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Effects of Replacing Groundnut Cake with *Moringa oleifera* Leaf Meal in the Diets of Grower Rabbits

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Abstract Seventy two (72) grower rabbits were used to assess the replacement of groundnut cake with *Moringa oleifera* leaf meal in the diets of grower rabbits and determining its effect on growth; nitrogen digestibility and the economics of rabbit production. There were six (6) dietary treatments with *Moringa oleifera* leaf meal replacing groundnut cake at 0, 20, 40, 60, 80 and 100%; each treatment was replicated three times with four rabbits per replicate in a completely randomize blocked design (CRBD). Proximate analysis of *Moringa oleifera* leaves on air-cured basis showed that the leaves contained Dry Matter 93.4, Crude Protein 24.8, Crude Fibre 11.1, Ether Extract 2.1, Ash 8.7 and Nitrogen Free Extract 53.5%; with a Metabolizable Energy of 3 316.52 Kcal/kg. Results showed that the final body weight, body weight gain, feed intake and feed to gain ratio showed significant difference (P<0.05) between the treatments. Weight gain values increased from the control diet up to the rabbits on 60% Groundnut cake replaced with *Moringa oleifera* leaf meal and there after began to decrease. There was also significant effect of treatment (P<0.05) on the cost of feed per kg. The cost of feed decreased as more *Moringa oleifera* replaced groundnut cake in the diets. Profit, gross profitability and feed cost efficiency increased as more *Moringa oleifera* replaced Groundnut cake in the diets. There was high nitrogen digestibility among the treatment although was not significantly different (P>0.05). The study revealed that *Moringa oleifera* leaf is rich in nutrient and can be used to replace 60% of Groundnut cake in the diets of grower rabbits.

Keywords Grower rabbit; Groundnut cake; *Moringa oleifera*; Growth; Economics of production

Introduction

Nigerians are among the lowest consumers of animal protein in Africa, despite their numerous natural and human resources (Egbunike, 1997). The average Nigerian consumption of animal protein has been estimated to be less than the recommended minimum for daily maintenance (FAO, 1997). Animal protein contains essential amino acids which are more balanced and readily available to meet human nutritional needs than plant protein (McDonald et al., 1988).

Rabbits have been reported to contribute significantly to solving the problem of animal protein shortage (Taylor, 1980; Lebas et al., 1986).

Rabbits can be fed unconventional feedstuffs and forage but, investigators used temperate forages which are reported to have on the average higher Crude Protein (CP), lower fibre content and thus higher nutritive value than tropical forage (Oyenuga, 1968).

Feed accounts for the dominant input in animal production ranging from 60%~70% of the total cost of production (Nworgu et al., 1999).

There is the need therefore, to explore the use of non-convectional feed sources that have the capacity to yield the same output as convectional feedstuffs and perhaps at a cheaper cost. The recommended policy is to identify locally available feed resource to formulate diets that are as balanced as possible (Gueye and Branckaert, 2002).

There has been increasing interest in the utilization of Moringa (*Moringa oleifera*) commonly called “Drumstick tree” or “Miracle tree” as a protein source for livestock (Makker and Becker, 1997; Sarwatt et al., 2002).

The plant can be easily established in the field and it has good potential for forage production. The plant can be harvested several times in a single growing season and also has potential for reducing cost of feed.

Hence, this study will help in determining the percentage level of groundnut cake which *Moringa oleifera* can successfully replace without causing any deleterious effect on the rabbits.

1 Results

Growth performance of the grower rabbits fed different levels of GNC replaced with MOLM is shown in Table 1.

Final body weight showed significant difference (P<0.05) between the treatment. The rabbits fed 60% groundnut cake replaced with *Moringa oleifera* had the highest final weight value of 2 216.2 g which was statistically different (P<0.05) from all the other treatments. The control (0), 80 and 100% groundnut cake replaced with *Moringa oleifera* showed lower final body weight which were comparable (P>0.05).

