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On-Farm Evaluation of *Moringa oleifera* Leaf Meal (MOLM) in the Diet of Pulletsin Sierra Leone

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Abstract: ***This study was carried out to investigate on-farm the effect of partial replacement of conventional imported broiler concentrate with Moringa oleifera Leaf Meal (MOLM) at 0%, 10%, 15%, 20% and 25% inclusion levels from September 2015 to March 2016. The experiment, which lasted for 12 weeks, was carried out using 150 pullets, randomly assigned to five dietary treatments with 30 birds per treatment and 3 replications of 10 birds per replicate. The birds were raised on ad libitum feeding and data collected on daily feed intake and weekly weight gain. Data analysis was carried out using SAS 2016 statistical software and results presented in tables and graphs. The result showed that the experimental groups (with inclusion levels of Moringa oleifera) were either at par or higher in weight than the control groups (P<0.05). Experimental groups with diets containing 10%, 20% and 25% Moringa oleifera leaf meal significantly (P<0.05) produced higher weight gain and flock uniformity than the control and the group with 15% Moringa based diet. The control and 15% Moringa based diets were not significantly different (P>0.05). The experiment having started with average weights of 267.8g, 269.5g, 284.8g, 285.3g, and 289.7g for MOLM 0%, MOLM10%, !5%, 20%, and 25% respectively and final weight gains of: 1575.5g, 1576.8g, 1572.8g, 1595.0g, and 1576.8g for the respective Moringa levels per diet treatment suggests Moringa oleiferacan serve as protein supplement for poultry diets in commercial poultry production. Inclusion levels of Moringa oleifera meal at 10%, 20%, and 25% in the diet were more superior to that without Moringa oleiferaleaf meal, but 20% inclusion level was most excellent***

Keywords: Concentrate, Maize, *Moringa oleifera*, pullets,

1. Introduction

The use of imported concentrate in poultry diets is a big challenge to poultry farmers and development workers in Sierra Leone. Poultry production is attractive, but the constraints of acquiring protein concentrate have restricted farmers raising birds at backyard level. Thus, the majority of farmers rear either native duck and/or chicken by free range where indigenous birds are maintained by daily scavenging for food and water.

There are however few poultry farmers who engage in the commercial production of table eggs and chicken meat. These farmers used expensive imported concentrate and sometimes locally produced fish meal as protein sources. But protein supplementation with conventional concentrates is seriously confronted with high costs, making even commercial poultry keepers frequently over-burdened with importation costs and taxes on imported concentrates. Ideally, protein sources are most required, but as of now, they are found to be more expensive and hence unaffordable to the small holder farmer. New low-cost alternatives to commercial protein concentrates are needed, and *Moringa oleifera* has been shown (from its ability to adapt to diverse growing conditions and nutritional attributes) to be one possible option. The high and increasing prices for animal feeds have compelled researchers in developing countries to therefore direct their attention to non-conventional feeds, with particular emphasis on protein substitutes (Gaia, 2005)[1]

*Moringa oleifera*is the most recent exotic tree species in Sierra Leone. The plant is adapted to all agro-ecologies in Sierra Leone as it is found in every rural human settlement. *The* tree contains high crude protein (CP) in the leaves (251 g/kg DM i.e. 25.1% CP) and negligible content of tannins and other anti-nutritive compounds and offers an alternative source of protein to ruminants and non-ruminants (Nouala *et al.*, 2006)[2]. Morphological part of *M. oleifera*such as the leaves, according to its high CP content (267.9 g/kg DM i.e. 26.8% CP) and crude fibre content of 210.0 g/kg DM (i.e. 21% CP) are considered safe nutrient levels for feeding growing pullets and layers (Mabruk *et al.*, 2010)[3].

The multiple uses of *M. oleifera*providea lot of potential for utilization of the feed in livestock diets. Despite the high CP content of MOLM, there are some reports in the literature on feeding trials with livestock that reflects the potential of the plant. Sarwatt *et al.* (2002)[4] stated that both large and small-scale farmers in Tanzania grew *M. oleifera* for extraction of seed oil, and this work demonstrated potential to use the foliage for feeding livestock and the cake as a protein source. In combination with concentrate, *M. oleifera* leaves further improved the efficiency of concentrate utilization. Ogbe and John (2012)[5] harvested the leaves of *M. oleifera*from Lafia in Nasarawa State of Nigeria during the rainy season in June 2011 and determined their proximate, mineral, and phytochemical analysis. The proximate analysis revealed the presence of high CP (17.01% ±0.1) and carbohydrate (63.11% ±0.09), CF (7.09% ±0.11), ash (7.93% ± 0.12), ether extract (EE) (2.11% ±0.11) and fatty acid (1.69% ±0.09). The presence of these essential nutrients and minerals implies that *M. oleifera*leaves could be utilized as a source of feed supplement to improve growth performance and health status of poultry. Therefore, the high protein content of Moringa leaves must be balanced with other energy feeds. Furthermore, the leaves are highly nutritious and contain significant quantities of vitamins (A, B and C), calcium, iron, phosphorus and protein (Murro *et al.*, 2003)[6].

