Original Research Article

Evaluating the Effect of Moringa (*Moringa oleifera*) Leaf Supplemented Feed on the Growth and Carcass Quality of Broilers in Calabar

ABSTRACT

Background: Rapid population growth of human and livestock create increasing demands for food, nutrition security in developing countries and therefore alternative feed resources must be identified and evaluated. This study was carried out to investigate the effects of *Moringa oleifera* leaf meal (MOLM) on supplemented feed on the growth and carcass quality of broilers in Calabar.

Methodology: Fresh leaves of *Moringa oleifera* were bought and collected from Calabar, Nigeria. The leaves were dried for four days and milled. A total of 40 broiler chicks that were 48 day-old, unsexed (rose 308) were sourced from a reputable poultry farm in Calabar. The broiler chicks were randomly allotted to four treatment groups (A, B, C and D). 0%, 5%, 10% and 15% of MOLM were incorporated into the broiler feed which constituted the four treatment groups. Each group was replicated ten times at 10 birds per replicate. The following parameters were taken: including feed intake, weight gain, feed conversion ratio, mortality rate and carcass quality. Data were subjected to statistical analysis.

Results: The diet supplemented with 5% of MOLM showed significantly high body weight and followed by 10% of MOLM. Feed intake values were significantly ($p<0.05$) different across the treatment groups. The weight gain (WG) was statistically similar for group B and C but significantly ($p<0.05$) different in group D; with birds fed with 10% MOLM based diet having the highest WG. The feed conversion ratio of the birds were not significantly ($p>0.05$) different in group B and C, but differed significantly ($P<0.05$) in group D when compared with the control in group A. Carcass characteristics showed higher values of dressing percentage in birds fed supplemented with 10% MOLM (group C).The levels of MOLM were not significantly different in terms of liver weight, heart weight, kidney weight and abdominal fat.

Conclusion: Overall, the best significant improvement in the response indices were obtained in birds fed 10% MOLM, while there was a reduced performance of birds feed with 15% MOLM.

Keywords: *Moringa oleifera*; growth; carcass quality; broilers; Calabar

1. INTRODUCION

The rapid population growth of human and livestock create increasing demands for food, nutrition security in developing countries [1] and therefore alternative feed resources must be identified and evaluated. Commercial poultry meat production is expanding daily [1 – 3],

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Comment [PE4]: Do you mean there were 10 birds per treatment group and each group was replicated ten times? This is impossible with a sample size of 40 birds. I believe you are referring to the former. Please, revisit.

Comment [PE5]: This is normally calculated or computed and not taken. Please, revisit.

Comment [PE6]: Your results shows that there was no mortality of the birds. Please, expunge.

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constituting an important pillar of food security improvement, socio-cultural and economic development in most countries [1 – 4]. Natural medicinal products originating from herbs, trees and spices have been used as feed additives for farm animals [1 – 2]. These natural products and their derivatives provides a rich source of drugs, food, vitamins and plant metabolites for man and animals [5-7]. As a result, it has become necessary to evaluate alternative protein sources, among which are the leaf meals. Presently, numerous studies are on-going into the viability of the *Moringa oleifera* leaf meal; especially in view of the quality and quantity of food nutrients in it such as crude protein, water and fat soluble vitamins, calcium, phosphorus and iron [8-12].

Moringa oleifera belongs to the family *Moringaceae*, which is widespread throughout the tropics and sub-tropics. It is a small to medium evergreen or deciduous tree that can grow to a height of 10–12 m (32–40 ft) and trunk diameter of 45 cm (1.5 ft). The bark has a whitish-grey colour and is surrounded by thick cork. This plant have sparse foliage, white flowers and long pods, often planted in farms and compounds. Moringa flowers are pentamerous, zygomorphic, 7-11mm long and the fruit is typically 3-valved capsule; 10-60 cm in length [13-14]. The plant possess multiple advantages, because different parts of the tree (leaves, fruits, immature pods and flowers) are useful [15].