The weight gain of rabbits fed on the experimental diets were significantly different (P<0.05). The rabbits fed on 60% groundnut cake replaced with *Moringa oleifera* had the highest body weight gain of 16.36 g which was statistically comparable (P>0.05) to those rabbits that fed on the 40% groundnut cake replaced with *Moringa oleifera* that gain 14.76 g. The rabbits fed on 0% (control) were statistically comparable (P>0.05) to those that fed on 80 and 100% MOLM with body weight gain values of 11.90 g, 10.33 g and 10.31 g respectively. The body weight gain of the rabbits fed on 20% and 40% groundnut cake replaced with *Moringa oleifera* were comparable (P>0.05) with body weight gain values of 12.61 g and 14.76 g respectively.

The feed intake values showed significant difference (P<0.05) between the treatments. The rabbits fed on 40% groundnut cake replaced with *Moringa oleifera* had the highest (P<0.05) feed intake value of 78.5 g which was significantly different from rabbits on other treatments. The lowest feed intake value of 64.4 g recorded at 100% MOLM was comparable (P>0.05) to the feed intake value recorded at 80% MOLM. The feed intake values showed a systematic increase from 0~40% levels of MOLM but later declined as more groundnut cake was replaced with MOLM.

The feed to gain ratio showed that there were significant difference (P<0.05) between the treatments. The rabbits fed on 60% MOLM had the lowest (P<0.05) feed to gain ratio of 4.39. The rabbits fed the 0 (control), 20% and 40% GNC replaced with MOLM had comparable (P>0.05) feed to gain ratios of 5.88, 5.77 and 5.33 respectively. The rabbits fed on 80% and 100% MOLM had the highest feed to gain ratio values of 6.44 and 6.25 respectively which were significantly comparable (P>0.05), but where higher than the feed to gain ratio of other rabbits fed MOLM diets. There was no mortality recorded on any treatment during the experiment.

Table 2 shows the economic implications of feeding rabbits with MOLM diets. The cost of feed (₦/kg)

Table 1 Growth performance of grower rabbits fed *Moringa oleifera* leaf meal (MOLM)

Parameters	Levels of groundnut cake replaced with *Moringa oleifera* leaf meal (%)						SEM
	0	20	40	60	80	100	
Initial body weight (g/rabbit)	1 330	1 200	1 230	1 300	1 333	1 325	23.38^{NS}
Final body weight (g/rabbit)	$1\,981.1^{bc}$	$1\,906.4^{c}$	$2\,056.6^{b}$	$2\,216.2^{a}$	$1\,911.5^{c}$	$1\,902.4^{c}$	50.51^{*}
Weight gain (g/rabbit)	11.90^{c}	12.61^{b}	14.76^{ab}	16.36^{a}	10.33^{c}	10.31^{c}	0.99^{*}
Feed intake (g/rabbit)	70.0^{b}	72.7^{b}	78.5^{a}	71.8^{b}	66.5^{c}	64.4^{c}	2.03^{*}
Feed to gain ratio	5.88^{b}	5.77^{b}	5.31^{b}	4.39^{c}	6.44^{a}	6.25^{a}	0.30^{*}
Mortality	0	0	0	0	0	0	−

Note: SEM = Standard Error of Means; NS = Not significantly different (P>0.05); * = Significantly different (P<0.05); a,b,c = Means in the same row with different superscript differ significantly (P<0.05)

Table 2 The economics of rabbit production fed *Moringa oleifera* leaf meal (MOLM)

