INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 13, No. 2, p. 387-401, 2018
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Performance of pekin Duck (*Anas platyrhynchos* F) fed with *Moringa oleifera* leaf meal as soybean oil meal substitute under mixed orchard farming system

Froilan A Pacris Jr.*

Cagayan State University, Gonzaga, Cagayan, Philippines

Article published on August 30, 2018

Key words: Growth performance, Profitability, Pekin duck, *Moringa oleifera* leal meal (MOLM), Mixed orchard farming system.

Abstract

This study explored the potential of *Moringa oleifera* Leaf Meal As Soybean Oil Meal Substitute Under Mixed Orchard Farming System in enhancing the growth performance, of pekin duck by evaluating the effect of varying levels of *Moringa oleifera* leaf meal (MOLM) as soybean oil meal (SOM) substitute. The treatments were: Treatment T_0 (control) 100% SOM as protein source, T_1- 25% MOLM substitution of SOM, T_2- 50% MOLM substitution, T_3- 75% MOLM substitution, T_4- 100% MOLM. The study was done in CRD with three replications per treatment. Significant results were found on the body weight, weight gain and feed consumption parameters. Significant results were found out on the feed conversion ratio and feed conversion efficiency. Pekin Duck fed T_1, T_2 and T_3 performed best based on their low FCRs and high FCEs. Insignificant results were found on carcass yield. T2 recorded the highest Red Blood Cell (RBC) count and Packed Cell Volume (PCV) value. The RBC counts and PCV values of different treatments were within the reference or normal range of values in ducks. The RBC and PCV indicate that the birds were not suffering from any disease like anemia. Significant results were found on the meat analysis particularly the crude protein and moisture content of thigh meat. T_2 recorded the highest crude protein content but statistically the same with T_0 and T_4 has the lowest moisture content among treatments. It was therefore concluded that partial substitution of MOLM from 25% to 75% for SOM could be used on the diet of pekin duck. However, substituting 25% MOLM for SOM is highly recommended under mixed-orchard farming system because it had the best results on all growth parameters.

***Corresponding Author:** Dr. Froilan A. Pacris Jr. ✉ gilbertmagulod_rdecsulasam28@yahoo.com

Introduction

Backyard broiler duck raising is one of the productive activities that can help augment family income. While the growth of the commercial broiler duck industry has been impressive, its backyard farming sector continues to lag behind owing to problems and practices impeding production. In the Philippines, the major sources of protein for poultry production are Fishmeal (FM) and Soybean Meal (SOM). However, these are imported and becoming more scarce, expensive and used extensively by other livestock and humans. Prices of these conventional protein sources have soared so high in recent times that it is becoming uneconomical to use them in poultry feeds.

Nutrition accounts for 60-70% of the total production cost in modern poultry production systems. Further, feeding has a great effect in poultry growth, egg production and meat quality. This situation has created a need to look for cheap, locally available and less competitive substitutes to some ingredients of poultry feeds and in particular, sources of protein. There is continued scarcity and consequent high prices of conventional protein (soyabeans) and energy sources and this hinders poultry production.

There is a need therefore, to look for locally available and cheap sources of feed ingredients. One possible source of cheap protein is the leaf meal of tropical legumes. Many studies have been conducted using various sources of leaf meal proteins for broilers (Iheukwumere *et al.*, 2008; Wude and Berhan, 2009; Onyimonyi *et al.*, 2009). Leaf meals do not only serve as source of protein but also provides some necessary vitamins, minerals and oxycarotenoids (D'Mello *et al.*, 1987; Opara, 1996). One plant that can serve as source of leaf meal in the diet of poultry is *Moringa olifera* tree (Kakengi *et al.*, 2007; Olugbemi *et al.*, 2010b).

Moringa oleifera leaves are packed with nutrients important both for humans and animals. A crude protein percentage of 25- 27% is suggestive that the leaves are a good source of protein for livestock. Moringa tree is indigenous to many provinces in the Philippines.

This tree thrives well in Sanchez Mira, the site of this study because of its being a coastal area with sandy loam and clay loam types of soil. Moringa is well known for its multipurpose attributes, wide adaptability and ease of establishment. The tree is fast growing and high yielding, initial trial in Nicaragua have shown a high biomass production of up to 120 tonnes dry matter/ha/year in 8 cuttings after planting one million seeds/hectare (Makkar and Becker, 1997). The tree bears for 30-40 years. The drought tolerant nature of the tree makes it particularly suited to those marginal areas where the cost associated with cultivation and harvesting of other commercial crops like soyabeans is high. The tree is resistant to most pests and diseases, thus making it a cheap source of feed for animals.

Moringa tree is drought tolerant, it is resistant to most diseases and pests, it has a high biomass yield per hectare, it can grow well in marginal areas and it has a high protein value which can support livestock production. All these facts make it a cheap feed source compared to soyabeans, which is a cash crop and it is expensive to produce by the small-scale farmer in marginal areas. Under such conditions, *Moringa oleifera* becomes the crop of choice to explore in livestock production.

In poultry production, the raising of chickens and other species organically by free range or pasture management is now becoming popular because of its higher demand. Health conscious consumers prefer organically grown poultry than commercial broilers because of its satisfying flavor and aroma. Recent researches revealed substantial increases in nutritional value of pastured poultry, particularly in Omega-3 Fatty Acids and Vitamin A, and a significant decrease in total fat thus becoming better food to eat (Lee, 2001).

In the Philippines, the main sources of protein for poultry production are fishmeal and soybean oil meal. However, these are imported and becoming more scarce, expensive and used extensively by other livestock and humans. Prices of these conventional protein sources have soared so high in recent times that it is becoming uneconomical to use them in poultry feeds.

There is a need therefore, to look for non-conventional, locally available and cheap sources of protein for poultry production. One possible source of cheap protein is the leaf meal of tropical legumes which are abundant in the Philippines. One plant that can serve as source of leaf meal in the diet of poultry is *Moringa oleifera*. It leaves are packed with nutrients important both for humans and animals. A crude protein percentage of 25- 27% is suggestive that the leaves are a good source of protein for livestock.

With these, *Moringa oleifera* leaf meal must be verified if what levels of its inclusion in the diet could significantly affect the growth, carcass yield, meat quality, and profitability of ranged pekin ducks. This study will benefit poultry raisers especially duck growers because they would be given options to lower down their production cost through the use of alternative protein source for feeds. Likewise, the consumers because of healthy, better tasting and possibly cheaper poultry meat from duck produced in the range and fed with nutritious *Moringa oleifera*.