Moringa oleifera is one of the plants that can be introduced into livestock production feedstock to increase feed quality and quantity or availability. This plant can be used as a cheap protein supplement to improve digestibility of other diets and also proffer medicinal values. *Moringa oleifera* has been widely valued as a versatile plant due to its multipurpose use~~s~~. The leaves, fruits, flowers and immature pods of the species are edible and form part of traditional recipes in many tropical and sub-tropical countries [15-16]. The leaves of *Moringa oleifera* are a good source of protein, vitamins A, B and C, and minerals such as calcium and iron [17]. Moringa leaves are used in animal diets as leaf meal because of its high nutritional and medicinal qualities

as documented by researches [1, 18-20]. *Moringa oleifera* can play an ~~imperative~~ important role in the ~~economy of~~ poultry industry. In Nigeria, precisely Calabar, there is a rising cost of conventional protein rich feeds. The high and increasing prices for conventional feeds have compelled researchers to direct their attention to non-conventional feeds; with particular emphasis on protein substitutes. Also there are contradictory results on the effects of *Moringa oleifera* leaf meal inclusion in the diet of broilers with respect to growth performance and carcass quality in some populations investigated [9-12, 18-20]. Against this back ground ~~drop,~~ there is an urgent need for an updated evaluation of *Moringa oleifera* leaf supplemented feed of broilers in Calabar, Cross River State of Nigeria. Therefore, this study is aimed at evaluating the growth and carcass quality of broilers using *Moringa oleifera* leaf supplemented feed in a dose-dependent manner in Calabar.

2. METHODOLOGY

2.1 Study Location and Duration of the Research

The study was carried out at the animal house, Department of Genetics and Biotechnology, University of Calabar, Calabar. The birds (broilers) were brooded and raised for a period of 12 weeks.

2.2 Source and Preparation of Plant Samples

Fresh *Moringa oleifera* leaves were purchased from farmers and some harvested with-in Calabar ~~environs~~. The collected plant~~s~~ samples were authenticated in the herbarium unit, Department of Plant and Ecological Studies, Faculty of Biological Sciences, University of Calabar, Calabar, Cross River State. The entire plant was washed with clean water, air dried under shade for 4 days

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Comment [PE12]: How did you authenticate leaves that you harvested from the plant? This process of authentication may not be necessary here.

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before ~~powdering~~ milling using **an** electric blender (Qlink-Q15L40). This was used as a supplement suitable for incorporation into the broilers' diets.

2.3 Experimental animals

A total of 40 broiler chicks that ~~was~~ were forty-eight day-old were purchased from a reputable farmer in Calabar for this experiment. Generally, the study was conducted in accordance with the recommendations from the declarations of Helsinki on guiding principles in care and use of animals.

2.3.1 Housing and management of experimental animals

The birds were randomly allocated to a deep litter brooder pens and given a floor space of 1.45m per bird as suggested by Emam *et al.* [3]. Prior to commencing the experiment~~s~~, the poultry house was cleaned and disinfected using formalin solution. Dry sawdust was used as a litter material with a depth of approximately 6 cm. Each of the chicks was wing tagged and examined physically to ensure fitness and general body soundness. Each pen was supplied ~~y~~ with a clean feeder and a drinker of diameter 40 and 20cm respectively. Light was provided for 24 hours throughout the experimental period. The electric~~al~~ bulbs were initially kept at about 15 cm above the ground level to provide heat and then raised gradually to 1.75m height towards the end of the experiment period. The birds were brooded and raised for a period of 12 weeks placed on the same diet as recommended by NRC, 1994 [21] for chick and growing pullets. Water, feed were given and all necessary vaccinations, medication were administered to the birds accordingly, as certified veterinary doctor. Chicks immediately after hatching were vaccinated against Marek's disease and Newcastle disease.

2.4 Experimental design and study parameters

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Comment [PE16]: Give appropriate description of the spacing used (e.g. 1mx1m)

Comment [PE17]: Why use formaldehyde (formalin) for disinfection. This is unconventional. Formaldehyde is a common preservative.

Comment [PE18]: Sawdust is not a conventional litter material as its usage may lead to respiratory challenges in the birds.

