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Original Research Article

Effects of graded levels of *Moringa oleifera* leaf meal on growth performance of growing male New Zealand white rabbits

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ABSTRACT

A 60 day trial with sixteen growing male New Zealand White rabbits aged 3 - 4 months and average weight of 1750±0.00g were used to determine the effect of graded levels of *Moringa oleifera* leaf meal (MOLM) on growth performance. The rabbits were divided into 4 treatment groups represented as T1 (No MOLM, control), T2 (5 % MOLM), T3 (10 % MOLM), and T4 (15 % MOLM), replicated four times with a rabbit per replicate and randomly assigned to the treatment diets in a completely randomized design. The rabbits were fed in the morning and evening daily with compounded feed (CP = 13.77-15.69 %, ME = 346.64-494.90 kcal/g). Freshly cut forage consisting of *Panicum maximum*, *Pennisetum purpureum* and *Centrosema pubescens* were equally fed as basal diet. Water was provided ad libitum to the rabbits. In the end of the trial, data on growth performance were subjected to analysis of variance and statistical means separated with Duncan's New Multiple Range Test. The results showed no significant differences (P>0.05) among T2, T3, and T4 in average daily weight gain and feed conversion ratio, and no significant differences (P>0.05) among T1, T2 and T3 in average daily feed intake. The results of the study further showed no mortality among the treatment groups. The results of this study indicated that New Zealand White rabbits could utilize *Moringa oleifera* leaf meal beyond the level of 15% inclusion without any deleterious effects on their growth performance and thus further trial of MOLM inclusion is recommended.

Keywords: Growth, *Moringa oleifera* , performance, rabbits,

INTRODUCTION

Protein malnutrition is one of the major nutritional challenges in developing nations including Nigeria. The search for more economical source of animal protein makes rabbit production attractive (Egbo *et al.,* 2001). The attributes promoting the production of rabbits include high fecundity, growth rate and the ability to utilize forages and turn out of low cost high quality proteins. This is because of their short gestation period, early sexual maturity, high prolificacy and ability to rebreed immediately after parturition, all leading to short generation interval (Biobaku & Dosumo, 2003; Ani, 2006; Ogundele & Apata, 2006; Safwat *et al.,* 2014; Adeniji and Lawal, 2012).

The New Zealand white rabbit is an exotic breed that survives in tropical environment. It is a heavy breed that weighs about 4.1-4.5 kg at maturity (Egu, 2016). They have white fur that covers every part of the body with shiny eyes. They are commercial meat type and reach puberty at about 5 - 6 months of age (Egu, 2016).

The rising prices of livestock feeds especially in Nigeria and the scarcity of conventional proteins and energy concentrates for the formulation of feeds have forced animal scientists to search for attractive, cheaper and readily available protein and energy sources. Green plants leaf ingredients with the crude protein content of fresh meal are used in the ration of the livestock to reduce cost of production, enhance reproductive performance, enhance health status and promote growth of farm animals, thus increasing overall livestock production when used as feed component or additive (Zendrato *et al.,* 2019). One of such plant is *Moringa oleifera. Moringa oleifera* is one of the world's

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most useful plants for a variety of food and medicinal purposes in many countries in Africa, South East Asia, the Pacific and Carribean Islands and South America (Henuk, 2018). In recent time, the most prominent herbal products used in animal diet in Nigeria include *Moringa oleifera* leaf meal (Ologhobo *et al*., 2013). *Moringa oleifera* is used as a cheap protein supplement and as well improve digestibility of other diet components. *Moringa oleifera* leaf contains high crude protein (CP) 30.3% with 251 kg DM and negligible content of tannins and other anti-nutritive compounds (Gadzirayi *et al.,* 2012; Abubakar *et al.,* 2015; Egu, 2018).

