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Response Of Different Breeds Of Rabbits To Diets Containing Graded Levels Of *Moringa oleifera* Leaf Meal.

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Abstract

Ninety-six Newzealand white (NZW) and crossbred (Newzealand x Dutch) weaner rabbits were used to assess the effect of including *Moringa oleifera leaf* meal (MOLM) in their diets. Effect of dietary treatments namely ML-10 (10% MOLM), ML-20 (20% MOLM), ML-30 (30% MOLM) and ML-0 (no MOLM), on performance and certain blood parameters were evaluated. The experimental design employed was a 2 x 4 factorial in a completely randomized design (CRD). Feed and water were supplied *ad libitum*. The effects of breed and dietary treatments on the traits studied were determined. The result showed that dietary inclusion of MOLM had no significant (P> 0.05) effect on feed intake and blood parameters, but significantly (P< 0.05) affected feed conversion ratio (FCR), body weight and morphmetric traits. Rabbits fed ML-10% and ML- 20 % diets had the highest final body weight with the NZW performing better than the crossbred rabbits. Similarly, the best FCR was associated with ML-10% and ML- 20 % diets (4.45 and 4.32). Interaction effect of breeds and treatments were not significant (P>0.05) The study showed that processed MOLM can conveniently be used for feeding weaner rabbits since it had no deleterious effect on the performance and blood parameters.

Keywords: Growth, Performance, Treatment, Parameters

Introduction

Many developing regions of the world are faced with the burden of a growing population, malnutrition, especially with regards to inadequate intake of protein and calories supply (Akinmutimi and Anakebe 2008). Currently, most of the animal protein available for human consumption is from large ruminants, poultry and pigs (Henchion *et al*. 2017). However, these livestock are continually declining probably because of high costs of feeding and maintenance leading to high cost of meat, making it difficult for an average Nigerian to afford animal protein. Many investigators have suggested ways of increasing low animal protein intake. One of the ways is by exploring and evaluating non-conventional livestock species (Ani *et al*. 2014). Rabbits (*Oryctolagus cuniculus*), which is considered as a non-conventional livestock species; appears to be a cheap, early maturing, have high genetic selection potential, high reproductive potentials and are efficient converters of feed to meat and can utilize up to 30% crude fibers (Hassan *et al*. 2012; Yakubu *et al*. 2013).

In spite of these potentials, lack of feed all year round and, inadequacy of feed ingredients has continued to be a major constraint to the survival of rabbits. Feed cost is always the largest item (60-70%) of expenditure in ruminant production and protein source are the most expensive among the ingredients used (Abonyi *et al*. 2012). Nutritional solutions can be achieved by taking full advantage of the alternative feed resources, such as tropical plants, in rabbit diets (Safwat *et al*. 2014). In Nigeria, herbage availability during the wet season often exceeds animal requirements (Olubunmi *et al*. 2013).With the onset of the dry season, protein level of the accumulated forages drops, fibre level increases and voluntary intake decreases leading to lose of weight (Olubunmi *et al*. 2013). Hence, any tropical plant of high protein ingredient which is available all year round is highly recommendable.

One of such plant, which is cheap, locally available and less susceptible to climatic fluctuation, is *Moringa oleifera* . It is used as animal forage, biogas, green manure and gum. Moringa leaves have very strong antioxidant activity (Siddhuraju and Becker 2003). Owen *et al*. (2013) studied the economics of raising rabbits using MOLM as a replacement for soyabeans in rabbit's feed. The results obtained shows that significant differences existed in growth parameters and cost of feed (kg). It also reveals that MOLM can conveniently replace up to 15% of expensive sources of protein in rabbit diet without compromising performance. Fayomi *et al*. (2014) in their study concluded that MOLM has nutritional advantages over other leafy meals as they contain high pepsin soluble nitrogen, low acid detergent insoluble protein and low anti nutritional factors.