Chollom *et al.* (2012)[7] investigated the effect of aqueous seed extract of *M. oleifera*against Newcastle disease virus

(NDV) using an *in ovo*assay and found that an increase in extract concentration was directly proportional to virus death and inversely proportional to the production of antibody against NDV. These findings have clearly demonstrated that *M. oleifera*seed extract has nutritional value, as well as, strong antiviral activity against NDV *in ovo*. Moringa is not only concentrated in nutrients but in the raw form, it seems to reduce the activity of pathogenic bacteria and moulds and improves the digestibility of other foods, thus helping chickens to express their natural genetic potential (Gaia, 2005)[1]

It was concluded that inclusion of MOLM as aprotein supplement in broiler diets at 25% promoted more growth than commercial diets. Kakengi *et al*. (2007)[8] in Tanzania investigated the effect of MOLM as a substitute for sunflower seed meal on performance of laying hens and found that MOLM could be used as a source of plant protein at 10% inclusion level in the diet. The authors mentioned that in areas where MOLM can be obtained for free, and quality of eggs fetch a higher premium price, the inclusion of MOLM at 20% is highly recommended. The study concluded that MOLM could be used as a source of plant protein since it was highly accepted by the birds even at high dietary inclusion levels. It was further concluded that broilers could be safely fed cassava-based diets containing MOLM at a maximum level of 5% without deleterious effects. In a related study, Olugbemi *et al*. (2010b)[9] found that MOLM could be safely included in cassava-based layer diets up to 10% without negatively affecting productivity. These results suggest that the inclusion level of MOLM is lower for broilers compared to layers. In another study, Olugbemi *et al*. (2010c)[10] investigated the potential of MOLM as a hypocholesterolemic agent using layers fed cassava-based diets and reported that *M. oleifera* possesses hypocholesterolemic properties and that it can be included in layers diets to facilitate reductions in egg cholesterol content.

In conclusion, dietary levels of 5% to 20% MOLM in broiler diets and 10% in layer diets have been found to improve bird performance in terms of growth rate and egg production (including egg size). However, if MOLM can be obtained for free and the price of eggs is high, the inclusion level of MOLM can also be increased up to 20% in layer diets. The results from previous researches indicate that MOLM could partially replace soybean meal and sunflower seed cake as a protein source in diets for chickens.

The objective of this investigation was to determine the optimal inclusion level of *Moringa oleifera* leaf meal that can replace imported concentrate to achieve higher growth rate and uniformity of growing pullets essential for higher peak egg production, maximum productivity, and profitability in egg production.

2. Materials and Methods

Source of other feed ingredients and *Moringa oleifera* and processing

The *Moringa oleifera* leaves were provided by the Catholic Agency for Overseas Development (CAFOD), which they bought from local farmers. The leaves were dried under shade at room temperature so they can be crispy for easy milling. Thereafter they were ground into a meal using a hammer mill with a mesh size of 3mm. The imported broiler concentrate and yellow maize were bought from Pa JAH enterprises, Freetown Sierra Leone. The samples of the various ingredients including *Moringa* leaf meal were subjected to proximate analysis before being used in the experimental diet formulation. The composition of the imported broiler concentrate was given in the manufacturers' guide.

Proximate analysis of ingredients for various diets

According to AOAC (2005, 2011)[11] proximate analysis of *Moringa oleifera*(% crude protein,% crude fat, %crude fiber, %moisture), and corn (western yellow) was done at the Animal nutrition laboratory, Department of Animal Science, Njala University, Sierra Leone West Africa and the data was used in ration formulation of various diets. No analysis was done for the imported concentrate as data on the composition was sufficiently provided by the manufacturer, which was assumed to be standardized. Some proximate composition values were compared with those obtained from literature to confirm the nutritive value of actual rations fed.

