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**Original Research Article**

# The Effect of Graded Levels of Dietary Atama (*Heinsia crinita*) Leaf Meal on the Growth Performance and Cost Benefits of Starter Broiler Chickens

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**Abstract:** This experiment was carried out to evaluate the effect of graded levels of dietary Atama (*Heinsia crinita*) leaf meal (ALM) on the growth performance and cost benefit of Starter Broiler chickens. A total of ninety-six (96) unsexed day old of Ross 308 broiler chicks were randomly divided into four (4) treatments and each treatment was further divided into three (3) replicates of eight (8) birds, each in a Completely Randomized Design (CRD) experiment which lasted for 4 weeks (28 days). Feed was formulated with different levels of Atama Leafmeal inclusion for the four treatments, as follows; T1, T2, T3 and T4 which contained 0%, 6%, 7% and 8% of Atama leaf meal, respectively. The parameters measured were initial weight gain, final weight, weight gain, daily weight gain, total feed intake, average feed intake, feed conversion ratio, protein intake and protein efficiency respectively. Significant ($p<0.05$) differences were observed for final weight, weight gain, daily weight gain, total feed intake, average feed intake, feed conversion ratio, protein intake and protein efficiency except for initial weight gain. The final weight gain, and daily weight gain followed the same trend, T1 (0%ALM) was significantly ($p<0.05$) higher than T2 (6%ALM), T3 (7%ALM), and T4 (8%AM). For the total feed intake, average feed intake and protein intake, T1 (0%ALM) was significantly ($p<0.05$) higher than T2, T3, and T4 while T4 was significantly ($p<0.05$) lower and statistically ($p>0.05$) similar to T3 (7%ALM). For the feed conversion ratio (FCR), birds fed diet 1 (0%ALM) had the least FCR which was the best followed by T2 (6%ALM) and T3 (7%ALM) while T4 (8%ALM) had the poorest FCR of 5.35. In conclusion, 6% ALM could be included in starter broiler chickens' diet without any detrimental effect on the growth performance in cases where PKC is scarce.

**Keywords:** Broiler, Growth, Chickens, Effect, Starter.

## 1. INTRODUCTION

Broiler chickens are a specialized breed of chicken raised specifically for meat production, characterized by their fast growth rate, large size, and high feed efficiency (FAOSTAT, 2017). They are typically slaughtered at 5-7 weeks of age, weighing between 1.5-3 kg (3.3-6.6 lbs) (Fasuyi, 2006). The increasing cost of feed ingredients, such as corn and soybean meal, coupled with nutritional requirements for optimal broiler growth, creates a challenge for farmers to balance feed formulation and cost, impacting profit margins and making it difficult to maintain a sustainable broiler production business. Hence, the need to reduce feed cost and bridge the animal protein gap through the utilization of novel, high quality, cheap and readily available feedstuff in livestock production enterprise. One of such feed stuffs as alternative is Atama leaf meal (Fasuyi, 2006). *Heinsia crinita* a plant-based protein source derived from leaves, has gained attention as a potential alternative feedstuff for poultry. Its leaf meal is rich in protein, fiber, and micronutrients, making it a nutritious feed supplement. Recent studies have shown that the leafmeal can replace up to 50% of traditional protein sources in

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poultry diets without compromising growth performance or meat quality (Mensah *et al.*, 2008). Atama (*Heinsia crinita*) leaf meal a locally available and underutilized resource, has potential as a nutritious and cost-effective alternative feed ingredient. The inclusion of Atama leaf meal can reduce dependence on expensive conventional feed ingredients, Lower production costs, improve the nutritional profiles of poultry products, Support sustainable agriculture and environmental conservation. This study aimed to evaluate the efficacy of Atama leaf meal in the diets of broiler starter birds. Poultry production involves the breeding, rearing, and management of domesticated birds such as chickens, turkeys, ducks, and geese for meat, eggs, and feathers. Some key aspects of poultry production include: Breeding and Genetics which involve the selection for desirable traits like growth rate, egg production and disease resistance (Oluwafemi *et al.*, 2019). Another aspect is nutrition and feed which involves the formulation of balanced diets to meet nutritional requirements (Ali, 2010). Use of alternative feed ingredients like insects and leaf meal. Health and disease management is another important aspect of poultry production, it has to do with vaccination programs to control infectious diseases. Housing and Management is another aspect which involves the design of housing systems to promote welfare and reduce stress, management practices like lighting, temperature, and ventilation (Oluwafemi *et al.*, 2020). Sustainability and environmental impact is an aspect in poultry production that deal with the reduction of greenhouse gas emissions and environmental footprint, Use of renewable energy sources and waste management strategies. (Oluwafemi *et al.*, 2020).