In the face of increasing challenges to produce cheap and good quality animals and animal products, there is need to intensively explore the use of non-conventional protein sources as replacers, substitutes and complements for the expensive conventional ones. The abundance of *Moringa oleifera* plant in most part of Nigeria is an indication that the plant can be successfully used to reduce the problems of the shortage of conventional protein source feedstuff currently being experienced by feed millers in Nigeria. In domesticating rabbits, there is need to develop variety of breeds with high feed efficiency and growth performance. However, there is paucity of information on the effect of *Moringa oleifera* on body weight and morphometric trait of the NZW and crossbred rabbits for Nigerian environment. It is against this background that this study was conducted to assess the growth performance and hematological response of 2 breeds of weaner rabbits fed diets containing graded levels of MOLM. The development of *Moringa oleifera* as a new plant in the farming systems of the tropical rain forest of Nigeria could be the panacea for the much needed alternative feed material for increased livestock productivity.

Materials and Methods

Environment of the study

The experiment was conducted at the Rabbitary unit of the Department of Animal Science, Teaching and Research farm, University of Nigeria, Nsukka. The farm is situated within the equatorial rainforest belt of the tropics and falls specifically within the derived savanna vegetation zone. It has well- defined rainy season (April- October) and dry season (November – March). Nsukka town is located on latitude 7^0 24^1 North and longitude 6^0 24^1 East with annual rainfall ranging from 986-2098mm. The town is situated at an altitude of 430m above sea level. The climate in this area is humid tropical (Ndofor-Foleng *et al*. 2015). The study was done in accordance with Institutional guidelines on the care and use of animals for scientific research, and in compliance with generally accepted rules of best practice worldwide.

Processing of the test feedstuff

Moringa oleifera leaves were harvested from household gardens and were air dried under a shed until they were crispy to touch, while retaining their greenish colouration. The leaves were then milled using a hammer mill of sieve size 3 mm, to obtain a product herein referred to as *Moringa oleifera* leaf meal which was incorporated into the rabbit's diets: ML-10 (10% MOLM), ML-20 (20% MOLM), ML-30 (30% MOLM) and ML-0 (no MOLM). Other feed ingredients included maize, wheat offal, groundnut cake, palm kernel cake, bone meal, salt, lysine, methionine and vitamin premix (Table 1).

Table 1: Percentage compositions of experimental diets

Ingredients	ML-0	ML-10	ML-20	ML-30
Maize	34.11	32.60	31.05	28.98
Wheat offal	41.74	39.81	37.97	35.45
Moringa oleifera	0	10	20	30
Groundnut cake	10.52	6.91	3.29	0.32
Palm kernel cake	8.62	5.64	2.69	0.25
Bone meal	4.00	4.00	4.00	4.00
Salt	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Vitamin premix	0.25	0.25	0.25	0.25
Total 100	100	100	100	100
Crude protein	16.00	16.00	16.00	16.00
Metabolizable energy kcal/kg	2453	2379	2309	2437
Crude fibre	9.96	10.95	11.94	12.92

Experimental Animals and management

A total of 96 Newzealand white (NZW) and crossbred of Newzealand x Dutch (CB) 6 weeks old weaner rabbits with their live body weight ranging from 771g-775g were used for the study. Rabbits of each breed were randomly distributed into four groups (12 rabbits each), assigned to receive one of the four experimental diets: ML-0 (no MOLM), ML-10 (10% MOLM), ML-20 (20% MOLM) and ML-30 (30% MOLM). Each treatment was replicated three times with 4 rabbits per replicate. The experimental design was a 2 x 4 factorial arrangements with 2 factors (breed and dietary treatment) in a completely randomized design. The rabbits were subjected to standard management procedures and were kept under similar conditions of management. Weighed quantities of feed were supplied to the experimental animals while water was supplied *ad-libitum*. The chemical composition of MOLM used for the study were analyzed for proximate composition using the procedure of A.O.A.C (2005). Body weight, body length, heart girth, height at withers, loin height, tail length, ear length and head length were recorded throughout the experimental period. Records of feed intake were also taken and FCR expressed as the ratio of mean feed consumed to mean weight gained for each breed.