The study generally aimed to evaluate the growth performance of pekin ducks ranged under mixed orchard given pelletized formulated rations with different levels of *Moringa oleifera* leaf meal (MOLM) as substitute for soybean meal (SBM). Specifically, the study aimed to: (1) Evaluate the effect on growing ducks of pelletized formulated rations with different levels of MOLM as substitute for SOM in terms of growth performance parameters such as; total gain in weight, feed intake, feed conversion ratio, and feed conversion efficiency; (2) Assess the effect on growing ducks of pelletized formulated rations with different levels of MOLM as substitute for SOM in terms of carcass yield parameters such as; processing live weight (kg/bird), dressing percentage, chill weight (kg/bird), chill weight (% of live weight), fat pad weight (kg/bird), fat fad weight (% of live weight), breast weight (% of chill weight), thigh weight (% of chill weight), drum weight (% of chill weight), wing weight (% of chill weight); (3) To evaluate breast and thigh meat quality of growing duck fed with different levels of MOLM as substitute for SOM in terms of moisture, protein, and fat contents.

Materials and Methods

The Experimental Animals

One hundred fifty 14-day old pekin ducklings, meat type were randomly selected and distributed to treated and control groups with 10 animals per group. The ducks are placed in individual open-ranged pens under mixed orchard farming system. To ensure uniformity of stocks, the experimental birds were purchased from Superior F1 Genetic Enterprise owned by free-range poultry specialist Dr. Erwin J. S. Cruz.

Experimental Treatments and Design

A completely randomized design (CRD) was used with 5 dietary treatments (control, and 4 levels of MOLM substitute diets) with three replications per treatment. For each of the replication, there were 10 randomly selected pekin ducks in each of the 15 pens (total of 150 heads). The birds were fed according to the type of experimental diet assigned to each treatment as follows: T0 – Control - 100% SOM as protein source, T1 – 25% MOLM substitution of SOM, T2 – 50% MOM substitution of SOM, T3 – 75% MOLM substitution of SOM, and T4 – 100% MOLM as protein source.

Statistical Analysis

Statistical analyses were performed, pre-processing live weights, feed consumption, feed conversion, feed conversion efficiency, dressing percentage, chilled carcass weight, breast, thigh, wing, and drum weights; as well as moisture, protein, and fat values for breast and thigh meat. Carcass yield values were evaluated on a weight basis and as a percentage of pre-processing live or chilled carcass weight as appropriate. Statistical analysis (ANOVA) in Completely Randomized design (CRD) was carried out using computer programs e.g. Statistical Tool for Agricultural Research (STAR). The statistical model included effects of treatments, with the experimental unit being the pen. The mean values that were obtained for the pekin duck fed soybean meal as protein source were compared with those fed malungay leaf as protein source diets at the 5% and 1% level of significance using a protected Fisher's least significant difference test (Fisher, 1949). After two weeks of brooding, 10 day old ducklings were randomly distributed to each rearing house/range area. The allocation of the rations was based on the randomized procedure for CRD.

Experimental Area

The experimental animals were ranged under mixed orchard to partly cover the birds from direct sunlight. The area is an ideal site to raise ranged poultry with coconut as the predominant crop, and other trees such as citrus, gmelina, molave, and mahogany. In addition, under the trees are mixture of native grasses and edible weeds, which are good sources of other nutrients for the birds' growth. The appearance and vegetation of the area is uniform.

Brooding & Rearing Area

An existing house was used for the brooding of ducklings for two weeks. A rearing house with a dimension of 1.0m x 1.5m was constructed for each replication to accommodate 10 heads during the experimental period. The structure was built using wood, bamboo and G.I sheet. Five inches deep rice hull was provided as litter materials. The rearing area served as shed for the birds during night time and inclement weather.

Preparation of the Experimental Area

The range area is four (4) sq m. per bird. A total of 150 heads of ducks was used for the whole duration of the study. The total area used in this study is 600 square meters which was divided into 15 experimental units to come up with 40 square meters per experimental unit. The experimental area was enclosed and divided with poultry nets to prevent transfer of birds to other groups and likewise protect them from predators.

Sources of Feed Ingredients

The ingredients such as SOM, fish meal, coco oil, molasses, DL-methionine, L-Lysine, diCal. Phos, and vitamin premix were bought at Decena Feed Mill in Enrile, Cagayan. Salt, copra meal, and yellow corn were purchased locally. *Moringa oleifera* leaves were collected from the locality, sun dried to 13-14% and milled to form into MOLM.

Physical Appearance

The pekin ducks used in the study are F1 meat-type, fast growing that are procured from F1 Superior F1 Genetic Enterprise owned by free-range poultry specialist Dr. Erwin J. S. Cruz.

This strain of duck is usually raised in confinement. During the experimental period, they grew fast even when in range and achieved an average of 2.4 kilograms in five weeks. Ducks fed with MOLM exhibited faster growth than the control group.

Pigmentation

During the study, ducks fed with MOLM have more prominent yellow beak and shank than the ducks fed with full soybean. Likewise, ducks fed with moringa have cleaner and smoother feathers than the control group. *Moringa oleifera* leaf meal does not only serve as protein source but also provide some necessary vitamins and oxy carotenoids which cause yellow color of broiler skin, shank and egg yolk (www.United caribbean.com. 2003)

The yellow pigment is highly visible in the skin of dressed ducks fed with moringa than the control group which exhibited slightly yellow skin. Generally, there was a pronounced intense yellowish coloration of the beak, legs, carcass cuts, abdominal fat and feathers of broilers that received dietary MOLM than birds that got no MOLM. This presumably may be due to the high content of beta-carotene in MOLM. The yellow color in the body and products of broilers observed in this study is an indication of the efficient absorption and utilization of the pigment xanthophyll present in MOLM. Similarly, Ayssiwede *et al.* (2011) observed that dietary MOLM inclusion to have produced yellow coloration of the skin and abdominal fat of growing indigenous chickens. The birds were experiencing yellow colouration of body parts which was mainly attributed to the presence of xanthophylls and carotenoid pigments in MOLM as in other tree and shrub leaf meals as outlined by Austic and Neishen (1990).

Livability

The ducks stayed on range from day 15 to day 37 under mixed orchard. There was no mortality observed during the experimental period even though there was intermittent rain and the temperature was very cold. This means that the feeds given and the range system of raising them have no adverse effect on their livability.

However, it was observed that in the control group, feed consumption decreased on the 1st to 2nd day of the 2nd week of rearing, but recovered on the 3rd day of that week. In the treatment groups, there were no cases of any sickness even there was an adverse conditions experienced by the ducks in their range environment. This implies that the birds were easily acclimatized to their environment after they were transferred from the brooder to the range area.