The active constituents in the leaves of *Moringa oleifera* are glucosinolates such as 4 (alpha-L-rhamanosyloxy) benzyl glucosinolate which yield 4 (alpha-L-rhamanosyloxy) benzyl isocyanate following enzymatic degradation with myrosinase. Phenol carboxylic acid and fatty acid including oleic acid (60 to 70%), palmitic acid (3-12%), stearic acid (3-12%) as well as eicosanoic and lignoceric acids in addition to mustard oil and other constituents are also found in the leaves *of Moringa oleifera* (Egu, 2018). *Moringa oleifera* can replace the soya bean meal in the diet of the rabbits to 15% level of inclusion without any deleterious effects on the rabbits' performance. (Alemede *et al.,* 2014). This study was carried out to determine the effects of graded levels of *Moringa oleifera* leaf meal on growth performance of growing male New Zealand White rabbits.

MATERIALS AND METHODS

The experiment was conducted at the Rabbitry unit of the Teaching and Research Farm of the Faculty of Agriculture, Abia State University, Umudike, Nigeria. This is within the South East Agro-ecological zone of Nigeria and lies within latitude 5^0 29´ N and longitude 7^0 33´ E and at an altitude of 122 m (400 feet) above sea level. The area has annual ambient temperature of 25 - 30 °C, relative humidity between 65 – 80 %, and annual rainfall of 2000 – 2484 mm. The soil is sandy loamy with average of pH 5.5 (Adiele *et al.,* 2005).

PROCEDURE FOR PROCESSING MORINGA LEAVES

Moringa oleifera is native to India, Red sea and some part of Africa including Madagascar (Onu and Aniebo, 2011). Moringa is drought-tolerant and grows at a rainfall of 250-1500mm per year (Martin, 2007). Fresh leaves of *Moringa oleifera* were harvested within Umudike near Umuahia, Abia State, Nigeria. The leaflets were stripped from the leaf petioles, washed in 1% saline solution for 3.5 minutes to remove dirt and microbes. The washed leaflets were drained using plastic buckets and spread on trays made with food-grade mesh before drying. The leaves were dried under the shade by spreading them thinly on mesh tied on racks in order to retain most of the nutrients, green colour and the phyto-chemicals according to procedures suggested by Yang and Tsou (2006). The leaves were turned over once a day to improve the drying. The leaves were dried to 10% moisture content. Dried Moringa leaves were milled using a stainless steel harmer mill and sieved to 2mm particle size. The dried leaf powder was packaged in dry plastic container and tagged *Moringa oleifera* leaf meal (MOLM). This was incorporated into the experimental diets during their formulation.

EXPERIMENTAL ANIMALS, DIETS, DESIGN AND DURATION

Sixteen growing male New Zealand White rabbits aged 3 - 4 months were used for this experiment. The rabbit were sourced from the National Root Crop Research Institute Umudike. Four experimental diets (Table 1) were formulated for the rabbits. MOLM was incorporated into the diets at 0.00%, 5.00%, 10.00% and 15.00% levels represented as T_1, T_2, T_3 and T_4 respectively. The proximate compositions of the diets were analyzed using the analytical procedure as described by AOAC (2002). Four rabbits were allotted to the treatment groups in a Completely Randomized Design (CRD). A rabbit served as a replicate. Treatment one (T_1) which contained no MOLM served as the control. The study lasted for sixty (60) days.

Table I: Ingredient composition of experimental diets containing varying levels of *Moringa oleifera* leaf meal

Ingredients	Dietary levels of leaf meal (%)			
	T_1 (0.00)	**T_2 (5.00)**	**T_3 (10.00)**	**T_4 (15.00)**
Maize	47.00	47.00	47.000	47.00
MOLM	0.00	5.00	10.00	15.00
Wheat offal	15.00	10.00	5.00	-
PKC	14.00	14.00	14.00	14.00
Soybean	18.00	18.00	18.00	18.00
Fish meal	3.00	3.00	3.00	3.00
Bone meal	2.00	2.0	2.00	2.00
Salt	0.25	0.25	0.25	0.25
Vita premix	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**