## 2.0. MATERIALS AND METHODS

### 2.1. Experimental Site

The experiment was conducted at the poultry unit of the Department of Animal Science. University of Uyo, Annex campus, Uyo, Akwa Ibom State, Nigeria. Uyo lies between Latitude $5^{0}2$ and $16^{0}$ N and longitude $7^{0}55$ and $16^{0}$ E. Uyo is 100m above sea level in Nigeria. Its topography is gentle slope. Uyo has annual rainfall which ranges from 800mm-3200mm per annum and that begins in March and continues till October. It peaks in June and September. Dry season in Uyo is from November and lasts till February while annual temperature varies between $22^{0}$c - $30.13^{0}$c with abundant sunshine. The soil type of Uyo is sandy loam and pH range of 4.5 - 6.5 (Udosen, 2012).

### 2.2. Experimental Birds and Managements

Ninety-six (96) day old Ross 308 (Agri-tec) chicks were purchased from Unfailing Veterinary and pest control services in Uyo Metropolis, Akwa Ibom State. The experimental birds were randomly allocated to four treatment groups, each treatment was replicated three times with eight (8) birds per replicate, in a Completely Randomized Design (CRD). Before the commencement of the experiment, the experimental pens, watering and feeding troughs were thoroughly washed, cleaned, disinfected and sprayed against external parasites and disease-causing organisms. The pens were allowed to dry for three days to ensure proper drying. A day before the arrival of the chicks, wood shavings, acting as litter material were eventually spread throughout the brooding pens. The breeding house was heated using heating system (electric bulb and stove) and also the pens were properly covered using black polythene bag for a minimum of 24hours before the arrival of the chicks. The birds (day old chicks) were brooded in deep liter system. The heat source (electric bulb and stove) was monitored on a regular basis by checking the flames on the stove to ensure uniform temperature regulation throughout the brooding area. The chicks were fed *ad libitum* throughout the period of the experiment and clean water was always available all the time. The chicks were vaccinated against New castle disease on day one (the first day) by intraocular (io) and day seven (7) through drinking water. On the 14th day, the birds were vaccinated against infectious bursal Disease (Gumboro) through drinking water and was repeated on the 26th and day. The experiment lasted for 4 weeks (28 days). Multivitamins such as intro Vitamin A, was administered alongside kepcox/cocifor drugs were administered through drinking water to prevent coccidiosis and chronic respiratory disease. Asaraginese Spectrilla Powder (ASP) was administered through drinking water to help check Escherichia Coli (Ecoli) that was diagnose to be caused by anti-nutritional factor found in soyabean, Antibiotics such as Lasota were administered through drinking water alongside multivitamins after each antibiotic was given as prophylaxis measures. The birds were housed in 12 pens (8 birds per pen). The pens were all of the same size (about 1.3m apart). Adequate sanitary measures were taken during the experimental period. Litter materials were removed two times in a week and the drinkers were usually washed daily.

### 2.3. Experimental Diets

#### 2.3.1. Procurement and Processing of the Experimental Materials (Atama Leafmeal)

Atama (*Heinsia crinita*) leaf used for the study was collected in Abak, Akwa Ibom State, Nigeria. The freshly harvested leaves were removed from its stalk, sorted, washed and rinsed properly with clean water to remove dirt and unwanted materials that may be adhering on the leaves and after washing, the leaves were chopped with knife for easy drying of the leaves. The Atama leaves were then dried until they were crispy to touch, while retaining their greenish coloration and were then grounded to fine particles, stored in nags and kept in an air tight container at room temperature to be incorporated into the experimental diets.