Based on the proximate and referenced nutrient composition of ingredients used and nutrient requirements of experimental units (growing pullets) in tables 1 and 2 below, nutritive values were calculated, and the five diets including the control were mixed according to the proportions (percentages) of various ingredients for feeding throughout the experimental period. The nutrients' requirements of the birds, when compared with the calculated nutritive values of the diets, would be met with the rations formulated based on the ingredients available.

Experimental Design and animal experimentation

One hundred and fifty (150), three weeks old brooded chicks bought by CAFOD from a poultry farmer in Freetown were taken to the experimental site at Jenneh, Kenema district for trial. The birds were raised in a well-ventilated building that was divided into three rows of five pens each. An opaque cardboard 30cm from the floor was placed between any two pens to reduce or prevent contact between birds in different pens. A passage 1.0m wide separated any two rows of pens to allow free human movement. The pens were equipped with modern feeders, and drinkers, and rice husk placed on the floor as litter material which serves as an absorbent for urine and droppings.

The birds were fed conventional ration (diet 1-chick mash), which contained maize (58%) and imported broiler concentrate (42%) mixed together during acclimatization period at the experimental site. Required chemoprophylaxis and immunoprophyl axis were administered against Marek's disease, Infectious bursal disease, and Newcastle disease during the experimental period. The experimental diets were made up of i. control diet (no *Moringa oleifera*leaf meal (MOLM)), ii. 10% MOLM, iii. 15% MOLM, iv. 20% MOLM, and v. 25% MOLM. In a randomized complete block design, five treatments (diets) were randomly allotted (one block after another) to fifteen pens prepared for fifteen replications (three replications per treatment). These were appropriately labeled, and the process fully involved farmers. The birds were placed based upon their weight, and these were distributed to various pens from block 1 to 3 of five pens each. Ten birds were put in each pen, and at the start of the experiment the birds were fed conventional ration containing imported concentrate and maize; thereafter the experimental diets were introduced after 6 weeks. The diets were mixed accordingly. Every morning before putting fresh feed, both fresh feeds and leftovers of each diet were weighed separately. The experiment lasted for 12 weeks

Data collection, analysis and presentation of results

Data collection forms were prepared for data collection on daily feed intake, weekly weight gain, daily and diurnal temperature, of the building. Daily feed consumption per diet replicated thrice was recorded from daily feed placed into the feeders and the daily leftovers. The birds were however weighed individually on a weekly basis. From the feed consumed and weight data the feed conversion ratios (FCRs) and feed efficiencies (FEs) of each diet were determined and compared on a weekly basis and per overall diet. Excel software program and SAS statistical package, were used for data analysis

3. Results

Feed Conversion Ratio (FCR) and Feed Efficiency (FE)on various diet treatments (Fig. 1 and 2)

The feed conversion ratio i.e. the number of kilogrammes of feed required to produce a kilogramme of weight gain was very low for all the treatments for the first week (D1T0 (0.22), D2T10 0.22), D3T15 (0.21), D4T20 (0.21), D5T25 (0.21). However, D3T15, D4T20, and D5T25 were still lower in the first week of introducing the Moringa diets. The trend continued and in the 14thweek, D2T10 produced better and lower(FCR= 0.09) than the concentrate containing diet (D1T0: FCR = 0.10). In the 19th week when the experiment was terminated for growers, all the diets showed the same FCR which were much lower as compared to the previous weeks (week 8-week18). Feed efficiency (weight gained over feed consumed) similarly improved as the birds got adapted to the rations and acclimatized to the environment. With a lower FE in the first week of the experiment (D1T0 (4.46), D2T10 (4.49), D3T15 (4.75), D4T20 (4.76), D5T25 (4.83) when the birds were 8 weeks old, the improvement trend in FE continued and in the 19th week, only D3T15 (FE=17.48) saw a lower FE than the concentrate diet (17.51). The FE in the other *Moringa* based diets (D2T10 (17.52), D4T20 (17.72), D5T25 (17.72) were still higher than that of the concentrate diet.