Feeding and Grazing Behavior

Feeds are given at 6:00 in the morning for all the treatment replications throughout the study period. Refill of feeds was done any time when necessary or if they already consumed their feed allotment for the day. On their first day at the range area, the birds appeared to be very nervous and huddled together around their rearing houses. As the day progress, they tend to adapt their new environment as they started to feed and graze. Throughout the study period, the birds generally exhibited normal feeding and grazing behavior. They fed and graze in the range alternately during the day and back to the rearing house to roost at night time. Lights were not provided at the rearing houses.

Results and Discussion

Initial and Weekly Body Weight

The initial and weekly body weight of pekin duck fed different levels of *Moringa oleifera* leaf meal as soybean substitute under mixed-orchard farming system is presented in Table 1. The initial weight of birds ranges from 845.8 to 903.3grams. The body weight of ducks on the first week of feeding ranged from 1271.7 to 1485grams and had different trend with the body weights of duck on the second week with body weight ranged from 1786.7 to 2038.7grams. The body weight of ducks on the second week and third week of feeding followed the same trend. On the third week of feeding, birds in T_1 (25% MOLM) had a body weight of 2602.8grams, followed by T_2 (50% MOLM) 2418.9grams, T_0 (SOM) 2389.5grams, T_3 (75% MOLM) 2374grams and T_4 (100% MOLM). During the fourth week of giving the feeds, birds in T_1 (25% MOLM) recorded 2952.7grams, followed by T_3 (75% MOLM) 2811.4grams, T_0 (SOM) 2751.9grams, T_2 (50% MOLM) 2740.8grams and T_4 (100% MOLM) 2638grams.

The analysis of variance of the data on weights on the first, second week and the fourth week showed no significant ($p>0.05$) differences among treatment means. This finding showed the different levels of MOLM as soybean substitute on their diet did not in any way affect their weekly weight performance during the first two weeks and during the fourth week. On the fourth week, although the difference is insignificant, there was reason to believe that the partial substitution of SB with MOLM from 25% to 75% could enhance the body weight of pekin duck which was shown by the performances of T_1 (2952.7grams), T_3 (2811.4grams) and T_2 (2740.8grams), which are greater than the performance of the To (control). Further, there was a reason to believe that full (100% substitution) of SB with MOLM could depress the performance of pekin duck which was shown by the performance of T_4 (100% MOLM) 2638grams which got the lowest body weight.

However, the analysis of variance on the weight of ducks on the third week feeding revealed significant ($p<0.05$) differences among treatment means. This shows that the different levels of MOLM as soybean substitutes on their diets affects the weekly weight performance of ducks at the end of the study. Comparison between means revealed that T_1 significantly ($p<0.05$) differed with T_0 (control) and the other treatments. On the other hand, T_0 (control) is not significantly ($p>0.05$) differed with T_2, T_3, and T_4. The highest weight (2602.8grams) was recorded by ducks given diets with T_1 (25% MOLM) as partial substitute to soybean while the lowest weight (2275.2grams) was recorded by ducks given diets with T_4 (100% MOLM) as soybean substitute. There was no significant ($p>0.05$) difference in the body weight between ducks fed diets T_0 (control), T_2 (50% MOLM), T_3 (75% MOLM) and T_4 (100% MOLM). This result implies that substituting soybean beyond 25% up to full replacement with moringa leaf meal significantly decreased the body weight of ducks. The lower body weight in $T_3$and T_4 was attributed to the higher levels of crude fiber in the mixture and the findings agree with literature that monogastrics cannot utilize high crude fibre diets efficiently.

The depression in growth with increased MOLM inclusion level agree with the general similar observations noted before with leaf meal inclusion in the diet of poultry (Ash and Akoh, 1992; Opara, 1996), even when maize oil was used to compensate for the low metabolizable energy value of the leaf meal (Opara, 1996). However, up to 24% inclusion level of MOLM in the diet of growing indigenous Senegal chicken with no negative impact on body weight, average daily weight gain and feed conversion ratio was reported (Ayssiwede *et al*., 2011).

Table 1. Initial and Weekly Body weights of (g) of Pekin Duck fed different levels of *Moringa oleifera* Leaf Meal (MOLM) as soybean substitute under mixed-orchard farming system.

Treatments	Weekly Body Weight (g)				
	Initial	1st	2nd	3rd	4th
To (SB)	903.3	1485.0	1853.5	2389.5[a]	2751.9
T1 (25% MOLM)	877.4	1391.0	2038.7	2602.8[b]	2952.7
T2 (50% MOLM)	853.0	1410.0	1871.5	2418.9[a]	2740.8
T3 (75% MOLM)	845.8	1305.7	1889.2	2374.0[a]	2811.4
T4 (100% MOLM)	902.0	1271.7	1786.7	2275.2[a]	2638.0
ANOVA Result	ns	ns	ns	*	ns
C.V. (%)	4.16	6.31	6.79	3.88	4.46
$LDS_{0.05}$				170.44	

ns = not significant

* = significant at 5% level

Note: Means with common letters are not significantly different with each other using LSD.

Cumulative Gain in Weight

The cumulative gain in weight (grams) of pekin duck fed different levels of MOLM as soybean substitute is presented in table 6. Based on the result, the range of the gain in weights attained by the ducks given diets with different levels of MOLM as soybean substitute on the first week was 369.7grams to 581.8grams with the T_0 (control) gained 581.8grams, followed by T_2 (50% MOLM) 557.0grams, T_1 (25% MOLM) 513.6grams, T_3 (75% MOLM) 459.9grams and T_4 (100% MOLM) with 369.7grams.

On the 2nd week of feeding the duck with different levels of MOLM as soybean substitute, the range on their cumulative gain in weight was 884.8grams to 1161.3grams. T_1 had a cumulative gain of 1161.3grams. T_1 (25% MOLM) 1161.3grams, T_3 (75% MOLM) 1043.4grams, T_2 (50% MOLM) 1018.5grams T_0 (control) 950.2grams and T_4 (100% MOLM) 884.8grams. On the third week of the study, T_1 (25% MOLM) had the total gain of 1725.4grams, followed by T_2 (50% MOLM) 1565.9grams, T_3 (75% MOLM) 1528.2grams and T_4 (100% MOLM) with 1373. 3grams. On the fourth week, T_1 (25% MOLM) recorded a weight gain of the analysis of variance on the cumulative gain in weight on the first and second week revealed that there were no significant ($p>0.05$) differences among the treatment means. This finding showed the different levels of MOLM as soybean substitute on their diet did not in any way affect their weight gain performance during the first two weeks. However, it is evident that partial substitution of SB with MOLM from 25% to 75% could enhance the growth of pekin duck which was shown by the performances of T_1, T_2 and T_3, 1161.3, 1018.5 and 1043.4grams, respectively, which are greater than the performance of To (control). Further, although not significant, there was a reason to believe that full (100% substitution) of SB with MOLM could depress the performance of pekin duck which was shown by the performance of T_4 (100% MOLM) 884.4grams which got the lowest weight gain.