**Table 1: Composition of Experimental starter diet (%)**

| Ingredients | T1 (0%) | T2 (6%) | T3 (7%) | T4 (8%) |
|---|---|---|---|---|
| Maize | 52.00 | 52.00 | 52.00 | 52.00 |
| SMB | 30.00 | 30.00 | 30.00 | 30.00 |
| P.K.C | 10.20 | 4.20 | 3.20 | 2.20 |
| Fish meal | 4.00 | 4.00 | 4.00 | 4.00 |
| ALM | - | 6.00 | 7.00 | 8.00 |
| Limestone | 1.50 | 1.50 | 1.50 | 1.50 |
| Bonemeal | 1.50 | 1.50 | 1.50 | 1.50 |
| Salt | 0.20 | 0.20 | 0.20 | 0.20 |
| Methionine | 0.20 | 0.20 | 0.20 | 0.20 |
| Lysine | 0.20 | 0.20 | 0.20 | 0.20 |
| Premix | 0.20 | 0.20 | 0.20 | 0.20 |
| **Total** | **100.00** | **100.00** | **100.00** | **100.00** |

**Table 2: Showing the Calculated Nutrient Content in percentages %**

| Ingredients | T1 (0%) | T2 (6%) | T3 (7%) | T4 (8%) |
|---|---|---|---|---|
| ME (kcal/kg) | 2964.60 | 2961.80 | 2961.32 | 2960.84 |
| Crude protein | 22.19 | 22.43 | 22.47 | 22.51 |
| Ether extract | 4.48 | 4.26 | 4.22 | 4.18 |
| Crude fiber | 5.12 | 4.45 | 4.34 | 4.22 |
| Ash | 3.51 | 3.47 | 3.46 | 3.36 |
| Methionine | 0.34 | 0.55 | 0.58 | 0.61 |
| Calcium | 0.63 | 0.66 | 0.70 | 0.73 |
| Phosphorus | 0.62 | 0.84 | 0.88 | 0.90 |
| Lysine | 1.04 | 1.23 | 1.26 | 1.28 |
| **Premix supplied per kg starter diet: Vitamin A 15,000 IU, Vitamin D3 13,000 IU, Thiamine 2mg, Riboflavin 6mg, pyridoxine 4mg, Cobalamin 0.05 mg, Biotin 0.08mg, Choline chloride 0.05g, Manganese 0.096g, Iron 0.024g, Copper 0.006g, Iodine 0.014g, Selenium 0.24mg, Calbalt 0.024mg and antioxidants 0.125g. ME-Metabolizable Energy, SYM- Soyabean meal, PKC- Palm kernel cake, ALM- Atama leaf meal.* | | | | |

### 2.4. Data Collection

#### 2.4.1. Growth Performance

Data on initial body Weight (g/bird) was gotten on the arrival of the birds, before the administration of the experimental treatments.

Final body weight was gotten at the end of the experiment.

The weight of birds was recorded weekly using a digital sensitive weighing scale.

**Daily Weight Gain**:

Was calculated as the difference between the final weight and the initial weight. Average daily weight gain was calculated as: Final live weight - Initial live weight / number of birds x number of days.

**Daily Feed Intake:**

This was taken at the begining of each day, feed were weighed and the leftover were weighed the next Morning and subtracting from the feed given to obtain the daily feed intake.

**Average Daily Feed intake (g)** = Feed consumed / number of birds x number of days
**Feed conversion ratio (FCR)** was calculated as Feed intake / Weight gain
**Protein intake** = %crude protein x Feed intake
**Protein efficiency** = Weight gain / Protein intake

#### 2.4.2. Cost Benefits

The cost of feed per kg, cost of feed intake per bird and cost of feed intake per kg body weight gain were evaluated. The cost of feed per kg was calculated as the summation of the price per kg of feed ingredient multiplied by their respective proportion in the feed or ratio. Cost of feed intake per bird was calculated as the product of quantity (in kg) of feed intake per bird to the cost of feed (₦) per kg. Cost of feed intake per bird = Total feed intake (kg) x Cost of feed (₦) per kg.
Cost of feed intake /kg body weight gain = Cost of feed / kg x feed conversion ratio

**2.5. The Experimental Design**

The experimental design was Completely Randomized Design

The statistical model was:

$Y_{ij} = \mu + T_i + e_{ij}$

Where:

$Y_{ij}$ = Single Observation

$\mu$ = Overall mean

$T_i$ =Treatment effect

$e_{ij}$ = Random error (~ijnd($0^2$)

**2.6. Data Analysis**

Data collected were subjected to Analysis of Variance (ANOVA), in a Completely Randomized Design (CRD) of Statistical Package for the Social Sciences (SPSS, 2017) and the means were separated with Ducan's Multiple Test (DMRT) option of the software.