Blood collection and evaluation: At the end of the experiment (12 weeks), animals were starved of feed for 24 hours before blood samples were collected. Two rabbits per replicate were randomly selected and blood samples were collected from the external ear vein using a sterilized disposable syringe and needle between 6.30 and 7.30 am and used to determine Packed Cell Volume (PCV), Red Blood Cell Counts (RBC), White Blood Cell Counts (WBC) and Haemoglobin Concentration (Hb) as described by Ewuola and Egbunike (2008).

Analytical procedure

The statistical model employed was:

$$\chi_{ijk} = \mu + A_i + B_j + (AB)_{ij} + \varepsilon_{ijk}$$

where, χ_{ijk} = the observation on the kth rabbits belonging to the ith breed subjected to the jth treatment;
μ =overall mean
A_i = effect of the ith breed (i=1, 2)
B_j = Treatment effect (j=1- 4) of different levels of MOLM (j= 0%, 10%, 20%, 30%)
$(AB)_{ij}$ = interaction effect of breed by treatment
ε_{ijk} = residual.

Data were subjected to one-way analysis of variance (ANOVA) using SPSS (2016) Version 22.0 to test for main and interaction effects. Significantly different means were separated using Duncan's New Multiple Range Test (SPSS, 2016). Comparison between breeds subjected to the same treatment was done using independent t-test.

Results and Discussion

The proximate composition of MOLM (Table 2) showed that, it contains, crude protein, 26.20 %, crude fibre 10.00 %, ether extract 13.00 %, ash 10.00 % and nitrogen free extract 33.00 %. The percentage compositions of the experimental diets (table 3) showed that, the values of dry matter increased with increase in *Moringa oleifera* leaf meal inclusion (96.88-97.40%). The crude fibre content also followed the same trend with the highest values in ML-30 (12.43 %) and the least values in ML-0 (10.30 %) while values for ether extract and nitrogen free extract declined with increasing levels of MOLM (5.00 and 52.03 % in ML-0 and (4.00 and 48.74 %) in ML-30, respectively). The crude protein increased as the percentage of MOLM increased from ML-10 –ML-30. The reverse was the case for the energy level; it decreased as the percentage of MOLM increased. The crude protein, ether extract and energy content of *Moringa oleifera* leaf meal meets the nutritional needs of rabbits and were similar to findings Safwat *et al*. (2014). The crude fibre and ash content were also much higher than the values reported by Ogbe *et al*. (2011**)** but lower than the values reported by Odeyinka *et al*. (2008). Crude protein content fell within the same range (18.55-18.59 %) and was within the recommended ranges by Johnson (2006). The dry matter values obtained in this study are in conformity with the values obtained by Iyabode *et al*. (2014). The value for ether extract obtained in this study were higher than the values obtained by Ani *et al*. (2014) but the values obtained for ash content are in conformity with the values obtained Odeyinka *et al*. (2008). The variations in the nutrients content of the plant could be attributed to the age of cutting, harvesting, edaphic factors as well as methods of processing and analysis (Safwat *et al*. 2014). These variations in the nutrient content therefore suggest that environmental factors such as season, geographical location and stage of maturity also plays a major role in the nutrient content of Moringa leaf (Yakubu *et al*. 2013).

Table 2. Proximate composition and energy value of *Moringa oleifera* leaf meal

Nutrients	Composition (%)
Dry matter	92.20
Moisture	7.80
Crude protein	26.20
Crude fibre	10.00
Ether extract	13.00
Ash	10.00
Nitrogen free extract	33.00

Table 3. Proximate composition of experimental diet (*Moringa oleifera*) fed to rabbits Dietary treatments (%)

Dietary treatments (%)				
Nutrients (%)	**ML-0**	**ML-10**	**ML-20**	**ML-30**
Dry matter	96.88	96.90	97.00	97.40
Moisture	3.12	3.10	3.00	2.60
Crude protein	18.55	18.56	18.57	18.59
Crude fibre	10.30	10.49	11.65	12.43
Ether extract	5.00	4.50	4.02	4.00
Ash	11.00	11.99	13.50	13.64
Nitrogen free extract	55.15	54.46	52.26	51.34
Total	100.00	100.00	100.00	100.00

Performance of weaner rabbits fed of *MOLM:*

The results of feed intake, FCR, body weight (BW) and body weight gain (BWG) of the experimental rabbits (NZW and CB) fed diets containing varying levels of MOLM are presented in Table 4.