On the 3rd and 4th week, the analysis of variance revealed that there were significant ($p<0.05$) differences among the treatment means. This shows that the different levels of MOLM as soybean substitute on their diets affects the weekly weight gain performance of ducks at the end of the study. Comparison between means on the weight gain of ducks on 3rd week showed that T_1 (25% MOLM) significantly differed with T_0 (SB), T_3 (75% MOLM), and T_4 (100% MOLM) but not with T_2 (50% MOLM). Likewise, T_4 differed from T_1 and T_2 but not with T_0 and T_3. On the 4th week, comparison of means showed T_1 (25% MOLM) significantly differed from T_0 (SB) and T_4 (100% MOLM) but not with T_2 (50% MOLM) and T_3 (75% MOLM). On the other hand, T_0 (SB) significantly differed with T_1 (25% MOLM) but not with T_2 (50% MOLM), T_3 (75% MOLM) and T_4 (100% MOLM). The result of the study would mean that the different levels of moringa leaf meal up to full

substitution resulted a significant ($p<0.05$) effect on the body weight gain of ducks. The highest weight gain was recorded and maintained by ducks given diets with 25% MOLM as partial substitute to SOM while the lowest weight gain was recorded by ducks given diets with full MOLM as SOM substitute. There was no significant ($p>0.05$) difference in the body weight gain between ducks fed diets with 25% and 50% moringa leaf meal as soybean substitute. Although 50% compared favourably with 25%, it had the lesser weight gain of 1565.9 g. Although there were no significant ($p>0.05$) differences in body weight gain among the control (full soybean), 75% and 100% Moringa leaf meal, there was a reason to believe that partially replacing SOM with MOLM at T_1 (25% MOLM), T_2 (50% MOLM) to T_3 (75% MOLM) could boost the weight gain of Pekin duck which was shown by the performance of T_1, T_2 and T_3, with 2075.3, 1887.8 and 1965.5grams, respectively which are greater than the performance of the T_0 (control) 1848.7grams. The full (100% MOLM) compared favourably with full soybean and 75% MOLM as soybean substitute; it had the least body weight gain which could be a reason to believe that fully substituting the SOM with MOLM could depress the growth of pekin duck. This implies that substituting soybean up to full replacement with MOLM evidently decreased the body weight gain of ducks although the difference is not significant.

Final weight and weight gained declined as MOLM level increased. This is also in line with findings from a study by Olugbemi *et al.* (2010) in inclusion MOLM to cassava based diets fed to broiler chickens. In the study of supplementing soyabean meal with MOLM, mean weight of broilers was significantly different for T_3 (50%MOLM), T_4 (75%MOLM) and T_5 (100%MOLM). However, there was no significant difference in the mean weight of broilers between T_1 (0%MOLM) and T_2 (25%MOLM). Significant weight gain differences were noted between treatment five and treatment one and between treatment two and five. The difference could be due to high fibre levels that were in treatment five with 100%MOLM in the diet as protein source.

The findings agree with literature that monogastrics cannot utilize high crude fibre diets efficiently.

Table 2. The cumulative gain in weight (g) of Pekin Duck fed different levels of *Moringa oleifera* Leaf Meal (MOLM) as soybean substitute under mixed-orchard farming system.

Treatments	Cumulative Weekly Weight Gain (grams)			
	1st	2nd	3rd	4th
To (SB)	581.8	950.2	1486.2^{bc}	1848.7^{bc}
T1 (25% MOLM)	513.6	1161.3	1725.4^{a}	2075.3^{a}
T2 (50% MOLM)	557.0	1018.5	1565.9^{ac}	1887.8^{ab}
T3 (75% MOLM)	459.9	1043.4	1528.2^{bc}	1965.5^{ac}
T4 (100% MOLM)	369.7	884.8	1373.3^{b}	1736.0^{b}
ANOVA Result	ns	ns	*	*
C.V. (%)	17.75	11.16	6.39	5.88
$LSD_{0.05}$			178.44	203.4

ns = not significant; * = significant at 5% level

Note: Means with common letters are not significantly different with each other using LSD.

Feed Consumption

The feed consumptions of pekin ducks were not comparable during the first two weeks of the feeding period. During the first week, the feed intake of pekin ducks ranged from 1265.3grams to 1377.1grams and on the second week, the feed intake ranged from 1411.9grams to 1787.3grams.

The analysis of variance on the cumulative feed consumption revealed that there were significant ($p<0.05$) differences among the treatment means. This shows that the different levels of MOLM as soybean substitute on their diets affects the feed intake performance of pekin ducks. Comparison between means showed that T_1, (25% MOLM) and T_0 (SB) are significantly ($p>0.05$) differed with T_3 (75% MOLM) and T_4 (100% MOLM) but not with T_2 (50% MOLM). The highest feed intake was recorded by pekin ducks given T_1 (25% MOLM) and this feed intake is comparable with the feed intake of pekin duck given diets T_0 (SB). The least feed intake was recorded by pekin ducks given diets T_2 (50% MOLM). On the third and fourth week, the analysis of variance revealed insignificant ($p>0.05$) differences among treatment means. This finding showed that the pekin duck given different diets had comparable feed intake on the third and fourth week.

On the total feed intake from week 1 to week 4, the analysis of variance revealed significant ($p<0.05$) differences on the means of the total feed intake of pekin. The highest feed intake was recorded by pekin duck given T_1 (25% MOLM) of 6291.1grams. The least was recorded by T_0 (SOM) 5955.9grams and this feed intake is comparable with the feed intake of pekin duck in T_2 (50% MOLM), T_3 (75% MOLM) and T_4 (100% MOLM). This result means that the feed intakes of pekin ducks were not the same and this is affected in any way by the different level of MOLM as SOM substitute. These finding is in accordance with the study of Paguia *et al.* (2012) that fed *M. oleifera* leaf and twig powder (MLTP) to force molted hens and assessed their performance. The authors found no effect of MLTP on feed intake, feed efficiency, egg sensory evaluation (egg flavour and egg acceptability score) but reported significant effect on egg weight and feed cost per kilogramme of eggs produced. In another study, the influence of MOLM on growth performance of broilers was assessed and treatment was found to have no effect on average cumulative feed consumption, final live weight, FCR, feed cost per kilogramme of broiler produced, and income over feed and chick cost.