Comment [PE19]: The birds should have been brooded at the age you brought them in (48 days old - see line 91). Please, revisit statement.

Comment [PE20]: Water and feed are essential requirements in any animal experiment. Rather, specify if there was any form of restriction/regulation.

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Forty-eight day old, unsexed commercial broiler chicks (rose 308) ~~was~~ were assigned into four groups of 10 chicks (replicates) in a pen, in a completely randomized design. Group one (A) was kept as a control with 0.0% *Moringa oleifera* supplement while the other three groups (group B, C and D) were given experimental diets containing 5%, 10% and 15% *Moringa oleifera* supplement respectively. The following parameters were taken:

2.4.1 Feed intake

The ~~food~~ feed was weighed on a weekly basis to determine the average feed intake per chick for the different treatment groups. ~~the~~ ~~f~~ Feed intake was calculated by obtaining the left-over food and divided by the number of each bird in each group per day than totalized to per week. Feed intake was calculated using the formula below:

Feed Intake = Introduced parts of foods – Residual parts of food

2.4.2 Weight gain

The weight of each bird was taken every ~~two weeks~~ fortnightly to determine the average weight gain per chick for the different treatment groups. The weight gain was calculated as the difference between two successive weekly body weights as given in the formulae: ~~below:~~

Weight gain = Final weight – Initial weight

2.4.3 Feed conversion ratio (FCR)

The birds and feed were weighed weekly to determining the average FCR per group~~s~~. FCR was calculated by dividing the amount of feed consumed in gram ~~with~~ by the body weight gained in gram i.e.

$$FCR = \frac{Average\ feed\ intake(g)\ of\ birds/week}{Average\ bodys\ weight\ gain\ (g)\ of\ birds/week}$$

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Comment [PE25]: Was feeding done daily or weekly?

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2.4.4 Mortality rate (MR)

The MR (%) was calculated using the formulae:

$$MR = \frac{number\ of\ death}{number\ of\ fatal\ chicks}\ x\frac{100}{1}$$

2.4.5 Evaluation of carcass quality

At the end of the experiment, two chicks from each replicate within each treatment were randomly selected and ~~from each grouping. The birds were~~ weighed to obtained live body weight after being fasted for about 12 hours. They were sacrificed without stunning, washed and allow to dry under wooden tables. Evisceration was performed by a ventral cut and visceral as well as thoracic organs were removed. The heart, river, kidney, abdominal fat, head, shanks, lungs, reproductive organs were weighed and calculated as percentage of live body weight using the formulae:

$$Dressing\ percentage = \frac{dressing\ carcas\ weight}{live\ body\ weight}x\frac{100}{1}$$

2.5 Data collection and statistical analysis

All data collected were subjected to analysis using the Statistical Package~~s~~ ~~of the~~ for Social Science~~s~~ (SPSS) ~~software version 20.0~~. Analysis of variance (ANOVA) for a completely randomized ~~ly~~ design ~~according to Stell and Torrie~~ [22] was used to test for significant differences among the treatment groups. Duncan's Multiple Range Test (DMRT) was used to separate ~~significant differences between~~ means as reported by Little and Hills [23]. Statistical significant was set at $P \leq 0.05$.

3. Results

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Comment [PE31]: This is not the formula for percentage mortality' please, revisit your denominator in the equation.

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Comment [PE33]: Were the birds plucked or unplucked before evisceration. Please, specify.

Comment [PE34]: Separate or individual organ weights are not referred to as dressing percentage. However, weight of individual organs weights can be expressed as a percentage of either the live carcass weight or dressed weight. Please, revisit.

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3.1 Body weight of broilers chicks fed with different levels of *Moringa oleifera* leaf mean

The results presented ~~on~~ in Table 1 shows ~~ed~~ the body weight of broiler chicks fed ~~on~~ different levels of *Moringa oleifera* leaf meal. The result shows ~~ed~~ significant difference at all levels of the *Moringa oleifera* leaf meal when compared to the control in group. ~~one designated as A~~. The diet supplemented with 5% ~~of~~ MOLM showed significantly high body weight and followed by 10% of MOLM.