Table II: Proximate composition of experimental rabbit diets

Parameters	Dietary level of leaf meal %			
	T_1(0.0)	T_2(5.0)	T_3(10.0)	T_4(15.0)
Protein	13.77±0.10	13.94±0.10	15.11±0.10	15.69±0.10
Fat	5.44±0.04	5.70±0.04	5.77±0.01	5.81±0.02
Fibre	5.09±0.02	4.60±0.35	5.53±0.01	5.70±0.04
Ash	4.71±0.01	3.88±0.04	3.97±0.01	4.17±0.01
Moisture	10.33±0.02	10.45±0.08	10.36±0.02	10.36±0.02
Carbohydrate	60.65±0.11	61.43±0.15	59.26±0.13	58.27±0.13
Energy (kcal/g)	346.64±0.28	352.78±0.16	494.9±0.16	481.00±0.11

Values show means of triplicate analysis ± standard deviation.

Table IIIa: Proximate composition of fresh moringa leaf and shade dried moringa Leaf meal (as fed basis %)

Parameters	Fresh (FML)	Dried (DMLM)
Protein	3.79±0.10	20.94±0.10
Fat	1.35±0.01	5.09±0.11
Fibre	2.07±0.12	8.15±0.03
Ash	0.91±0.03	6.18±0.04
Moisture	70.41±0.03	10.37±0.01
Carbohydrate	21.46±0.14	49.27±0.06
Energy (kcal/g)	113.13±0.53	326.48±0.68

Values show means of triplicate analysis ± standard deviation.
FML= Fresh Moringa Leaf
DMLM= Dried Moringa Leaf Meal

Table IIIb: Chemical composition of forage (% DM)

	PM	PP	CP
DRY MATTER	85.30	73.69	71.91
CRUDE PROTEIN	9.79	7.87	7.97
CRUDE FIBRE	8.70	8.50	7.21
ETHER EXTRACT	1.20	2.59	2.31
ASH	8.10	8.51	8.14
N-FREE EXTRACT	57.43	67.24	62.54
*ME (MJ/KGDM)	1.46	1.20	1.10

Calculated
PM = *Panicum maximum*
PP = *Pennisetum purpureum*
CP = *Centrosema pubescens*

MANAGEMENT OF ANIMALS

A 2-week pre-experimental period was allowed to enable the rabbits acclimatize. Each rabbit was housed in a single hutch of 50x50cm^2 with wire mesh floor and wooden frames. Each hutch was tagged for easy identification of the rabbits. The house was naturally ventilated and the rabbits were reared in a clean environment. The necessary routine management practices were maintained. The rabbits were fed commercial concentrate diet (Grower Mash) (CP = 16%; ME = 2450kcal/kg) during 2 weeks of acclimatization. Freshly cut forage consisting of *Pancium maximum, Pennisetum purpureum and Centrosema pubescens* were fed as basal diet. The animals were fed two times daily (6am and 4pm) using 700 g of each forage, and 2 kilograms of Grower Mash as supplement. Water was provided *ad libitum* to the rabbits. They were fed the experimental diets for 60 days, after which data collection and analysis were carried out.

DATA COLLECTION

GROWTH PERFORMANCE

Weight gain: At the commencement of the experiment after acclimatization, the rabbits were weighed using Electronic kitchen weighing scale, IndiaMART which weighs 1 gram-7000grams and their initial average weights recorded. Thereafter, the rabbits were weighed every seven (7) days before feeding. The difference between the preceding and current week's weight was the weekly weight gain.

Feed intake: Daily feed intake was obtained using weigh back mechanism.

Feed conversion ratio (FCR): FCR = Feed intake/Weight gain.

The legislative provisions on the care and use of animals were observed as approved by the Abia State University committee for research ethics.

DATA ANALYSIS

Data collected were subjected to one-way analyses of variance (ANOVA) using the technique of Steel & Torrie (2006). Significant treatment means were separated using Duncan's New Multiple Range Test as described in Obi (2002).

RESULTS

The results of growth performance of grower male New Zealand white rabbits fed graded levels of *Moringa oleifera* leaf meal are shown in Table IV. There were no significant differences (P>0.05) among the treatment groups in initial body weight. However, there were significant differences

Table IV: Growth performance of growing male new zeland white rabbits fed graded levels of *Moringa oleifera* leaf meal.