Parameters	Levels of groundnut cake replacement with *Moringa oleifera* leaf meal (%)						SEM
	0	20	40	60	80	100	
Cost of feed (₦/kg)	62.02[a]	60.56[a]	59.12[ab]	56.92[b]	55.18[c]	53.76c	1.3*
Cost of feed consumed (₦)	243.12[a]	244.86[a]	259.89[a]	228.86[b]	205.49[c]	193.88c	10.3*
Cost of rearing (₦/Rabbit)	1 043.12	1 044.86	1 059.89	1 028.86	1 005.49	993.88	10.3
Selling price (₦)	1 500	1 500	1 500	1 500	1 500	1 500	−
Profit (₦)	456.88	455.14	440.11	471.14	494.51	506.12	10.3
Gross profitability (₦)	43.80	43.56	41.53	45.79	49.18	50.92	1.5
Feed cost efficiency	0.71	0.72	0.70	0.80	0.89	0.95	0.04

Note: SEM = Standard Error of Means; * = Significantly different (P<0.05); a,b,c,d = Means in the same row with different superscript differ significantly (P<0.05)

showed significant difference (P<0.05) between the treatments. It was observed that the feed cost (₦ per kg) decreased with the increase in the level of MOLM in the experimental diet from ₦62.02 at 0% which was the highest to ₦53.76 at 100% replacement which was the lowest cost of feed.

The cost of feed consumed was also significantly different (P<0.05) between the treatments. Rabbits fed 40% MOLM showed the highest (₦259.89) cost of feed consumed which was statistically different the other treatments. Rabbits fed 80 and 100% MOLM had the lowest cost of feed consumed which were comparable (P>0.05).

The cost of rearing was also significant (P<0.05) between the treatments. The highest cost of rearing (₦1059.89) was recorded at 40% MOLM diet while the lowest cost of rearing (₦993.88) was recorded at 100% MOLM diet.

The Profit, Gross profitability and Feed cost efficiency showed the same trend as the highest and lowest values were recorded at 100% and 40% MOLM respectively. The highest profit, gross profitability and feed cost efficiency values of ₦506.12, ₦50.92 and 0.95 respectively were obtained at 100% MOLM diet.

The nitrogen intake, faecal nitrogen and the nitrogen digestibility were shown in Table 3. The nitrogen intake did not vary significantly (P>0.05) between the treatments. All the rabbits had comparable (P>0.05) nitrogen intake. The values ranged between 2.29~2.31 g. The faecal nitrogen also did not vary between the treatments. The faecal nitrogen between the treatments were comparable (P>0.05). The values ranged between 0.66~0.68 g. The nitrogen balance represents the difference between the nitrogen intake and the faecal nitrogen. The values showed no significant effect (P>0.05). The values obtained were highly comparable. The experimental diets had no significant effect (P>0.05) on the nitrogen digestibility of the grower rabbits, although this values were high in all the treatment.

2 Discussion

The final body weight showed significant difference (P<0.05) between the treatment, as high weight gain in animals is normally as a result of increased feed intake. In this study, there was increase in final body weight and body weight gain with increase in the level

Table 3 Nitrogen digestibility of rabbits fed *Moringa oleifera* leaf meal (MOLM)

Parameters	Levels of groundnut cake replacement with *Moringa oleifera* leaf meal (%)						SEM
	0	20	40	60	80	100	
Nitrogen intake (g)	2.31	2.29	2.30	2.30	2.30	2.29	0.001[NS]
Faecal nitrogen (g)	0.68	0.67	0.66	0.66	0.68	0.68	0.004[NS]
Nitrogen balance (g)	1.63	1.62	1.64	1.64	1.62	1.61	0.005[NS]
Nitrogen digestibility (%)	70.56	70.74	71.30	71.30	70.43	70.31	0.018[NS]

Note: SEM = Standard Error of Means; NS = Not significantly different (P>0.05)