3.2 Performance of broiler chick fed with different levels of *Moringa oleifera* leaf meal

The performance of broiler chicks fed on different levels of *Moringa oleifera* leaf meal **(**MOLM) is shown ~~on~~ in Table 2, indicating that there was a significant difference~~s~~ in all measured parameter with regard to the control group. There was no mortality in any of the groups.

3.3 Body weight of organ proportions of broiler carcass fed with different levels of *Moringa oleifera* leaf meal

Table 3 shows body weight of organ proportions of broiler chicks feed on different level of MOLM. The levels of MOLM were not significantly different in terms of liver weight, heart weight, kidney weight and abdominal fat.

Table 1: Body weight of broiler chicks fed on different levels of *Moringa oleifera* leaf meal (MOLM)

Age (weeks)	A	B	C	D
0	40.20±10.61[a]	40.65±28.81[a]	40.05±16.30[a]	40.68±28.67[a]
2	102.46±28.30[a]	163.38±62.30[b]	158.37±19.81[c]	154.52±87.10[c]
4	319.28±67.90[a]	380.42±16.34[b]	379.24±29.16[c]	380.44±13.81[c]

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Comment [PE38]: Table 1 categorized the birds into different ages. Analysis was done based on the age(s) of the birds. Please, discuss with recourse to the age(s) of the birds.

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Comment [PE40]: Why then include the calculation of mortality in this write up (see lines 133-138). Please, revisit.

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Comment [PE42]: Please, note that body weight is different from organ weights. There is no body weight of organ(s). Revisit this sub-title.

Comment [PE43]: Carcass cannot be fed. Please, revisit.

Comment [PE44]: Refer to comment PE28

Comment [PE45]: Discuss with reference to the organs weights and not the MOLM as you are investigating the effect of different levels of MOLM on live or organ weights.

Comment [PE46]: Please, define A, B, C and D as footnote to this Table.

6	608.89±21.30[a]	690.53±32.40[b]	654.11±34.41[c]	438.21±16.71[d]
8	816.25±33.16[a]	873.31±12.19[b]	848.16±24.90[c]	690.13±44.85[d]
10	939.18±10.51[a]	992.61±34.16[b]	974.30±16.81[c]	834.13±48.86[d]
12	236.14±37.70[a]	1716.79+22.10[b]	1692.21±26.70[c]	9.72.40±36.94[d]

a-b Values in the same raw with different superscripts are significantly different (P<0.05).

Table 2: Performance of broiler chicks feed ~~on~~ different levels of *Moringa oleifera* leaf meal (MOLM)

Parameter	A	B	C	D
Initial body weight (g)	40.20±10.6	40.65±28.81	40.5±96.30	40.68±28.67
Final live weight	40.20±37.70[a]	1716.79±22.10[b]	1692.21±26.70[c]	792.40±36.54[d]
Body weight gain (g)	1195.94[a]	1676.14[b]	1651.95[b]	931.72[c]
Total feed intake (g)	2642.81[a]	2864.31[b]	2721.91[c]	2486.31[d]
Feed conversion ratio (g)	2.21[a]	1.71[b]	1.65[b]	1.16[c]

a-b Values in the same raw with different superscripts are significantly different (P<0.05).

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Table 3: Body weight of organ proportions of broiler carcass fed on different levels of *Moringa oleifera* leaf meal (MOLM)

Parameter	A	B	C	D
Liver weight (g)	3.20±16.81[a]	3.21±81.20[a]	3.20±16.31[a]	3.21±16.71[a]
Heart weight (g)	1.04±19.70[a]	0.03±28.30[a]	1.03±81.71[a]	1.04±28.41[a]
Kidney weight (g)	4.22±10.80[a]	4.21±2060[a]	4.21±18.10[a]	4.21±69.2[a]
Abdominal fat weight (g)	2.13±19.31[a]	2.14±71.13[a]	2.17±17.173[a]	2.19±69.10[a]
Dressing percentage (%)	68.51±1.71[a]	68.74±1.90[a]	69.32±1.81[a]	67.84±1.57[a]

a-b Values in the same raw with different superscripts are significantly different (P<0.05).