## 3. RESULTS AND DISCUSSION

### 3.1 Results

The results for the proximate composition of Atama leaf is presented in Table 5. The result for Crude protein, Crude fibre, Ash and Crude fat were 19.97, 16.77, 8.72 and 3.81 respectively. These values were found to be higher than those reported by Agbaire *et al.,* (2012). The higher values could be due to the specie or variety of Atama used.

**Table 3: Proximate Composition of Atama (*Heinsia crinita*) Leaf**

| Parameters | Composition (%) |
|---|---|
| Ash | 8.72 |
| Crude Fibre | 16.77 |
| Crude Protein | 19.97 |
| Crude Fat | 3.81 |
| Moisture | 11.22 |
| Dry matter | 88.78 |
| NFE | 3953 |
| ME (kcal/kg) | 2452.44 |

***NFE = Nitrogen Free Extract, ME = Metabolizable Energy***

The results for the mineral composition of Atama (*Heinsia crinita*) leaf is shown in Table 6. The values for iron, manganese, zinc, cobalt, iodine, sodium, potassium, calcium, magnesium and phosphorus were 128.69, 38.75, 58.82, 13.39, 8.27, 0.22, 0.79, 0.24, 0.25 and 3.7 respectively. Calcium, magnesium, potassium and sodium were found to be relatively lower than the values reported by (Agbaire *et al.,* 2012), while iron and phosphorus were higher than those values reported by the same author.

**Table 4: Mineral Composition of Atama *(Heinsia crinita*)**

| Mineral Parameters | Ranges (%) |
|---|---|
| Iron | 128.69 |
| Manganese | 38.75 |
| Zinc | 59.82 |
| Cobalt | 13.39 |
| Iodine | 8.27 |
| Sodium | 0.22 |
| Potassium | 0.79 |
| Calcium | 0.24 |
| Magnesium | 0.25 |
| Phosphorus | 0.37 |

The anti-nutritional composition of Atama leaf is presented in Table 7. The values determined for the antinutrients were 0.05, 0.38, 0.27 and 0.26 for tannin, phytate, oxalate and saponin respectively. The antinutrients were found to be below the permissible levels as reported by Agbaire *et al.,* (2012) for safe leaf meals.

**Table 5: Anti- Nutritional Composition of Atama (*Heinsia crinita*)**

| Antinutrient | Ranges (%) |
|---|---|
| Tannin | 0.05 |
| Saponin | 0.26 |
| Phytate | 0.38 |
| Oxalate | 0.27 |