The feed intake values showed significant difference (P<0.05) between the treatment. This was in contrast with the findings of Adeniji and Omonijo (2004) who also reported no significant difference (P>0.05) in feed intake when groundnut cake was replaced with palm kernel cake in the diets of weaner rabbits. Feed intake did however show a systemic increase from 0~40% GNC replaced with MOLM and a decrease from 60~100% GNC replaced with MOLM. This trend in feed intake by the rabbit is understandable since leaf meals contains relatively high fiber which increases the total fiber content of the diet and also dilute other nutrient. Rabbits must eat to meet their energy requirement hence increased feed intake. This was observed between the control and the 40% groundnut cake replaced with MOLM. The high amount of leaf meal in the 60%~100% MOLM would increase the volume of the feed which in turns makes it very bulky and light. Since there is a limit to the rabbit's gastro-intestinal tract and the volume of feed it can consume, a decline in feed intake was recorded. The crude fiber increased as more groundnut cake was replaced with MOLM. The first instance was in agreement with Aduku et al (1988) who reported higher feed intake with increasing level of crude fiber in the diets of rabbits. The latter diets where feed intake decreased was in agreement with the findings of Nworgu et al (1999) who reported a reduction in feed intake on rabbits on increased forage meal diets. The feed intake values of 64.4~78.5 g recorded in this study were generally higher than the values 24.02~60.54 g reported by Eshiet et al (1979) in the tropics and were however lower than the values 105.6~133.9 g reported by Ayers et al (1996) when rabbits were feed in tropical condition.

The feed to gain ratio showed significant difference (P<0.05) between the treatment. This was in agreement with the Omole and Onwudike (1983) and Nuhu (2010) who both reported significant difference (P<0.05) in feed to gain ratio when weaner rabbits were fed cassava peel supplemented with palm oil and when soya bean meal was replaced with MOLM in the diets of weaner rabbits respectively; but contradicts the report of Adeniji and Omonijo (2004) who reported no significant difference (P>0.05) when groundnut cake was replaced with palm kernel cake in the diets of weaner rabbits. The feed to gain ratio value of 4.30~6.44 (Table 3) obtained in this study were higher than 2.63~4.00 reported by earlier researchers in the tropics Ayers et al (1996). These generally low values were probably due to the relatively low growth rates and also the genetic differences might also contribute to this result.

The feed cost decreased with increase in the level of MOLM replacing GNC increases from the (control) 0%~100%. The cost of feed per kg showed significant difference (P<0.05) between the treatment. There was a reduction of ₦8.26 in the cost of feed per kg between the treatments. This was expected, since a low cost MOLM was used to replace more quantity of a more expensive feedstuff (GNC). The prevailing market price of groundnut cake and *Moringa oleifera* were ₦89 and ₦10 per kg respectively at the time this study was carried out. The high cost of groundnut cake was as a result of it used as a convectional feedstuff and the low cost attributed to MOLM was due to the fact that the plant was cheaply harvested around this locality. This was in agreement with Adeniji et al (2010) who reported that *Moringa oleifera* inclusion reduces the cost of feed per kg, but was conflicting with the report that there was increase in cost of feed per kg of the diets when *Moringa oleifera* was used to replace Soybean meal in the diets of weaner rabbits (Nuhu, 2010).

Result of nitrogen digestibility showed that there was no significant difference (P>0.05) in the nitrogen digestibility between the treatments. This may suggest that the Crude Fibre contents in all the dietary treatments were similar and therefore, did not affect the digestion of the various nutrients investigated. This observation may be as a result of the highly digestible nature of *Moringa oleifera*. Fahey et al (2001) reported that *Moringa oleifera* is an outstanding indigenous source of highly digestible protein. The findings on nitrogen digestibility agrees with that of Adeniji et al (2010) who reported that there was no significant difference between the treatments when *Moringa oleifera* leaf was included in the diets of growing rabbits but was in contrast with the findings of Adeniji and Omonijo (2004) who reported significant difference (*P*<0.05) in the nitrogen digestibility of the rabbits when groundnut cake was replaced with palm kernel cake.

In conclusion, considering the effects of the diets on growth, economics and nitrogen digestibility, it is obvious that 60% GNC replaced with MOLM gave the best result and is recommended as the best replacement level of MOLM for GNC. The 60% GNC replaced with MOLM had the best feed to gain ratio of 4.39 and high digestibility of 71.30%.