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4. Discussion

Moringa oleifera have proved to be a valuable plant that is useful in mitigation of food insecurity and poverty reduction in poor rural settlements [17-20]. Therefore, incorporation ~~parts of this plant (~~ the leaf~~)~~ in poultry feed formulation is necessary for cost reduction and enhancing the performance and quality of chicken carcasses; but in varying percentage as documented by researchers [9-12]. The results of the ~~is~~ present study showed significant body weight increment of broiler chicks fed ~~on~~ different levels of *Moringa oleifera* leaf meal (MOLM) at 5% and 10%~~.~~. ~~but~~ However,there was no significant improvement at 15% of MOLM. The~~se~~ significant improvements in body weight ~~are~~ is an indication for higher growth rate and could be attributed

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to the higher protein content of the MOLM. This findings agrees with the results of other documented studies [1, 12]. The significant reduction in body weight noticed ~~with~~ at 15% MOLM inclusion ~~this study~~ could be ~~as a~~ the result of excess protein which may not be metabolized by the broiler chicks. This is not in ~~tandem~~ agreement with the ~~results~~ report~~ed by~~ of Tijani *et al*. [9], where high body weight were observed in birds fed at 15% of MOLM.

In ~~our~~ present study, there were reduction in weight gain, feed efficiency and body weight as a result of the addition of higher level of MOLM (15%) to the broiler~~s~~ diet. This may be due to the presence of phytate which is an anti-nutritional factor found in ~~m~~ *Moringa* seed and can be probably found in the leaf of ~~m~~ *Moringa*. Phytate was reported to reduce bioavailability of minerals in non-ruminant animals [24], and decline digestibility of starch and protein [25]. Furthermore, it was observed that *Moringa oleifera* and *Moringa stenopetala* methanol and n-hexane seed extracts produced inhibitory effect on *Salmonella typhi*, *E. coli* and *Vibrio cholerae* which normally cause water borne diseases [26]. *Moringa oleifera* proved to be good source of fat, protein, antioxidants and minerals (Mg and Zn), hence malnutrition due to micronutrient~~s~~ deficiencies ~~y~~ in children could be overcome~~d~~ [27]. However, ~~an~~ the increase ~~ment~~ in abdominal fat weight with increased supplementation level of MOLM to broiler chicks' diet might be due to the higher level of fat content in *Moringa* leaves and seeds as observed by Compaoré *et al*. [27]. The absence of death cases among the broilers might be due to antimicrobial and availability of vitamins, proteins and minerals in *Moringa* plant, besides the good house management during the experiment. This is in ~~tandem~~ agreement with the findings of Abbas [18] that reported no case of death in the broilers used for the study. The inclusion of MOLM did not significantly affect abdominal fat, heart, liver and kidney weight of the broilers. ~~Although the reason behind~~

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~~this result is still not clear but~~ ~~i~~ It is suspected that the internal organs were able to effectively regulate their nutrient requirement through the metabolic function of the liver. This result is similar to the findings of Zanu *et al*, [28] that reported no significant differences in carcass parameters of birds fed diets containing MOLM supplement and Nuhu [29] who reported that there were no significant differences among treatments for carcass characteristics ~~for~~ in weaner rabbits fed *Moringa oleifera* leaf meal. There was no significant ($P<0.005$) difference in carcass dressing percentage in all the dietary treatments. However, the highest carcass dressing percentage was recorded in birds fed MOLM diet at 10% and followed 5%.

Comment [PE53]: The preceding statement "There was no significant difference in carcass dressing percentage…" invalidates this statement from a statistical standpoint. Expunge statement.

5. CONCLUSION

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This present study provide credible information on the performance of broiler chicks fed ~~at~~ different levels of MOLM. The results showed a net body weight gain, feed intake and feed conversion ratio of birds at 5% and 10% of MOLM, while there was a reduced performance of birds feed with 15% MOLM.

Comment [PE55]: Ambiguous. Please, revisit.

Recommendation(s)

Comment [PE56]: What recommendation(s) can you make from this investigation. Please, include your recommendation(s)

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