This finding is also supported by results from studies of substitution on sunflower seed meal with MOLM in diets of laying hens by Kakengi *et al.* (2007) that indicated significant progressive increase in feed intake were on birds fed 10% and 20% MOLM levels. The results show that there was no significant difference in mean feed intake between T1 (0% MOLM) and T2 (25% MOLM) as demonstrated by Kakengi *et al.* (2007) where dietary treatments did not show any significant effect on feed intake and dry matter intake up to 5% MOLM.

Feed Conversion Ratio and Efficiency

The Feed Conversion Ratio (kg/kg) and Feed Conversion Efficiency (%) of Pekin Duck fed Different Levels of MOLM as SBM substitute under mixed-orchard farming system is highlighted in Table 4. The feed conversion ratio and efficiency varied among the treatments.

The feed conversion ratio ranged from 3.04 to 3.53. T_1 (25% MOLM) and T_3 (75% MOLM) recorded 3.04, T_2 (50% MOLM) 3.19, T_0 = (SBM) 3.23 and T_5 (100% MOLM) 3.53. The feed conversion efficiency ranged from 28.38% to 32.96%. T_5 (100% MOLM) recorded 28.38 and T_1 (25% MOLM) recorded 32.96%.

Table 3. The cumulative feed consumption (g) of Pekin Duck fed different levels of *Moringa oleifera* Leaf Meal (MOLM) as soybean substitute under mixed-orchard farming system.

Treatments	Weekly Feed Intake (grams) Cumulative				
	1st	2nd	3rd	4th	Feed Consumption
To (SB)	1371.7^{a}	1594.4^{b}	1277.1	1712.7	5955.9^{b}
T1 (25% MOLM)	1377.1^{a}	1787.3^{a}	1543.8	1582.9	6291.1^{a}
T2 (50% MOLM)	1322.3^{ab}	1411.9^{c}	1544.8	1719.0	5997.9^{b}
T3 (75% MOLM)	1265.3^{b}	1649.9^{ab}	1321.1	1734.2	5970.5^{b}
T4 (100% MOLM)	1274.0^{b}	1644.9^{ab}	1436.0	1765.6	6120.5^{b}
ANOVA Result	*	*	ns	ns	**
C.V. (%)	3.16	6	14.51	5.02	1.37
$LDS_{0.05}$	76.13	176.66			201.26

ns = not significant

* = significant at 5% level

** = significant at 1% level

Note: Means with common letters are not significantly different with each other using LSD.

The analysis of variance on the feed conversion ratio and feed conversion efficiency revealed significant ($p<0.05$) differences among the treatment means. The FCR of T_1, T_2, and T_3, are significantly differed with T_4 but not with T_0. The FCE of T_1, T_2, and T_3, are significantly differed with T_4 but not with T_0 and the FCE of T_2 is comparable with the FCE of T_4. This finding showed the different levels of MOLM as soybean substitute affect in any way the feed conversion ratio and feed conversion efficiency of pekin duck. Pekin duck fed diets T_1 (25% MOLM) and T_3 (75% MOLM) performed the best because of lowest FCR and highest FCE of 3.04 and 32.96%, respectively. Since the FCR and FCE of T_2 are comparable with that of T_1 and T_3, then T_2 may be regarded best.

This implies that substitution of SBM by MOLM by 25% up to 75% improves the conversion ability of the birds. This could be explained by the literature that *Moringa* is not only concentrated in nutrients, but it

seems to reduce the activity of pathogenic bacteria and molds and improves the digestibility of other foods, thus helping chickens to express their natural genetic potential (Gaia, 2005). This could also be supported by the study conducted in Botswana, Kwedibana (2008) who evaluated the effects of MOLM at 10% inclusion level on the growth rate of broilers and found that commercial broiler diet significantly ($P<0.05$) promoted higher weight gain (1.04 kg) than MOLM. Feed intake was also higher for birds fed commercial diets than those on MOLM. On the other hand, FCR was higher for birds on MOLM than those fed commercial diets.

The findings are also in accordance with a study conducted in Zimbabwe and with the experiment conducted by Portugaliza and Fernandez. In Zimbabwe, Gadzirayi *et al.* (2012) investigated the effects of supplementing soya bean meals with MOLM as a protein source in poultry and found no significant differences in feed intake of broilers, however, significant differences in FCR were noted. It was concluded that inclusion of MOLM as protein supplement in broiler diets at 25% promoted more growth than commercial diets. Portugaliza and Fernandez (2012) supplemented Cobb broiler diets with varying concentrations of *M. oleifera* aqueous leaf extract (MoALE) through drinking water and found that at 90 ml MoALE, feed intake of broilers was consistently lower than that of control group (commercial diet). The live weight of broilers given 30 ml, 60 ml and 90 ml MoALE were significantly higher than the control group. The MoALE treated broilers were more efficient converters of feeds into meat than the control group. 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.

Carcass Yield

Processing Live Weight

The live weight of pekin duck fed with different levels of *Moringa oleifera* leaf meal as soybean substitute ranged from 2342.7grams to 2894grams. The analysis of variance revealed insignificant effect of the different levels of MOLM as soybean substitute on the live weight of pekin duck.

Table 4. The Feed Conversion Ratio (kg/kg) and Feed Conversion Efficiency (%) of Pekin Duck fed Different Levels of *Moringa oleifera* Leaf Meal (MOLM) as Soybean substitute under mixed-orchard farming system.

Treatments	Feed Conversion Ratio (kg/kg)	Feed Conversion efficiency (%)
To (SB)	3.23^{ab}	31.04^{ab}
T1 (25% MOLM)	3.04^{b}	32.96^{a}
T2 (50% MOLM)	3.19^{b}	31.42^{ac}
T3 (75% MOLM)	3.04^{b}	32.92^{a}
T4 (100% MOLM)	3.53^{a}	28.38^{bc}
ANOVA Result	*	*
C.V. (%)	5.47	5.57
$LSD_{0.05}$	0.319	3.175

* = significant at 5% level

Note: Means with common letters are not significantly different with each other using LSD.

Dressing Percentage

The dressing percentage with giblets ranged from 64.45 to 72.81 while the dressing percentage without giblets ranged from 51.66 to 58.97. The analysis of variance on this two carcass parameters revealed that there were no significant differences among the treatment means.

Chill Weight

The chill weight of pekin duck ranged from 1441grams to 1714.7grams. on the other hand, the chill weight per percent of live weight of pekin duck ranged from 57.88 to 71.83. The analysis of variance on these carcass parameters revealed insignificant differences among treatment means.