The results of the effect of broiler chicken fed graded levels of dietary Atama (*Heinsia crinita*) leafmeal on the growth performance of starter broiler chickens is shown in Table 8. The parameters measured were initial weight, final weight, weight gain, daily weight gain, total feed intake, average feed intake, feed conversion, protein intake and protein efficiency. Significant (p<0.05) differences were observed for final weight gain, weight gain, daily weight gain, total feed intake, average feed intake, feed conversion ratio, protein intake and protein efficiency except for initial weight gain which had no significant differences among the treatment means. The mean initial weight ranged from 50.00 in the (T1) control (0% ALM) to 50.47 in (T4) (8%ALM). They were no significant (p>0.05) differences among the treatment means. For the mean final weight, the value ranged from 678.92 in (T1) control diet (0% ALM) to 264.58 in T4 (8%ALM). They were significant (p<0.05) difference among the treatment means. Birds fed with 0% ALM were significantly (p<0.05) higher than those fed with 6%, 7%, and 8% ALM respectively and birds fed 8% ALM were significantly (p<0.05) lower than 0%, 6% and 7% ALM. The values for weight gain were 628.92, 410.42, 346.22 and 214.11 for 0%, 6%, 7%, and 8% ALM respectively. Significant (p<0.05) difference was observed among the treatment means. Birds fed 0% ALM were significantly (p<0.05) higher than birds fed 6%, 7% and 8%ALM while those fed 8% ALM were significantly (p<0.05) lower than birds fed 0%, 6% and 7%ALM. For daily weight gain, the values were 22.46, 14.66, 12.36 and 7.65 for 0%, 6%, 7%, and8% ALM respectively. T1 ((0% ALLM) was significantly (p<0.05) different from T2 (6%ALM), T3 (7%ALM) and T4 (8% ALM) while birds fed 8%ALM was significantly (p<0.05) lower than birds fed 7% ALM, 6% ALM and 0% ALM. Total feed intake values were 12394.00, 10552.67, 9336.33 and 9133.67 for 0%, 6%, 7%, and 8% ALM respectively. Birds fed 0% ALM were significantly (p<0.05) higher than 6%, 7% and 8% while 7% and 8% were statistically (p>0.05) similar. Average feed intake of birds fed 0%ALM was significantly (p<0.05) higher than 6%, 7%, and 8% respectively while those fed 7% and 8% ALM were statistically (p>0.05) similar but significantly (p<0.05) different from T1 (0%ALM) and T2 (6%LM). The value for feed conversion ratio ranged from 2.47 in T1 (0%ALM) to 5.35 in T4 (8%ALM). Birds fed 8% ALM were significantly (p<0.05) higher than 0%, 6% and 7% ALM while those fed 0%ALM were significantly (p<0.05) lower than 6% and 7% which were statistically (p>0.05) similar. The best feed conversion ratio was recorded for birds fed 0% ALM followed by diet containing 6% and 7% ALM. Significant (p<0.05) difference existed among the treatment means for protein intake. Birds fed 0% was significantly (p<0.05) higher than birds fed 6%, 7%, and 8% ALM while birds fed 8%ALM were significantly lower than 0%, 6%, and 7% but statistically (p>0.05) to 7% ALM. In protein efficiency, there was significant (p<0.05) difference among the treatment means. Birds fed 0% was significantly (p<0.05) higher than birds fed 6%, 7%, and 8%ALM while birds fed 8%ALM was significantly (p<0.05) lower than 0%, 6%, and 7% ALM with 7% and 6%ALM being statistically (p>0.05) similar.

**Table 6: Growth Performance of Starter Broiler Chickens fed Graded Levels of Dietary Atama (*Heinsia crinita*) Leafmeal**

| **Treatments Levels of ALM (%)** | **T1 (0% ALM)** | **T2 (6% ALM)** | **T3 (7% ALM)** | **T4 (8% ALM)** | **SEM** |
|---|---|---|---|---|---|
| **Parameters** | | | | | |
| Initial weight (g) | 50.00 | 47.92 | 45.45 | 50.47 | 1.37 |
| Final weight (g) | 678.92$^{a}$ | 458.33$^{b}$ | 391.67$^{c}$ | 264.58$^{d}$ | 17.45 |
| Weight gain (g) | 628.92$^{a}$ | 410.42$^{b}$ | 346.22$^{c}$ | 214.11$^{d}$ | 16.78 |
| Daily weight gain (g) | 22.46$^{a}$ | 14.66$^{b}$ | 12.36$^{c}$ | 7.65$^{d}$ | 0.60 |
| Total feed intake (g) | 12394.00$^{a}$ | 10542.67$^{b}$ | 9336.33$^{c}$ | 9133.67$^{c}$ | 268.07 |
| Average feed intake (g) | 55.33$^{a}$ | 47.11$^{b}$ | 41.68$^{c}$ | 40.78$^{c}$ | 1.20 |
| Feed conversion ratio | 2.47$^{c}$ | 3.24$^{b}$ | 3.37$^{b}$ | 5.35$^{a}$ | 0.17 |
| Protein intake | 12.28$^{a}$ | 10.56$^{b}$ | 9.36$^{c}$ | 9.17$^{c}$ | 0.27 |
| Protein efficiency | 1.83$^{a}$ | 1.38$^{b}$ | 1.33$^{b}$ | 0.54$^{c}$ | 0.06 |

$^{a, b, c, d}$ means of the same row with same superscript are significantly different (P<0.05); ALM= Atama leaf meal.

