL	100.00	100.00	100.00	100.00
CALCULATED ANALYSIS				
Crude protein (%)	17.60	17.36	17.10	16.86
Metabolizable energy (MJ/Kg)	2507	2533	2559	2585
Fat (%)	4.17	4.19	4.21	4.24
Crude fibre (%)	12.19	12.36	12.54	12.72
Calcium (%)	1.79	1.79	1.82	1.86
Phosphorus (%)	0.53	0.53	0.53	0.54

Data collection

Feed intake and morphometric parameters

Rabbits were weighed individually at the commencement of the experiment and thereafter, on weekly basis. Each morning, feed that was not consumed (residual feed) was weighed, deducted from the feed given and recorded in order to determine the daily feed intake. Linear body measurements were taken on each rabbit on weekly basis which included body length, heart girth, ear length, tail length, keel length and height at withers by using a tape rule.

Digestibility study

A digestibility study was conducted using three rabbits per treatment during the last week of the experiment. Adjustment period of 4 days were allowed, followed by 4 days of faecal collection. Faecal samples were oven dried for analysis. Samples of MOLM and experimental diets were also pooled, labelled, stored and then analysed for proximate composition (AOAC, 1995).

Economic benefit

This was calculated using the prevailing market prices of feed ingredients at the time of the study in order to determine the cost benefit of feeding the diets in relation to the performance of the rabbits.

Statistical analysis

Data collected were subjected to one way analysis of variance (ANOVA) in a Complete Randomized Design (CRD) using the General Linear Model procedure of SAS (2003). Significant means were separated and compared using Duncan's Multiple Range Test of the statistical package at 5% level of probability.

Results and Discussion

The chemical composition of concentrate diets at various levels of inclusion of dried *Moringa oleifera* leaf meal and the proximate composition of *Moringa oleifera* leaf meal are shown in Table 2. The CP content of 14.78 % for T2 (30% MOL) was lowest, followed by CP content of 14.96% in T4 (45% MOL), 15.17% for T1 (0% MOL) then 15.33% CP in T3 (15% MOL). The inclusions of MOL in T2 to T4 (15% to 45% MOL) could be responsible for the increase in the CP content of the diet T3 only. The crude fibre ranged from 15.86% to 16.48% while the gross energy was between 3.29 - 3.32 MJ/kg. These CP contents of between 14.78% and 15.33% were just within the minimum of 12-14% recommended in the dry matter of rabbits' ration (Fielding, 1991). The crude protein, ether extract, crude fibre and ash were 15.49, 4.06, 18.65 and 8.79 g, respectively, for dried *Moringa oleifera* leaf meal. The CP content of *Moringa oleifera* leaf meal used in this study was lower than the values (282 g/kg DM) reported by Melesse *et al.* (2011) and (361 g/kg DM) obtained by Negesse *et al.* (2009) for M. *Stenopetala* and (251 and 173 g/kg DM) reported by Makkar and Becker (1996) and Sánchez *et al.* (2006) for *M. oleifera* leaves, respectively. These variations could be due to the age of leaves at harvest, method of processing, soil type and fertility, as well as agroecology in which the trees were grown. Plant species/variety, soil, climate, grazing, plant fraction and stage of maturity at sampling affect the nutritive value of forages, sample preparations and analysis as noted by Ashaolu *et al.* (2012).

Table 2: The proximate composition of experimental diets and *Moringa oleifera* leaf meal

Parameters	T1	T2	T3	T4	*MOLM*
Dry matter	89.44	89.74	89.63	89.59	88.95
Crude Protein	15.17	14.78	15.33	14.96	15.49
Ether extract	3.72	3.64	3.75	3.61	4.06
Crude Fibre	16.48	15.86	16.25	16.03	18.65
Total Ash	6.85	6.67	6.79	7.05	8.79
Nitrogen Free Extract	47.22	48.79	47.51	47.94	41.96
Gross Energy (MJ/Kg)	3.32	3.29	3.30	3.30	3.32