Fat Pad Weight

The fat pad weight of pekin duck as affected by different levels of MOLM as soybean substitute ranged from 42.3 to 71.3. On the other hand, the fat pad weight based on the percent live weight of pekin duck as affected by the different levels of MOLM as soy bean substitute ranged from 1.80 to 2.86. The analysis of variance revealed that there was no significant effect of substituting soybean with MOLM on these two carcass parameters.

Breast, Thigh, and Drum Weights

The breast weight, thigh weight and drum weight based on percent chill weight ranged from 23.62 to

25.41, 7.33 to 10.16, and 10. 33 to 12. 04, respectively. The same observation was observed on these carcass parameters. The analysis of variance revealed insignificant differences among the treatment means. This means that the different levels of MOLM as soybean substitute did not in any way affect the carcass yield of pekin duck.

Red Blood Cell Count and Packed Cell Volume

A three milliliter of blood was drawn via the wing vein with a 3ml syringe and a gauge 24 needle. Prior to puncture, the area was sanitized by a 70% isopropyl alcohol. The blood was placed in purple top vacutainers containing EDTA as anticoagulant.

Table 5. The live weight and carcass evaluation data of pekin duck fed Different Levels of *Moringa oleifera* Leaf Meal (MOLM) as Soybean substitute under mixed-orchard farming system.

Treatments	Live weight (g/bird)	Dressing Percentage w/ Giblets	Dressing Percentage w/o Giblets	Chill Weight (g/bird)	Chill weight (% of live weight)	Fat Pad weight	Fat Pad weight (% live weight)	Breast Weight (% chill weight)	Thigh weight (% of chill weight)	Drum weight (% of chill weight)
To (SB)	2367.7	64.45	53.45	1483.0	71.83	62.0	2.61	23.62	8.87	11.11
T1	2894.0	69.84	51.66	1714.7	57.99	52.7	1.82	25.41	7.33	10.33
T2	2523.3	71.84	58.97	1545.7	63.99	71.3	2.86	23.68	9.97	11.06
T3	2342.7	72.81	58.68	1441.0	64.48	42.3	1.80	23.79	10.10	12.04
T4	2467.7	70.30	57.54	1460.7	57.88	60.7	2.51	24.03	10.16	11.13
ANOVA Result	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
C.V. (%)	11.92	5.69	10.52	13.34	7.01	4.6	4.8	12.9	12.55	8.66

* = significant at 5% level

Note: Means with common letters are not significantly different with each other using LSD.

Red blood cell count was performed using the hemocytomer method. A portion of the anticoagulated blood was drawn into a hematocrit tube. After which it was centrifuged for 5 minutes at a rate of 10,000rpm. The tubes were removed and result was read using the hematocrit tube reader.

Table 10 shows the mean RBC count of the different treatment groups. It can be observed that T2 recorded the highest RBC count at 4.22cells/µL followed by T4 (3.85cells/µL), T1 (3.65cells/µL), T3 (3.40cells/µL) and To at 3.39cells/µL. Although there were differences in the mean values, the RBC counts of the different treatments were within the normal range of values of RBC in ducks which is 40.24±4.21cells/µL. Also reflected in the table is the mean PCV values in percentage of the different treatment groups. The same trend as with the RBC count has been observed in the PCV values wherein all PCV means of the different treatments were within the reference rate of 36±1.5%.

These results indicate that the birds were not suffering from any disease like anemia which is the decrease number of functional erythrocytes which might be due to deficient blood formation because of poor nutrition including dietary deficiencies of iron, vitamins and amino acids. Also, packed cell volume (PCV) is an indirect way of measuring the volume of the animal's erythrocytes as a percent of the whole blood. A low haematocrit and erythrocyte count indicate the presence of anemia while a high PCV can indicate dehydration (Coles, 1986).

Red blood cells functions primarily in the oxygen and carbon dioxide transport between the tissues and the lungs. Results show that the treatments have normal functioning RBC which may be attributed to the reported large amount of iron component of Moringa oleifera (Zvinorova *et al.*, 2014). Also, Djakalia *et al.*, (2011) reported that the protein present in moringa are readily degraded and absorbed in the body as amino acid sources for the growth and maintenance of the animal.

Table 6. Red blood Cell Count and Packed Cell Volume.

Treatments	RBC Count (cells/microliter)	PCV (%)
To	3.39	35
T1	3.65	36
T2	4.22	38
T3	3.40	36
T4	3.85	37

* 40.24±4.21cells/µL: RBC Reference Value 36±1.5%: PCV Reference Values from Berl Munch Tierarztl Wochenschr 1996 Aug; 109(8):324.

Meat Quality (Thigh and Breast Meat)

The carcass quality of pekin ducks fed with different levels of *Moringa oleifera* leaf meal as supplements, i.e., from 25%- 100% substitution of MOLM did not differ significantly in terms of moisture percentage, crude protein(%) and crude fat analysis (%) in both thigh and breast, respectively except for crude protein analysis in thigh and moisture analysis in thigh (Table 7).

The moisture contents of breast meat of pekin duck fed with 25% to 100% MOLM as protein source gave comparable results with pekin ducks fed with 100% SOM as protein source. However, moisture analysis of thigh meat gave significant results. T4 which has the lowest moisture content is significantly different with To, T1, T2, T3. Numerically feeding 25% MOLM can give acceptable carcass yield moisture of 67.88% in thigh, while 74.79% in breast. Interestingly, 75 to 100% MOLM substitution reduced the moisture in the breast and thigh by 1.43% and 12.95%, respectively.

Similarly, no significant differences is observed in the crude proteins of breasts meat of pekin duck fed with 25% to 100% MOLM as protein source with pekin ducks fed with 100% SOM as protein source in breast pekin ducks. But in crude protein analysis of thigh meat, significant results were obtained. T4 which has the lowest crude protein content among treatments is significantly different with To, T1, T2, and T3. However, the same trend of data is observed i.e., as the percentage of MOLM substitution increases, the crude protein content decreases. An increase of 75% to 100% MOLM yielded to 9.30% reduction in crude protein in breast while 9.40% reduction in crude protein in thigh. This observation is true to both breast and thigh of the pekin ducks fed with MOLM.

The analyzed crude fat from the meat of Pekin ducks fed with 25% to 100% MOLM as protein source again gave the same comparable results with pekin ducks fed with 100% SOM as PS in both breast and thigh of pekin ducks. An increase of 50% to 75% MOLM reduces the crude fat to 33.26 in breast and 64% in thigh. The observations from this study had shown that substituting 25% *Moringa oleifera* leaf meal (MOLM) might be high enough, though have comparably improved moisture percentage, crude protein composition and fatty acid composition of the pekin duck meat. However, feeding pekin ducks with more than that of 25% or 50% MOLM as substitute noticeably tends to reduce the moisture percentage, crude protein and fatty acid contents of the pekin duck meat. This is may be due to the fact that, even though M. *oleifera* contains nutritional qualities, it is also interested to note that the plant also contains toxins that might give negative results.