The result for cost benefit of broiler stater chickens fed graded levels of dietary atama is presented in table 9. The cost of feed per kg increased with increase in dietary levels. Significant (p<0.05) differences were observed among the treatment means. Birds fed 0% ALM were significantly (p<0.05) lower than birds fed 6%, 7%, and 8%ALM while birds fed 6% ALM was statistically (p>0.05) similar to birds fed 7% ALM and significantly (p<0.05) different from birds fed 8% ALM, birds fed 7% ALM was statistically (p>0.05) similar to 8% ALM. For the cost of feed intake per bird, the values were 1126.53, 1117.46, 1011.99 and 1012.86 for 0%, 6%, 7%, and 8%ALM respectively. There was significant (p<0.05) difference among the treatment means, birds fed 0% and 6% ALM were statistically (p>0.05) similar and significantly (p<0.05) different from 7% and 8% ALM. Dietary inclusion of ALM at 7% and 8% were statistically (p>0.05) similar and significantly ($p<0.05$) different from 0% and 6% ALM. Cost of feed per kg body weight gain showed significant ($p<0.05$) differences among the treatment means with birds fed 8% ALM being significantly ($p<0.05$) higher than 0%, 6%, and 7% ALM and 0% ALM being significantly ($p<0.05$) lower than 6%, 7%, and 8% ALM.

**Table 7: Cost Benefit of Starter Broiler Chickens fed Graded Levels of Dietary Atama (*Heinsia crinita*) Leaf meal**

| Treatments<br>Levels of ALM (%) | T1<br>(0% ALM) | T2<br>(6% ALM) | T3<br>(7% ALM) | T4<br>(8% ALM) |
|---|---|---|---|---|
| Cost parameters | | | | |
| Cost (₦) of feed per Kg | $727.15^{c}$ | $847.15^{b}$ | $867.15^{ab}$ | $887.15^{a}$ |
| Cost (₦) of feed intake per bird | $1126.53^{a}$ | $1117.46^{a}$ | $1011.99^{b}$ | $1012.86^{b}$ |
| Cost (₦) of feed intake per Kg body weight gain | $1796.06^{d}$ | $2744.76^{c}$ | $2922.29^{b}$ | $4746.25^{a}$ |

$^{a, b, c, d}$ means of the same row with same superscript are significantly different (P<0.05). ALM= Atama leaf meal.

### 3.2. Discussion

The inclusion of ALM at graded levels up to 6% enhanced the growth performance of birds as recorded in the final weight, total weight gain, and daily weight gain. This could be attributed to the fibre content in the diet as reported by Tewe (1991) that high fibre content and presence of anti-nutritional factors are major factors limiting utilization of leaf meal in poultry diets. The inclusion of ALM at 7% had a reduction in weight gain, total weight gain and daily feed intake but not as low as the birds fed 8%. The inclusion of ALM at 8% reduced growth performance as recorded in the final weight gain, total weight gain and daily weight gain of the birds this result is in line with a study conducted by Okon and James (2015) who reported that high fibre content in broiler diets is one of the major limiting factors in the utilization of leaf meals. These fibre content may depress feed intake and thus growth performance of broilers. For feed conversion ratio (FCR) diet containing 8%ALM recorded the highest FCR which showed that birds did not adequately utilize their feed which gave rise to the low final weight, weight gain and daily weight gain. The inclusion level with the least FCR was recorded in birds fed 0%ALM followed by birds fed 6%ALM. The cost of feed/Kg increased with increase in dietary levels of T1 (0%), T2 (6%), T3 (7%) and T4 (8%). The cost of feed intake per bird showed a decrease in cost of feed intake per bird as the dietary levels increases. The cost of feed intake per kg body weight gain increases with increase in dietary levels.

The treatment with the least cost of feed per bird was found in birds fed 0% ALM making it the most cost-effective diet. For addition of Atama leaf meal, the cost-effective diet was found in diet containing 6% ALM.

## 4. CONCLUSION AND RECOMMENDATION

### 4.1. Conclusion

Based on the results of the experiment, the proximate, minerals and antinutrients of atama leaf showed that atama has high crude protein and crude fibre contents and little amount of antinutrients making it suitable and less toxic for inclusion in broiler diets. Birds were able to consume the feed with inclusion level up to 6% and there was no adverse effect on the chicks. The cost-benefit of starter broiler chickens fed graded levels of dietary Atama leaf meal showed that the cost (₦) of feed per kg increased with increase in dietary levels. The most cost-effective diet with inclusion of dietary Atama leaf meal was found in the diet containing 6% ALM.

### 4.2. Recommendation

Based on findings from this study the following recommendations are made:

- Farmers should use Atama leaf meal up 6% in broiler starter diets as above that percentage can result in weight loss.
- For cost effective diets with inclusion of Atama leaf meals, inclusion level up to 6% is recommended.

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