3 Materials and Methods

Moringa oleifera leaves were collected fresh from a plantation and were air-cured until they were crispy to touch. Proximate analysis of the leaves was done according to the methods of A.O.A.C. (1990). On analysis the leaves contained 24% CP, 11.1% CF, ether extract and ash content were 2.1% and 8.7% respectively. Other feedstuffs were purchased from a commercial feed mill. Six (6) experimental diets were formulated (Table 4). Diet 1 was designated to serve as the control with no *Moringa oleifera* leaf meal (MOLM) inclusion. All other diets contain MOLM replacing groundnut cake (GNC) at 20%, 40%, 60%, 80% and 100% respectively, with groundnut cake being 10% of the control diet. Diets formulated were iso-nitrogeneous. The rabbits were arranged into six (6) groups. The groups were assigned to the experimental diets using a Completely Randomized Block Design (CRBD). Each treatment was replicated three (3) times with four (4) rabbits per replicate. The study lasted for a period of eight (8) weeks.

The rabbits were housed in metal hutches with wire mesh at the base for easy passage of faeces and urine and raised above ground. The hutches were disinfected before the rabbits were introduced into the hutches. Their initial weight, final weight, feed intake

Table 4 Composition of experimental diets (g/kg)

Ingredients	Levels of *Moringa oleifera* leaf meal (%)					
	0	20	40	60	80	100
Groundnut cake	100	80	60	40	20	0
Moringa leaf meal	0	20	40	60	80	100
Maize	500	500	500	500	500	500
Fishmeal (72%)	5	5	5	5	5	5
Corn bran	190	175	145	160	150	120
Brewer dried grains	40	60	85	120	150	180
Wheat offals	100	100	100	50	30	30
Bone meal	25	25	25	25	25	25
Limestone	30	30	30	30	30	30
Salt	3.5	3.5	3.5	3.5	3.5	3.5
Vitamin mineral premix a	2.5	2.5	2.5	2.5	2.5	2.5
Methionine	1	1	1	1	1	1
Lysine	1	1	1	1	1	1
Coccidiostat b	2	2	2	2	2	2
Total	1 000	1 000	1 000	1 000	1 000	1 000
Analyzed values of the experimental diets						
Dry matter (%)	90.88	89.89	90.18	90.38	91.02	90.20
CP (%)	14.41	14.34	14.36	14.36	14.38	14.29
Crude fibre (%)	10.25	8.50	8.50	9.50	9.80	8.46
Energy (Kcal/kg) (Calculated)	2 732.89	2 777.03	2 805.64	2 914.09	2 974.84	3 004.37

Note: a: Vitamin-mineral (Premix) supplied the following/kg diet: vitamin A, 8 000 IU; vitamin D, 3 000 IU; vitamin E, 8 IU; vitamin K, 2 mg; vitamin B1, 1 mg; vitamin B2, 2.5 mg; vitamin B12, 15 mg; niacin, 10 mg; panthothenic, 5 mg; antioxidant, 6 mg; folic acid, 0.5 mg; choline, 150 mg; iron, 20 mg; manganese, 80 mg; copper, 8 mg; zinc, 50 mg; cobalt, 0.225 mg; iodine, 2 mg; selenium, 0.1 mg; b: Coccidiostat used was Amprolium P with active ingredient amprolium 9.6%

values were recorded, and on the 8th week, the faeces of the rabbits were collected by the total faecal collection method, analyzed and the nitrogen digestibility calculated. The current market prices of feed ingredient used in the feed composition for this experiment were used for the economic appraisal of the diet. All data obtained were subjected to Analysis of Variance (ANOVA) using the Completely Randomized Block Design model as described by Steel and Torrie (1980). Differences between means were separated using Duncan Multiple Range Test (Duncan, 1955).

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