The result of this study on carcass quality is in consonance with the findings of Safa MA El Tazi (2014) who reported that, chicks fed on *Moringa oleifera* with 7% MOLM based diets produced significantly higher breast and drumstick percentages as compared to control group. He concluded that, feeding *M. oleifera* leaf meal at 0.2, 0.4 and 0.6 levels had no negative influence on carcass quality but rather improved the breast and drumstick of broiler chicks. The results also corroborate with the statements of Makkar and Becker (1997), that M. *oleifera* Lam leaves are rich in carotenoids, ascorbic acid and iron. The leaves are widely recognized as a food source for humans and a dry season feed for animals because of the nutrient contents it contains. In addition, analysis on fat and water soluble vitamins indicated that *Moringa* is rich in vitamins and their precursors. Results of this study agreed with those of past workers (Atawodi, S.E., Atawodi, J.C., Idakwo, G.A., (2010) and Anjorin *et al*., 2010) who noted high concentrations of vitamins in *Moringa oleifera* products. Donovan (2007) noted that *Moringa oleifera* provides twice, the vitamin A in carrots and seven times, the ascorbic acid in citrus.

Analyses of some macro- and micro-minerals revealed the plants to be high in concentration of phosphorus (1600 ppm), potassium (9615 ppm), sodium (9240 ppm), calcium (2925 ppm), magnesium (2998 ppm) and zinc (41 ppm), copper (28.25 ppm), manganese (125 ppm), respectively. Data obtained on mineral composition of *Moringa* in this analysis confirmed reports of early works (Fahey, 2005; Donovan, 2007) that *Moringa* products contain 9-times the iron in spinach, 14-times the calcium in milk and 4-times the potassium in bananas and plantains warranting the tree crop products as healthy food/feedstuff sources. But equally important is the fact that some parts of the tree contain toxins and other anti-nutritional factors that might decrease its potential as a source of food for animals or humans. For instance its bark contains tannins, alkaloids, saponnins and inhibitors (Makkar *et al*., 1990).

The results of the study can be explained by the reasons that although, *Moringa* products have been demonstrated to contain numerous valuable nutrients and to be potential sources of cheap carbohydrate, protein, vitamins, lipids, essential minerals, the presence of the toxic chemicals could cause constraints to the enhanced utilization of the seeds in nutrition of man and animal as exemplified in decreasing weight gain or growth rate with increasing intake observed in this study. This claim may be true since Kieg and Fox (1978) reported that toxicants like phenols including tannins and many others can bind or enzymatically destroy particular nutrients present in feeds thereby decreasing availability and utilization, thus are no longer used by the animals.

The general observation on decreasing the moisture, crude protein and crude fat analyses while increasing the MOLM contents may be due to the negative effect of the anti-nutritional factors present in MOLM on pekin ducks. *M. olefeira* contains 1-23g of tannin in every 1 kg of leaves (Kakengi *et al*., 2003). Tannin has been reported to interfere with the biological utilization of protein and to a less extent available carbohydrate and lipids (Esonu, 2001). The reducing moisture percentage, crude protein and fat analysis may be explained by evidence abound in literature on the effects of *Moringa* phytochemicals that when consumed in high doses could prove or may be fatal, hence further research must be carried out to ascertain the toxicity of the materials applied in this study.

Table 7. Moisture (%), Crude Protein% and Crude Fat Analyses of Breast and Thigh of Pekin Ducks Fed with Different Levels of M. *oleifera* Leaf Meal (MOLM) as Protein Source (2016).

Treatment	Breast			Thigh		
	Moisture	Crude Protein	Crude Fat Analysis	Moisture	Crude Protein	Crude Fat Analysis
100% SOM	75.64	21.13	2.71	69.67a	19.64a	6.15
25% MOLM	74.06	19.54	4.51	70.36a	19.18ab	6.18
50% MOLM	74.95	19.58	4.90	69.03a	19.90a	5.54
75 MOLM	74.71	20.09	3.27	68.69a	18.75ab	5.02
100% MOLM	74.57	18.21	3.86	61.68b	17.40b	5.49
Cv	4.44	7.10	53.73	4.91	6.32	28.29
Statistical inference	ns	ns	ns	*	*	ns

ns- not significant at 5% level of significance

*= significant at 5% level

Note: Means with common letters are not significantly different with each other using LSD

Return Above Feed Cost

The cost per kilogram of feeds for the different treatments showed that Treatment 4 (100% MOLM) had the least cost with P22.11, followed by Treatment 3 (75% MOLM) with P22.29, Treatment 2 (50% MOLM) with P22.59, T1 (25% MOLM) with P22.91 and the highest cost of feeds was attained by Treatment 0 (Control) with P23.52 . It is evident that the higher the MOLM content of the ration, the lower will be the cost of feed production, thereby commanding a lower price per kilogram of feed. The cost of duck and feed for the different treatments showed that T_1 had the highest cost, followed by T_0, T_4, T2, and T_3 with costs of P 231.86, P230.41, P225.55, P220.25, and P217.64, respectively.

The profitability would not rely primarily on the cost of duck and feeds but on the growth performance of the ducks which could compensate the cost spent on ducks and feeds. In this study, results showed that T_1 recorded sales of P 311.30 per bird followed by T_3 with P 294.83, T_2 with P 283.17, To with P277.31 and T_4

got the lowest sales of chicken with P 260.40. It can be deduced that birds fed diets with MOLM particularly 25%, 75%, and 50% MOLM levels could generate more income because of a better gain in weight which resulted in bigger birds as compared to 100% MOLM and full soybean diet.

With respect to income per duck, again Treatment 1 (25% MOLM) got the highest income with P 79.43, followed by Treatment 3 (75%MOLM) with P77.18, which are far from the income achieved by T_4 and T_0 with 34.85 and P 46.89 respectively. It is clear that the best MOLM levels that can be used to attain a good income in ranged Pekin duck would be 25% and 75%, which recorded the best return above feed cost.

Table 8. Return Above Feed and Bird Costs of Pekin Ducks fed Different Levels of *Moringa oleifera* Leaf Meal (MOLM) as Soybean substitute under mixed-orchard farming system.