Figure 3 gives the distribution of weight of various diets according to the general linear procedure. There is ahigh level of significant difference between the diets containing no *Moringa* and those containing *Moringa* ($p<0.05$).The diets containing 10%, 20%, and 25% were significantly different in terms of weight gain from diets containing 0% and 15% Moringa. However, there was no significant difference between diets containing 0% and 15% Moringa ($p>0.05$). It is quite evident that all the diets produced a significant amount of weight gain. But diets containing 10%, 20% and 25% Moringa were superior in their effects compared to the one containing imported concentrate alone ($P<0.05$)

Table 3 shows that diet 4 having 20% Moringa leaf meal produced the highest gain (1595.0 g) and hence the maximum uniformity in the birds placed on that ration (having sd. = 12.1) against 1575.5g attained weight and 45.5 Sd. for birds on diet 1 (diet having no *Moringa oleifera* leaf meal). Only D3T15 containing 15% Moringa and an achieved weight of 1572.8g competed with conventional diet(1575.5g) at 19 weeks. The result shows that there is a high significant difference between the concentrate based (D1T0) and the *Moringa* based diets (10%, 15%, 20% and 25%) ($P<0.05$)

Table 4 shows Student-Newman-Keuls (SNK) Test for weight that controls type 1 experimentation error rate under the complete null hypothesis, as a post-ANOVA multiple comparison test. It compared the mean weight gains of birds for various weeks from week 8 (start of the experiment) to week 19 (end of experiment). The SNK test shows where the significant differences indicated by ANOVA lies. The test showed that significant differences prevail in terms of weight gain for all the weeks ($P<0.05$) except for weeks 9 and 10 when weekly weight changes were not significantly different ($P>0.05$).

Table 5 shows the Student-Newman-Keuls (SNK) ranking of the means of various diets (D1T0, D2T10, D3T15, D4T20 and D5T25) over the experimental period of 12 weeks (week 8 –week 19). According to the SNK ranking, there was no significant difference ($P>0.05$) in average weight gain for birds in group A diets (D2T10, D4T20, and D5T25); group B diets (D2T10, D3T15, and D4T20; and group C diets (D1T0, D2T10, and D3T15). It was however noted that significant difference prevailed ($P<0.05$) among the three groups (A, B, and C). The diet containing 25% Moringa leaf meal (D5T25) produced the highest average weight gain (888.04 g) followed by diet D4T20 with 20% Moringa (876.67 g). In fact, the control diet (D1T0) gave the least average overall gain of 825.15 g. The control trailed behind all the Moringa containing diets with a significant difference ($P<0.05$) between the former and 20 and 25% Moringa diets.

4. Discussion

Moringa oleifera as a protein-rich plant has attracted much attention over the years throughout the world with strong recommendations for feeding to non-ruminants and ruminants alike.

The study found that Moringa based diets produced higher average weight gain with least standard deviation than imported concentrate based diet in layer growers maintained from 8weeks to 19 weeks (Table 3). This is in accordance with the findings of Banjo (2012)[12] who investigated the effects of inclusion of four levels (*i.e.*, 0%, 1%, 2% and 3%) of MOLM on growth performance of Anak 2000 strains of broilers and found that inclusion of 2% significantly enhanced weight gain. Meleaseet al.(2011)[13]reported that use of *Moringastenopetala* leaf meal in the diet of Rhode Island Red chicks produced a significant increase in feed and crude protein intake, average weight gain, feed efficiency ratios, and protein efficiency ratios when compared to a control diet (P<0.05). The authors related these findings to the presence of readily available protein in Moringaleafmeal, which is convenient for monogastric animals, and also to the higher levels of methionine and other essential amino acids when compared to the soybeanmeal of a control diet. The authors concluded that inclusion of *Moringastenopetala* leaf meal in amounts of upto 6% in the diet of growing chicks to replace expensive conventional protein sources has no negative effects on the chicks. Many authors have reported the use of Moringa in poultry diets with evidence of better performance in terms of growth and egg production.

Olugbemietal.(2010b)[9] reported on the effect of Moringa leaf meal on the performance of broilers and found that an addition of 5% *Moringa oleifera* leaf meal to cassava-based broilers' diet (20% and 30%) had no significant (P>0.05) effect on weight gain, feed conversion ratio, final body weight and feed cost per kilogram of weight gain when compared to a diet free of cassava and free of *Moringaoleifera* leaf meal, a diet containing 20% cassava and 0% *Moringaoleifera* leaf meal, and a diet containing 30% cassava and 0%*Moringa oleifera* leaf meal . This is in contravention to our findings in which the positive attributes such as increased in weight gain, high feed intake, and feed conversion ratio could be as a result of the active chemo and immuno-prophylaxes that were administered during the experimental period which probably promoted the health of the birds and hence respond to high feed intake. .