	Dietary level of leaf meal %				
Parameters	**T1 (0.0)**	**T2 (5.0)**	**T3 (10.5)**	**T4 (15.0)**	**SEM**
Initial body weight (g)	1750	1750	1750	1750	0.00
Final body weight (g)	1780^{bc}	1810^{a}	1790^{b}	1800^{ab}	6.45
Av. daily weight gain (g)	0.50^{b}	0.83^{a}	0.67^{ab}	0.83^{a}	0.08
Av. total weight gain (g)	30.00^{bc}	60.00^{a}	40.00^{b}	50.00^{ab}	6.45
Av. daily feed intake (g)	21.34^{ab}	22.34a	20.39^{b}	20.75^{b}	0.43
Av. Total feed intake(g)	1280.40^{ab}	1340.40a	1223.40^{b}	1245.00^{b}	25.56
Feed conversion ratio	42.68^{a}	22.34^{b}	30.59^{ab}	24.90^{b}	4.53
Mortality	0.00	0.00	0.00	0.00	

^{abc}: Means in the same row with different superscript are significantly (P<0.05) different.
SEM = Standard error of mean.

(P<0.05) among the treatment groups in final body weight, average daily weight gain, average total weight gain, average daily feed intake, average total feed intake and feed conversion ratio.

Rabbits on T_2 recorded the highest value of 1810g in final body weight and this differed significantly (P<0.05) from rabbits on T_1 and T_3 which were similar (P>0.05) to each other in final body weight and also similar (P>0.05) to those on T_4. There was no significant difference (P>0.05) between rabbits on T_2 and T_4 in final body weight. The lowest value in final body weight was observed in rabbits on T_1 (1780 g).

Rabbits on T_2 and T_4 recorded the highest value of 0.83g in average daily weight gain and this differed significantly (P<0.05) from rabbits on control treatment (T_1) (0.50 g) which were similar (P>0.05) to rabbits on T_3 (0.67 g) in average daily weight gain. There were no significant differences (P>0.05) among rabbits on T_2, T_3 and T_4 in average daily weight gain. The lowest value in average daily weight gain was observed in rabbits on control treatment (T_1).

Rabbits on T_2 recorded the highest value of 60 g in average total weight gain and this differed significantly (P<0.05) from rabbits on T_1 and T_3 which were similar (P>0.05) to each other in average total weight gain. Rabbits on T_3 were also similar (P>0.05) to those on T_4 in average total weight gain. There was no significant difference (P<0.05) between rabbits on T_2 and T_4 in average total weight gain. The lowest value in average total weight gain was observed in rabbits on control treatment (T_1) (30 g).

Rabbits on T_2 recorded the highest value of 22.34 g in average daily feed intake which was similar (P>0.05) to rabbits on T_1 but differed significantly (P<0.05) from rabbits on T_3 and T_4. The lowest value in average daily feed intake was observed in rabbits on T_3 (20.39g).

Rabbits on T_2 recorded the highest feed conversion ratio (general ability to convert feed to meat) of 20.83 which differed significantly (P<0.05) from rabbits on T_1 (39.83) but were similar (P>0.05) to rabbits on T_4 (23.26) and T_3 (28.55). The lowest value in feed conversion ratio was observed in rabbits onT_1.

DISCUSSION

The values for final body weight obtained in this study were higher than the range of 44.50 – 64.25(g) for final body weight reported by Iheukwumere (2004) for weaner rabbits fed with raw and boiled pigeon pea seed meal, and higher than the range of 1248.34 – 1376.60(g) for final body weight reported by Iheukwumere *et al.* (2005) for grower rabbits fed with *Microdesmis puberula* leaf meal. This disparity in body weight could be attributed to age and nutritional status of these rabbits.