Table 4: Performance traits of rabbit fed varying levels of *Moringa oleifera*

Parameters	Breed	ML-0	ML-10	ML-20	ML-30	SEM	P value
Initial weight (g)	NZW	775.14	773.89	772.89	771.02		
	CB	773.00	774.10	772.19	771.20		
Average Final weight (g)	NZW	1367.34 ^{b}	1583.22 ^{a}	1599.76^{a}	1442.43 ^{b}	0.74	0.04^{s}
	CB	1309.50 ^{b}	148.13 ^{a}	1479.05 ^{a}	1313.50 ^{b}	0.22	
Average daily Feed intake(g)	NZW	76.07	78.13	78.04	77.00	0.61	0.50^{ns}
	CB	75.99	76.11	76.96	74.10	0.81	
Weight gain (g/day)	NZW	15.40^{b}	17.55^{a}	18.06^{a}	15.78^{b}	0.21	0.03^{s}
	CB	15.26^{b}	15.57^{a}	15.74^{a}	14.98^{b}	0.11	
Feed conversion ratio	NZW	4.93	4.45	4.32	4.87	0.55	0.04^{s}
	CB	4.98	4.88	4.89	4.94	0.33	
Heart girth (cm)	NZW	21.15^{b}	23.40 ^{a}	23.34 ^{a}	22.46^{b}	0.42	0.14
	CB	20.45 ^{b}	22.93 ^{a}	22.98^{a}	21.68^{b}	0.81	
Head length (cm)	NZW	8.71	8.84	8.77	9.04	0.34	0.42
	CB	8.69	8.74	8.73	8.78	0.61	
Tail length (cm)	NZW	7.94	7.32	7.69	7.18	0.33	0.73
	CB	7.45	7.11	7.34	7.18	0.41	
Body length (cm)	NZW	26.73^{b}	27.83 ^{a}	27.17 ^{a}	26.62 ^{b}	0.12	0.04^{s}
	CB	24.00	25.00	25.41	24.89	0.14	
Height at winters (cm)	NZW	16.56 ^{b}	17.07 ^{a}	17.25 ^{a}	16.56 ^{b}	0.16	0.49
	CB	16.10	16.89	16.90	16.02	0.45	
Loin height (cm)	NZW	24.89	24.91	24.52	24.63	0.11	0.26
	CB	24.01	24.81	24.34	23.19	0.33	
Ear length (cm)	NZW	11.06	11.58	11.02	11.01	0.45	0.35
	CB	11.01	11.14	11.34	11.11	0.23	

$^{a\ b\ c}$ *means in the same row for each parameter with different superscripts are significantly different* (p <0.05).

There was no significant (P>0.05) difference between the NZW and the CB breed in feed intake and FCR. When different treatments were considered, no significant variations (P>0.05) were noted in feed intake with rabbits on ML-10 and ML-20, consuming more feed than rabbits on ML-0 and ML-30 diets. The daily feed intake was not significantly (P>0.05) influenced by inclusion level of the experimental diet. Yakubu *et al*. (2013) reported higher feed intake with increasing levels of crude fibre in the diets of rabbits. This trend in feed intake can be explained by the fact that leaf meals contain relatively high fibre which tends to increase the total fibre content of the diet and result in dilution of other nutrients. Rabbits like any other monogastric animal must eat to meet their energy requirement for a sustained growth and development. However, a reduction in feed intake though not significant, was observed in rabbits on increased forage meal (ML-30) in the diet.

Superior FCR was observed in NZW rabbits on ML-10 (4.45) and ML-20 (4.32). FCR however became poorer in rabbits on ML-0 (4.93) and ML-30 (4.99). Treatments ML-10 and ML-20, recorded similar FCR, whereas counterparts fed with ML-0 and ML-30, diets recorded a higher FCR and suffered a non significant (P>0.05) depreciation in both breeds. However, NZW breed tended to show better (P<0.05) FCR than the CB rabbits.