Moringa oleifera, otherwise regarded as a "miracle tree" has been used in the treatment of numerous diseases (Pal et al., 1995; Makomen et al., 1997; Gbasi et al., 2000)[14-16] including heart disease and obesity due to its hypocholesterolemic property. It is probable that the non-incidence of diseases in the flock was due to those properties. The leaves of *Moringa* are good sources of protein, vitamins A, B and C and minerals such as calcium and iron. The leaves of *Moringa* has high protein content which is between 20 – 33% on a dry weight basis; the protein is of high quality having significant qualities of all the essential amino acids as reported by Foidl and Paull (2008)[17]. Murro et al. (2003)[6] also indicated that the leaves contain high levels of vitamins A, B, C and calcium. These data on mineral profile, vitamin, and essential amino acid profiles goes to support enhanced growth uniformity manifested as the birds approached egg laying phase at 19 weeks.

Kakengi et al. (2003)[18] reported that Moringa oleifera leaf meal was substituted for sunflower seed meal as a protein source for layers. The effects of substitution on feed intake, dry matter intake, weight gain, laying percentage and feed conversion ratio were investigated, and they suggested that Moringa leaves could completely replace SSM up to 20% without detrimental effect on layers. However the crude fibre content if high can impair nutrient digestion and absorption (Aderemi, 2003; Omu 2011)[19-20]. All these reports provide information regarding the potential of Moringa over the traditional concentrate in effecting higher weight gain when included in the diet of chickens. It should carry no reservation, therefore, to see higher average weight gain in birds fed on Moringa based diets than in those maintained on imported concentrate based diet alone.

The study showed that all the levels of *Moringa* included (10%, 20%, 25%) produced higher weight gains in layer growers (Table 3) than the control group which is devoid of Moringa and the difference was found to be significant (P<0.05%).Our study further revealed that the feed efficiency of various diet treatment increases linearly from week 8 to week 19, while the weekly feed conversion ratio of birdson different diet decreases from week 8 to week 19 (Figures 1 and 2). This implies that the lower the FCR, the higher the feed is converted into products (meat and eggs) and equally the higher the feedefficiency, the better the feed utilization. The weekly weight changes were significantly different except for weeks 9 and 10 in which weekly weight changes were not significantly different (Table 4). The diet containing 25% *Moringa* leaf meal produced the highest average weight gain (888.04g), followed by diet with 20% *Moringa* (876.67g). The control diet gave the least average overall weight gain of 825.15g. Statistically, weight gain due to the addition of 10%, 20% and 25% *Moringa* was significantly higher than the control group given diet having only imported concentrate devoid of *Moringa* and that containing 15% *Moringa* (Figure3). Many works have also reported concerning the % inclusion of *Moringa* in poultry diets on weight response, and several reports have indicated the positive response of birds to *Moringa* at different levels of inclusion. Banjo (2012)[12]indicated that addition of *Moringa* significantly (P < 0.05) enhanced weight gain of birds at 2% level of inclusion.

Ayssiwede et al. (2011)[21] in his study on effects of *Moringa oleifera* (Lam) leaf meal incorporation in diets on growth performance, carcass characteristics and economic results of growing indigenous chickens found some interesting results that agree closely with results of this research. The *Moringa oleifera* leaves inclusion in the diets up to 24% did not cause any adverse effect on live body weight, average daily weight gain, feed conversion ratio, and mortality. Except for the significant decrease in daily feed intake obtained in birds of 16% and 24% treatments. Significantly better growth performances, feed costs, and economic margins were recorded in birds fed 8% and 16% *Moringa oleifera* based diets. Thus, these two dietary treatments were the most economically profitable (respectively 357 and 206 FCFA/kg carcass of additional profit) compared to the control.

5. Conclusions

The study arrived at the following conclusions:

1) *Moringa oleifera* leaf meal in combination with some % of imported concentrate has great potential to influence the growth of layer growers uniformly
2) *Moringa oleifera* leaf meal can be included in the diet of layer growers as high as 25%
3) Inclusion levels of *Moringa oleifera* meal at 10%, 20%, and 25% in the diet were more superior to that without *Moringa oleifera* leaf meal, but 20% inclusion level was most excellent.

6. Recommendations

1) Studies on optimal level of inclusion of *Moringa* in the diet of layer growers should be conducted to actually ascertain the amount required for growing layer pullets
2) Studies to include higher levels of *Moringa* should be exclusively undertaken
3) Studies of this nature should be done not only off-farm but on-farm as well

7. Acknowledgement

We highly appreciated the support given by the European Union through CAFOD in the conduct of this research at Jenneh Village with smallholder farmers in Sierra Leone. CAFOD deserves our thanks for accepting the nutrition unit of the Animal Science Department to carry out this research. We look forward to continued work on *Moringa oleifera* leaf meal in poultry diet through EU support.