Table 3 shows daily feed intake and apparent digestibility of weaner rabbits fed *Moringa oleifera* leaf meal diet. The feed intake of 65.69-68.34 g/day was in line with the findings of De Blas and Wiseman (2003) that rabbits had high feed intake (65 – 80 g/kg body weight) to meet their nutritional needs. The dry matter intake of 53.17 – 55.31g/day increased with inclusion of *Moringa oleifera* leaf meal in the diets which was not in lieu with Nworgu *et al*. (1999) who reported a reduction in feed intake by rabbits on increased forage meal in the diet. This was also at variance with the observation of Kakengi *et al*. (2003) that *Moringa oleifera* leaf meal reduced palatability which invariably led to reduced dry matter intake. Feed quality and physical characteristics of forage, such as a dry matter (DM) content, fibre content, particle size, and resistance to fracture are known to affect ease of prehension and thus intake rate (Inoue *et al*., 1994). There was significant difference (P<0.05) in crude fibre digestibility and the values were a bit lower than the one obtained by Bamikole *et al*. (2005) who reported a value of 81.67%. According to De Blas *et al*. (1999), fibre is not considered a real nutrient in rabbits because of its low digestibility (average dietary digestibility is less than 20%), it is considered a nutrient to maintain the gut motility.

Table 3: Nutrient intake and apparent digestibility of weaner rabbits fed *Moringa oleifera* leaf meal diets

Parameters	Inclusion level				SEM
	0%	15%	30%	45%	
Daily feed intake (g/d)	68.34[a]	67.74[a]	65.69[b]	67.53[a]	0.26
Dry matter (%)	53.17	54.97	55.31	55.21	1.68
Crude protein (%)	69.67	69.17	68.25	71.36	1.30
Crude fibre (%)	78.87[a]	77.17[ab]	74.61[b]	76.61[ab]	0.96
Ether extract (%)	80.80	83.31	82.21	82.93	1.08
Ash (%)	61.68	61.94	61.66	61.57	1.92
Gross energy (MJ/kg)	83.86	84.42	84.33	84.40	0.61

[ab] *Means on the same row having different superscripts are significantly different (P<0.05).*

Growth performance of weaner rabbits fed M*oringa oleifera* leaf meal diets is shown in Table 4. The results showed that there was significant (P<0.05) difference in the daily feed intake of the rabbits fed *Moringa oleifera* leaf meal diets across the treatments. The feed consumed (g/day/rabbit) were in the range of 65.70 – 68.30g. Rabbits fed 0% *Moringa oleifera* leaf meal had the highest daily feed intake while rabbits fed 30% *Moringa oleifera* leaf meal had the lowest feed consumed. This result agrees with the report of Onu *et al*. (2014) who reported lower feed intake in broiler finishers at 7.5% dietary level of MOLM but contradicts the observations of Gadzirayi *et al*. (2012) who reported an increase in feed intake of broilers receiving solvent-extracted soybean meal supplemented with *Moringa oleifera* leaf meal. The result showed that the inclusion of *Moringa oleifera* leaf meal at varying levels in the diets had no significant (P>0.05) effect on the final body weight but decreased with increase in inclusion levels. This may be attributed to higher crude fibre content which may impair nutrient digestion and absorption (Onu and Aniebo, 2011) since they are young rabbits and the negative effect of the anti-nutritional factors present in MOLM on the rabbits. *Moringa oleifera* contain 1-23g of tannin in every 1 kilogram of leaves (Kakengi *et al*., 2003).Tannin has been reported to interfere with the biological utilization of protein and to a less extent available carbohydrate and lipids (Esonu, 2001). FCR did not differ between dietary treatments ($p<0.05$). The feed conversion ratio values obtained in this study were higher than the 2.63- 4.00 reported by earlier researchers in the tropics (Ayers *et al*., 1996; Okorie, 2003). The generally poor FCRs obtained might be due to genetic differences, reduced palatability of the diet (Kakengi et al., 2003) and probably feed wastage by the rabbits.

Table 4: Growth performance of weaner rabbits fed *Moringa oleifera* leaf meal diets

Parameters	Inclusion level				SEM
	0%	15%	30%	45%	
Initial body weight (g)	765.00	720.00	711.00	782.85	29.25
Final body weight (g)	1427.50	1403.33	1341.00	1337.14	28.97
Daily feed intake (g/d)	68.34^{a}	67.74^{a}	65.69^{b}	67.53^{a}	0.26
Average weight gain (g/d)	662.50	683.33	630.00	554.28	21.26
Daily weight gain (g/d)	9.46	9.90	9.00	7.91	0.30
Feed conversion ratio	7.35	7.15	7.79	9.08	0.33

^{ab} Means on the same row having different superscripts are significantly different (P<0.05).