Interaction effect between treatment and breeds on feed intake and FCR were not significant. A rabbit regulates its feed intake according to the energy need. In monogastric animals the glycemia plays a key role in food intake regulation, while in ruminants the levels of volatile fatty acids in blood have a major role. Since rabbit is a monogastric herbivore, it is not clear which is the main blood component regulating feed intake, but it is likely to be the blood glucose level (Maertens 2009). Also environmental conditions affect the FCR because of their effect on the requirements for thermoregulation. During the dry season, a more favourable FCR is obtained than during the rainy season despite the lower growth rate (Maertens 2009). The feed-to-gain ratio of between 4.32 to 4.93 obtained in this study is within the range of values (3.45-5.12) reported by Yakubu *et al*. (2013) and Safwat *et al*. (2014) on *Moringa oleifera leaf meal*. However, Safwat *et al*. (2014) reported the best FCR was associated with 30 % MOLM and control groups (3.2 and 3.4).

Body weight

There was a significant (P<0.05) effect of the dietary treatment on the final body weight of rabbits, with rabbits on ML- 10 and ML-20 having a better final weight and gain than rabbits on ML-0 and ML-30 in both breeds. The higher weight gain of rabbits fed 10% and 20% Moringa diets might be an indication that the diets were more palatable and easily assimilated by the rabbits. The superior feed conversion ratios for the ML-10 and ML-20 diets might have also contributed to the superior growth rate and weight gain by the rabbits as compared to those on ML-0 and ML-30 diets. Final body weight was significantly (P<0.05) influenced by the breed of rabbits. NZW rabbits had a higher final body weight when compared to the crossbred (CB) rabbits.

Results also showed that the inclusion of MOLM in the diets of rabbits significantly (P<0.05) increased some morphometric traits: heart girth, body length and height at winters. The estimated means of all the morphometric traits (Table 4) were significantly (P<0.05) different with rabbits on ML-10 to ML-20 being superior to ML-0 and ML-30. However, non-significant differences were observed in head length, tail length, loin height and ear length. Differences between breeds were significant in body length with the NZW rabbits being superior to the CB rabbits. The effects of breed by diet interaction on body weight, body weight gain and linear body measurements were not significant (P>0.05) in this study. Though rabbits on all the treatments consumed similar quantity of feed, those on ML-0 and ML-30 gained less weight. This might have been due to the high crude fibre content suggesting that the metabolizing energy probably decreased as the level of inclusion of MOLM in the diets increase. Similarly, the poor performance of rabbits on ML-30 could be due to the presence of some oxalate, phytate, trypsin and tannin in moringa leaves. However, it has been reported by Enechi and Odunwodu (2003), that, phytochemical composition and antinutrients in *Moringa oleifera* leaves are low. Olugbemi *et al*. (2010) in evaluating the suitability of MOLM confirmed that, it contains all essential amino acids, which makes it (*Moringa oleifera*) one of the most valuable sources of feed ingredients for monogastric animals. This report was different from Safwat *et al*. (2014) who reported that rabbits fed control and 30 % MOLM diets had the highest final body weight and daily weight gain being 2,040 and 2,000 g and 31.6 and 30.6 g/day, respectively.

Pond *et al.* (1995) stated that Vitamin A deficiency in the diets of rabbits makes the rabbits to exhibit poor growths. MOLM is reported to have a high Vitamin A (Fuglie 2005). The control diet (ML-0) might have provided insufficient Vitamin A for the rabbits hence resulting in poor growth since Vitamin A aids in promoting growth in rabbits. The high performance of weaner rabbits on ML-10 and ML-20 diets could be explained by the reports of Siddhuraju and Becker (2003) that Moring leaves do not only serve as protein source but also provide some necessary vitamins and minerals. The role of dietary materials to depress or promote growth performance in rabbits has been documented by Yakubu *et al*. (2013).The interaction between breeds and levels of includion of MOLM (treatments) had no significant (p>0.05) effect on all the parameters measured.

Effects of Different Diets on Haematology of Rabbits: The results of this investigation are presented on Table 5.