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Figures

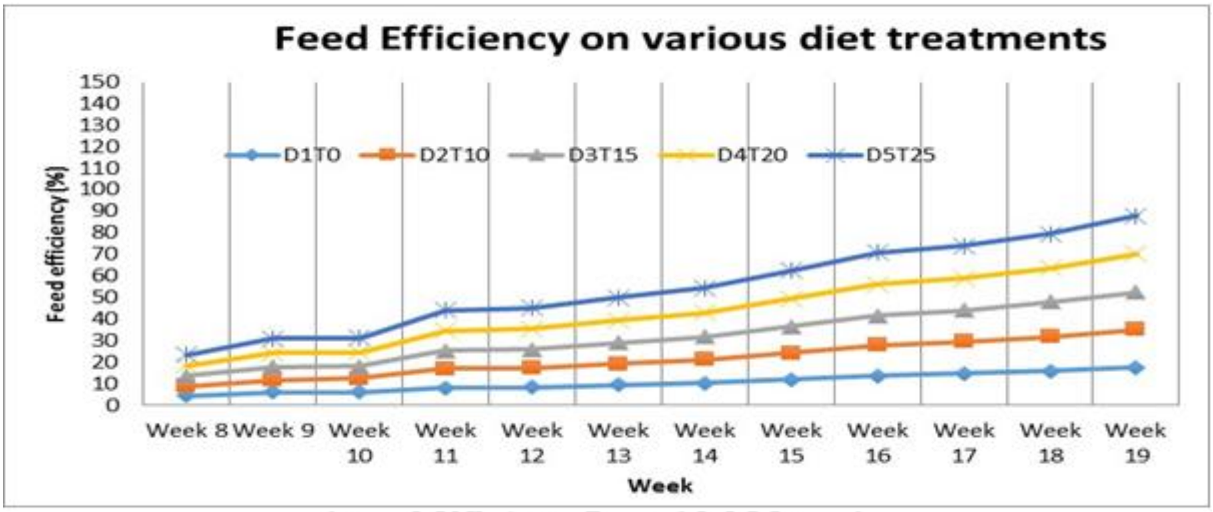

Figure 1: Feed Efficiency

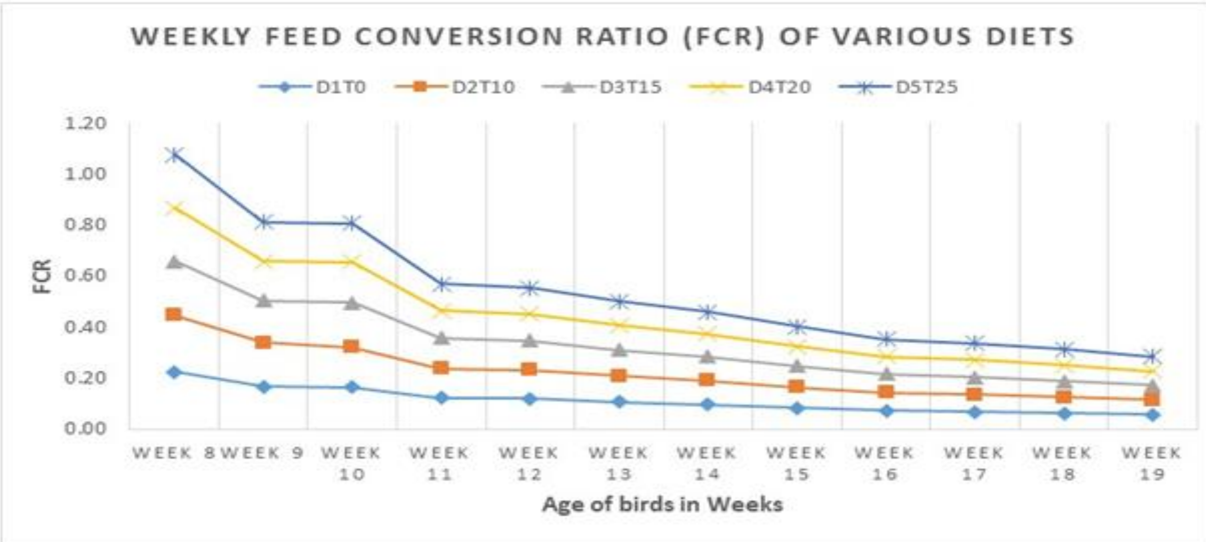

Figure 2: Feed Conversion Ratio

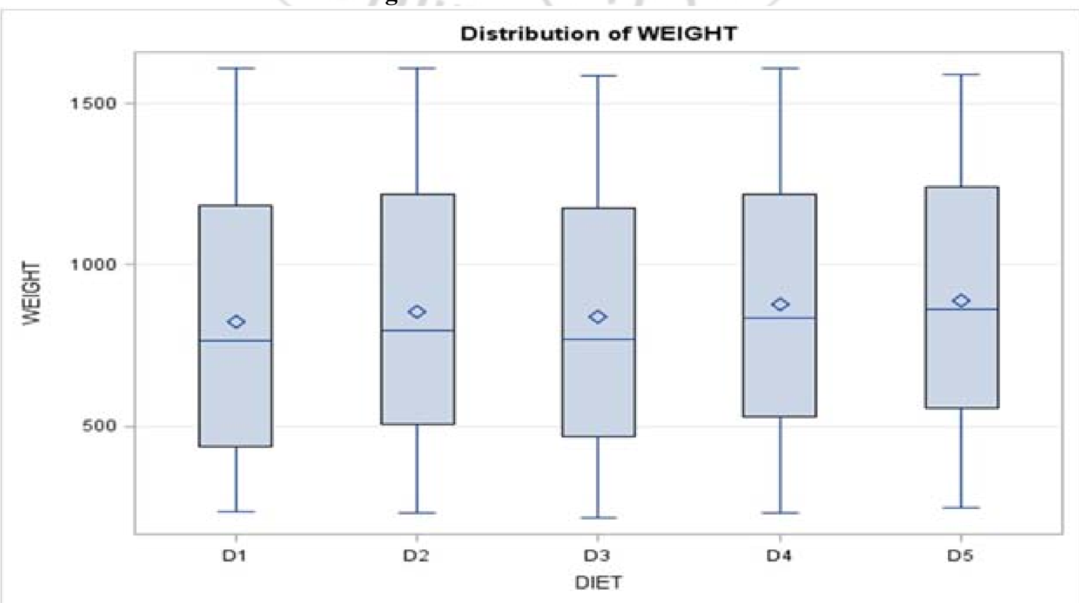

Figure 3: Distribution weight of birds over the experimental period

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Tables

Table 1: Nutrient composition of ingredients used in ration formulation and nutrient requirements of chicks (1-8 weeks) and growers 9 weeks - 20/23 weeks

Ingredient	Metabolizable energy (ME – Kcal/kg	Crude P %	Lysine %	Meth. %	Meth. + C %	Crude fat %	Crude fiber %	Ca %	P %	M %
Maize	3340	8.70	0.22	0.20	0.35	3.60	2.10	0.04	0.30	13
Concentrate	2230	43.0	2.95	1.40	2.00	4.40	5.00	1.00	1.05	12
MOLM	2271	25.0	1.41	4.97	3.39	5.20	19.1	2.06	0.24	-
Nutrients requirements of layer chicks and growers										
Feed	Kcal ME/kg	C.protein %	Lysine %	Meth %	Meth + C %	Crude fat %	Crude fiber %	Ca %	P %	Pa
Chick mash	2800	20.0	1.00	0.45	0.80	5.00	4.00	1.00	0.70	0.
Grower mash	2800	16.0	0.80	0.32	0.70	5.00	5.00	1.00	0.60	0.

Table 2: Calculated nutritive values (ME, crude protein, etc.) of five diets formulated based on available ingredients and their proximate composition from table 1