Linear body measurements of weaner rabbits fed graded level of *Moringa oleifera* leaf meal are shown in Table 5. All parameters observed in this study were found to be non-significant (P>0.05) among MOLM inclusion levels. Total head length ranged from 74.22 to 84.92 cm. Keel length was from 201.64 to 246.66cm. Accurate method for estimation of body weight of livestock is a very important aspect of livestock breeding and production. Knowledge of animal′s live weight is of importance in determining its feed requirements for growth, maintenance, production and the correct dosage in drug administration (Akanno and Ibe, 2006). Measurement of various body conformations is of value in judging quantitative characteristics of meat and is also helpful in developing suitable selection criteria. Moreover, because of the relative ease in measuring linear body dimensions, they can be used as an indirect way to estimate live weight (Lukefahr and Ozimba, 1991).

Table 5: Linear body measurements (cm) of weaner rabbits fed graded levels of *Moringa oleifera* leaf meal diets

Parameters	MOLM inclusion levels				SEM	P-value
	0%	15%	30%	45%		
Head length	76.56	76.68	84.92	74.22	8.53	0.427
Keel length	225.39	201.64	246.66	217.26	22.86	0.212
Breast girth	180.31	165.17	198.84	174.46	18.20	0.241
Tail length	70.67	63.06	75.19	65.47	6.96	0.269
Height at wither	94.68	85.91	103.23	90.42	9.32	0.239
Ear length	86.31	76.33	93.64	82.05	8.39	0.191

^{ab} Means on the same row having different superscripts are significantly different (P<0.05).

Table 6 shows the economic implication of feeding rabbits with graded levels of M*oringa oleifera* leaf meal-based diets. The feed cost decreased with the increasing inclusion levels of MOLM. This was so because a low cost of *Moringa oleifera* leaf meal was used to replace more quantity of an expensive feedstuff (soybean meal). The high cost of soybean meal was a result of its use as conventional feedstuff and the lower cost of *Moringa oleifera* leaf meal was due to the fact that the plant was cheaply harvested and processed around the locality. This was in agreement with Adeniji *et al.* (2010) who reported that *Moringa oleifera* inclusion reduces the cost of feed per kg. It also agrees with the findings of Fasuyi (2000), Akpodiete and Inoni (2000), and Agbede and Agbede (2009) that a viable way of reducing feed cost is through the use of alternative feed resources which would ultimately reduce the cost of livestock production in developing country. The difference in feed cost per kg live weight was not significant ($p>0.05$), although the values obtained for 30% MOLM and 45% MOLM were comparatively higher than those for 15% and 0% MOLM diets; this could be due to the increase awareness of the health benefits of moringa to man therefore leading to increase in demand. Based on the present results, it could be concluded that the rabbits fed the various dietary treatments produced similar economic efficiency in feed cost per kg weight gain.

Table 6: Economic implication of feeding rabbits with graded levels of *Moringa oleifera* leaf meal diets

Parameters	Inclusion level				
	0%	15%	30%	45%	SEM
Feed consumed (g/day/trt)	68.30	67.70	65.70	67.50	0.56
Feed cost (₦/g/trt)	0.84	0.83	0.83	0.83	0.002
Feed cost/weight gain ₦/g/trt)	6.06	5.80	6.09	7.08	0.28
Cost of production (₦)	1894.60	1890.04	1879.90	1886.90	3.09
Selling price (₦)	3200.00	3200.00	3200.00	3200.00	0.00
Profit (₦)	1305.40	1309.96	1320.10	1313.10	3.09

Conclusion

Based on the results of this study, it is concluded that the performance of weaner rabbits in terms of weight gain, daily weight gain, intake, digestibility, body morphology and feed conversion ratio were not negatively affected by the inclusion of *Moringa oleifera* leaf meal up to 45% in their diets. Therefore, *Moringa oleifera* can be a good substitute for soybean meal up to 45% replacement whenever soybean meal is scarce or there is increase in the price.

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