The lowest value in average daily weight gain observed in rabbits on control treatment (T_1) could be attributed to decreased nutrients in the control group diet since T_1 contained no Moringa leaf meal. The values for average daily weight gain in this study were lower than range of 5.95 - 13.39 g in daily weight gain reported by Abubakar *et al.* (2015) for growing rabbits fed graded levels of *Moringa oleifera* leaf meal in diets. Similarly, the values for average daily weight gain obtained in this study were lower than the range of 10.31 – 11.80 (g) reported by Iheukwumere *et al.* (2005) for grower rabbits fed *Microdesmis puberula* leaf meal, and lower than the range of 18.87 - 22.35 g in daily body weight gain reported by Zendrato *et al.* (2019) for weaner rabbits fed dried Moringa oleifera leaf meal, and lower than the range of 16.71 – 21.90 g reported by Jiwuba and Ogbuewu (2019) for rabbits fed *Moringa oleifera* leaf meal supplemented diets. This may not be unconnected to differences in age, breed and nutritional status of the rabbits.

The values for average total weight gain obtained in this study were higher than the range of 16.77 – 34.73 g reported by Iheukwumere (2004) in weaner rabbits fed raw and boiled pigeon pea seed meal, except rabbits on T_1 whose average total weight gain was within the range. Similarly, the values for average total weight gain obtained in T_2 and T_4 were higher than the range of 20.75 – 45.10g for average body weight gain reported by Iheukwumere *et al.* (2008) for 24 weeks old rabbits while the values obtained in T_1(30g) and T_3(40g) were within the range. However, the values for average total weight gain in this study were lower than the range of 256.25 g – 483.75 g in average total weight gain

reported by Ufele *et al.* (2013) for rabbits fed *Moringa oleifera* (Drumstick tree), and lower than the range of 250.00 – 562.50 g in total weight gain reported by Abubakar *et al.* (2015) for growing rabbits fed graded levels of Moringa oleifera leaf meal in diets. The disparity in the values for average total weight gain obtained in this study could be attributed to genetic differences, age and nutritional status of the rabbits. The significant increase in body weights of rabbits fed *Moringa oleifera* leaf meal in this study compared to those on control diet may be linked to the excellent amino acid content of MOLM. The proteins of *Moringa oleifera* have very high biological value and essential amino acid (Mbajiorgu *et al.*, 2011). Generally, the observed low growth rates in this study could be explained by the fact that the rabbits did not consume a lot of feeds to ensure higher growth. The rabbits must be fed to meet the energy requirement to sustain a rapid growth and development.

The values for average daily feed intake obtained in this study were lower than the range of 27.04-40.65g reported by Iheukwumere (2004) for weaner rabbits fed raw and boiled pigeon pea seed meal, and lower than the range of 73.10-79.81g reported by Iheukwumere *et al.* (2005) for grower rabbits fed *Microdesmis puberula* leaf meal, and lower than the range of 30.05-56.35g reported by Iheukwumere *et al.* (2008) for rabbit bucks. This disparity in average daily feed intake could be attributed to the crude fibre content of the various diets.

The highest average total feed intake observed in rabbits on T_2 could be attributed to reduced crude fibre content of the diet which could have improved the palatability of the diet as T_2 contained only 5% *Moringa oleifera* leaf meal (Amaefule & Obioha, 2001; Iheukwumere *et al.*, 2008). Genetic differences might have also contributed to the higher feed intake in rabbits on T_1 and T_4 relative toT_3.

The fact that rabbits on T_2 (5%) *Moringa oleifera* leaf meal showed the best feed conversion ratio followed by T_4 signified that *Moringa oleifera* leaf meal had the capacity of improving efficiency of feed utilization at these levels. This resulted in the highest average total weight gain observed in rabbits on T_2 followed by T_4. That no mortality was observed in all the treatments is an indication that *Moringa oleifera* leaf meal was not detrimental to the performance of the rabbits. Ayssiwede *et al.* (2011) found that MOLM inclusion in the diet up to 24% did not cause any adverse impact on the live body weight, average daily weight gain, feed conversion ratio and mortality in birds compared to their control.

CONCLUSION

The results of this study showed that *Moringa oleifera* leaf meal could affect growth performance of the growing New Zealand white rabbits: weight gain, feed intake and feed conversion ratio positively at the level beyond 15% inclusion. Hence, further trial of the spectrum of *Moringa oleifera* leaf meal inclusion level for growth performance in New Zealand White rabbits is desirable.

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