Inclusion level of ingredient (%) in each diet		ME (kcal/kg)	Crude protein %	Lysine %	Meth + C %	C. fat %	c. fiber %	Ca %	P %
Diet 1: Maize	58	1937.2	5.05	0.13	0.20	2.09	1.22	0.02	0.17
Concentrate	42	936.6	18.06	1.24	0.84	1.85	2.10	0.42	0.44
MOLM	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.00
T0%: TOTAL:	**100**	**2873.8**	**23.11**	**1.37**	**1.04**	**3.94**	**3.32**	**0.44**	**0.61**
Diet 2: Maize	58	1937.2	5.05	0.13	0.20	2.09	1.22	0.02	0.17
Concentrate	32	713.6	13.76	0.94	0.64	1.41	1.60	0.32	0.34
MOLM	10	227.1	2.51	0.14	0.03	0.52	1.91	0.21	0.02
T10%:TOTAL:	**100**	**2877.9**	**21.32**	**1.21**	**0.70**	**4.02**	**4.73**	**0.55**	**0.53**
Diet 3: Maize	58	1937.2	5.05	0.13	0.20	2.09	1.22	0.02	0.17
Concentrate	27	602.1	11.61	0.80	0.54	1.19	1.35	0.27	0.28
MOLM	15	340.65	3.77	0.21	0.05	0.78	2.87	0.31	0.04
T15%: TOT.:	**100**	**2879.95**	**20.42**	**1.14**	**0.79**	**4.06**	**5.44**	**0.60**	**0.49**
Diet 4: Maize	58	1937.2	5.05	0.13	0.20	2.09	1.22	0.02	0.17
Concentrate	22	490.6	9.46	0.65	0.44	0.97	1.10	0.22	0.23
MOLM	20	454.2	5.02	0.28	0.07	1.04	3.80	0.41	0.05
T20%: TOT.:	**100**	**2882.0**	**19.53**	**1.06**	**0.71**	**4.10**	**6.14**	**0.65**	**0.45**
Diet 5: Maize	58	1937.2	5.05	0.13	0.20	2.09	1.22	0.02	0.17
Concentrate	17	379.1	7.31	0.50	0.34	0.75	0.85	0.17	0.18
MOLM	25	567.8	6.28	0.35	0.09	1.30	4.78	0.52	0.06
T25%:TOT.:	**100**	**2884.05**	**18.63**	**0.98**	**0.63**	**4.14**	**6.85**	**0.71**	**0.41**

Table 3: Weekly weight changes (g) and Feed Intake per bird per diet treatment (Control and *Moringaoleifera*diets)

Par		D1T0	Sd.	D2T10	Sd.	D3T15	Sd.	D4T20	Sd.	D5T25	Sd.	feed Intake (g)
T1	Week 8	267.8	43.64	269.5	35.68	284.8	31.91	285.3	48.62	289.7	39.52	60
T2	Week 9	357.8	70.28	347.7	86.85	364.5	39.95	389.1	35.78	393.9	29.95	60
T3	Week 10	396.4	132.3	411	140.9	373.9	136.7	406.8	135.6	433.5	100.3	65
T4	Week 11	527.2	133	567.5	82.7	547.1	60.68	603.6	30.88	623.3	24.91	65
T5	Week 12	579.9	124	629	86.84	607.2	58.43	666	29.51	683.1	24.75	70
T6	Week 13	695.2	128.8	745	76.39	725.9	58.2	780.1	27.9	799.9	26.8	75
T7	Week 14	818.6	128.6	865.1	86.6	845.8	73.3	907.2	33.3	921	32.1	80
T8	Week 15	948.3	131.7	994.6	76.2	971.6	58.91	1030	32.8	1047	28.8	80
T9	Week 16	1076	130.9	1141	68.6	1106	55	1170	32.6	1183	27.5	80
T10	Week 17	1241	57.8	1272	43	1238	39.6	1260	17.8	1276	10.7	85
T11	Week 18	1419	26.7	1449	6.84	1435	5.2	1427	3.3	1430	10.3	90
T12	Week 19	1576	45.5	1577	38.6	1573	13	1595	12.1	1577	17.25	90

Table 4: Student –Newman – Keuls Test for weekly mean weight

Time	T12	T11	T10	T9	T8	T7	T6	T5	T4	T3	T2	T1
Age (Wk)	19	18	17	16	15	14	13	12	11	10	9	8
Means (wt. (g)	1579.4	1431.7	1257.4	1135.2	998.2	871.6	749.2	633.0	573.8	404.3	370.6	279.4
SNK ranking	A	B	C	D	E	F	G	H	I	J	J	K

Means with the same letter are not significantly different (P<0.05). Alpha 0.05, Error degree of freedom 120, Error MS 4880.206.

Table 5: Student –Newman – Keuls Mean weight of birds over 12 weeks fed Moringa based rations and the control

Diet	Mean	Sd.	SNK Ranking		
0% Moringa	825.16	427.49		C	
10% Moringa	855.70	428.24	A	C	B
15% Moringa	839.32	421.43		C	B
20% Moringa	876.67	417.27	A		B
25% Moringa	888.04	411.13	A		

Means with the same letter are not significantly different (P<0.05). Alpha 0.05, Error degree of freedom 120, Error MS 4880.206.