There were no significant (P>0.05) effect of MOLM diets on the haematological indices of rabbits. However, PCV values in this study ranged between 30.75 to 31.75; Hb concentration (9.40-10.73g/dl), RBC count (4.54-5.68) and WBC (4.28 -4.30 X 10^3/mm^3). The mean haemoglobin (Hb), PCV, RBC and WBC value of rabbits were numerically higher in ML-10 and ML-20 than those of the control. Crossbred rabbits had non significant higher values of haemoglobin compared to NZW rabbits. Mortality was very low and this was not traceable to any dietary effect.

Table 5: Effect of *Moringa oleifera* leaf meal on the haematological characteristics of rabbits.

Parameters	Breeds	ML-0	ML-10	ML-20	ML-30	SEM	P Values
Packed cell volume (%)	NZW	31.25	31.75	31.50	30.75	0.71	
	CB	31.11	31.00	31.23`	30.81	0.41	0.06
Haemoglobin (HB g/dl)	NZW	10.15	10.65	10.73	10.10	0.35	
	CB	10.23	10.67	10.75	10.22	0.44	0.09
Red blood cell count ($x10^6/mm^3$	NZW	5.05	5.55	5.68	4.54	0.22	
	CB	5.10	5.41	5.55	5.01	0.12	0.99
White blood cell count ($x10^3/mm^3$	NZW	4.28	4.29	4.29	4.30	0.05	
	CB	4.22	4.12	4.29	4.28	0.11	0.68

Packed cell volume (PCV) is a measure of the relative mass of blood. Though there were slight variations (P>0.05) in the values obtained for PCV, they were all within the normal physiological ranges of 30-50% for rabbits as reported by Nse abasi *et al*. (2014) and Dettweiler *et al*. (2017). The normal PCV value is suggestive of adequate nutritional status of the rabbits and indicates the absence of normocytic anaemia. The result is in agreement with the findings of Yakubu *et al*. (2013) who observed no significant (P >0.05) effect of feeding *Moringa oleofera* leaf meal in the diet on PCV of Rabbit, but differed from findings of Chineke *et al*. (2006) who detected significant variation between rabbits breeds. .

NseAbasi *et al*. (2014) opined that increased RBC values are associated with high quality dietary protein and with disease free animals. The similarity in the RBC components in the breed and dietary treatments indicated that the use of MOLM in rabbit diets has no adverse health implication. The normal hemoglobin concentration for all the experimental rabbits is probably an indication that MOLM supplement supported hemoglobin synthesis. Normal range of values for haemoglobin (Hb) indicated that the vital physiological relationship of haemoglobin with oxygen in the transport of gases (oxygen and carbon dioxide) to and from the tissues of the body has been maintained and was normal.

WBC values were not significantly (p>0.05) affected by breed and dietary treatments and ranged between 4.28 -4.30 ($x10^3/mm^3$). This indicates that body defense system of the rabbits in all the treatment groups was not negatively affected by MOLM supplement. However the normal range indicates the absence of toxins in the diets. Maryam *et al.* (2017) noted that a decrease in WBC count reflects a fall in the production of defensive mechanism to combat infection. High WBC count is usually associated with microbial infection or the presence of foreign body or antigen in the system (Ogbuewu *et al*. 2013).

Haematological components of blood are valuable in monitoring feed toxicity especially with feed constituents that affect the formation of blood (Mohammed *et al*., 2010). Haematological studies represent a useful process in the investigation of the extent of damage to the blood and provide the opportunity to clinically investigate the physiological, nutritional and pathological status of an animal. In this study, haematological parameters were not affected by rabbit breeds. The similarity of the haematological indices is an index of good physiological, pathological and nutritional status of rabbits fed the experimental diets (MOLM) and could be related to nutritional adequacy and safety of the test ingredients.

Conclusion

In this study, reductions in weight gain and morphometric characters were recorded as a result of the addition of higher level of MOLM (above 20%) to rabbit's diet. However, to promote rabbit enterprise, *Moringa oleifera* leaf meal could be included in the diets of weaner rabbits up to 20% inclusion level; without any deleterious effect on performance. Hence, incorporation of the leaves of this plant in rabbit feed formulation is imperative to solve the problem of scarcity of forage during the dry season and enhancing the performance of the rabbits breeds in Nigeria.

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