	Treatments				
Item	$To_{Control}$	$T1_{25\%}$ MOLM	$T2_{50}$ MOLM	$T3_{75\%}$ MOLM	$T4_{100\%}$ MOLM
Cost, P					
Cost/kg feed	23.52	22.91	22.50	22.29	22.11
Cost of Pekin duck/ treatment	2,709.90	2,632.20	2,559.00	2,537.40	2,706.00
Cost of feed/Treatment	4,202.48	4,323.72	4,048.44	3,991.86	4,060.61
Cost per Pekin Duck	90.33	87.74	85.30	84.58	90.20
Cost of Feed/Duck	140.08	144.12	134.95	133.06	135.35
Total Cost per Duck	230.41	231.86	220.25	217.64	225.55
Sales					
Cost/kg Duck live weight	150.00	150.00	150.00	150.00	150.00
Total Sales/Treatment	8,319.15	9,338.85	8,495.10	8,844.75	7,812.00
Total Sales/Duck	277.31	311.30	283.17	294.83	260.40
Income/Duck	46.89	79.43	62.92	77.18	34.85

Conclusion and Recommendation

Based from the results of the study on the effect of different levels of MOLM as SOM substitute in Pekin Duck under orchard farming system, it is therefore concluded that partial substitution of *Moringa oleifera* from 25% to 75% for soybean meal could be used on the diet of pekin duck. It is further concluded that Treatment 1 (25% MOLM) obtained the best in terms of body weight, gained weight, feed intake, FCR and FCE, and return above feed cost. Substituting 25% MOLM for SOM as protein source on the diet of pekin duck is recommended under mixed-orchard farming system because it had the best results on all growth and income parameters.

It is also recommended that a similar study be conducted substituting fishmeal with different levels of MOLM as protein source in the diet of pekin duck and also to broiler and laying chickens. Likewise, a study on the anthelmintic property of moringa on poultry is also recommended.

References

Ash AJ, Petaia LA. 1992. Nutritional value of *Sesbania grandiflora* leaves for ruminant and monogastrics. Trop. Agric. (Trinidad) **69,** 223-228.

Opara CC. 1996. Studies on the Use of *Aklchornia cordifolla* Leaf Meal as Feed Ingredient in Poultry Diets. MSc Thesis. Federal University of Technology, Owerri, Nigeria.

Atawodi SE, Atawodi JC, Idakwo GA. 2010. Evaluation of the polyphenol content and antioxidant properties of methanol extracts of the leaves, stem, and root barks of *Moringa oleifera* Lam. J. Med. Food **13,** 710-716.

Austic RE, Neishen MC. 1990. Poultry Production. Lea and Febiger Publisher pp. 260-275.

Aye PA, Adegun MK. 2013. Chemical composition and some functional properties of *Moringa, Leucaena* and *Gliricidia* leaf meals. Agriculture and Biology Journal of North America **4(1),** 71-77.

Ayssiwede S, Dieng A, Bello H, Chrysostome C, Hane M, Mankor A, Dahouda M, Houinato M, Hornick J, Missohou A. 2011. Effects of *Moringa oleifera* (Lam.) leaves meal incorporation in diets on growth performances, carcass characteristics and economics results of growing indigenous Senegal chickens. Pak. J. Nutr **10,** 1132-1145.

Coles EH. 1986. Veterinary Clinical Pathology. 4th Ed. WB Saunders. Philadelphia **Djakalia B, Guichard B, Soumaila D.** 2011. Effect of *Moringa oleifera* on Growth Performance and Health Status of Young Post-Weaning Rabbits. Research Journal of Poultry Sciences **Vol 4 (1),** pp 7-13.

D'Mello J, Acamovic T, Walker AG. 1987. Evaluation of leucaena leaf meal for broiler growth and pigmentation. Trop. Agric. (Trinidad) **64,** 33-35. DZARC (Debre Zeit Agricultural Research Center), 2003.

Djakalia B, Guichard B, Soumaila D. 2011. Effect of *Moringa oleifera* on Growth Performance and Health Status of Young Post-Weaning Rabbits. Research Journal of Poultry Sciences **Vol 4 (1),** pp 7-13.

Donovan P. 2007. *Moringa oleifera* seeds for cultivation.

Esonu BO, Emenalom OO, Udedibie ABI, Herbert U, Ekpor CF Okolie. 2001. Performance and Blood Chemistry of Weaner Pigs fed with raw mucuna (velvet bean) Tropical Animal Production Investigation **4,** 49-54.

Fahey JW, Zalcmann AT, Talalay P. 2001. The chemical diversity and distribution of glucosinolates and isothiocyanates among plants. Phytochemistry **56(10),** 5-51.

Gadzirayi CT, Masamha B, Mupangwa JF, Washaya S. 2012. Performance of broiler chickens fed on mature *Moringa oleifera* leaf meal as a protein supplement to Soybean meal. International Journal of Poultry Science **11(1),** 5-10.

Gaia S. 2005. Wonder tree 100 facts *Moringa* fact 04 exceptional animal feed *Moringa* as livestock feed & pet food. Moringa Mission Trust. Available at: http://gaiathelivingplanet.blogspot.com/2005/06/wondertree-100-facts-moringa-fact-04. html (Accessed 31 October 2013).

Gaia S. 2005. Wondertree 100 fact 04 exceptional animal feed *Moringa* as livestock feeds and pet food> *Moringa* mission trust.

Golden Valley Agricultural Research Trust. 2010. Strengthening HIV/AIDS and food security mitigation mechanisms amongst smallholder farmers in Botswana, Lesotho Namibia and Zambia; Phase 2.GART Annual Report.

Hatipoğlu S, Bağci C. 1996. Some hematologic values of Peking ducks. Berl Munch Tierarztl Wochenschr. Aug **109(8),** 324.

Iheukwumere FC, Ndubuisi EC, Mazi EA, Onyekwere MU. 2008. Performance, nutrient utilization and organ characteristics of broilers fed cassava leaf meal (*Manihot esculenta* Crantz). Pak. J. Nutr **7,** 13-16.

Kakengi AMV, Kaijage JT, Sarwatt SV, Mutayoba SK, Shem MN, Fujihara T. 2007. Effect of *Moringa oleifera* leaf meal as a substitute for sunflower seed meal on performance of laying hens in Tanzania. Int. J. Poult. Sci **9,** 363-367.

Kakengki AMV, Shen MN, Sarwat SV, Fujihara. 2003. Can *Moringa oleifera* be used as protein supplement to ruminant diet? Asian-Australian Journal of Science **(3),** 467-480.

Kwedibana J. 2008. Effect of *Moringa oleifera* leaf meal on the growth rate of broilers. RM0875, Botswana College of Agriculture, Botswana.

Mabruk AA, Talib HN, Mohamed MA, Alawad AH. 2010. A note on the potential use of *Moringa oleifera* tree as animal feed, Hillat Kuku. Journal of Veterinary Medicine and Animal Production **1(2),** 184-188.

Makkar HPS, Becker K. 1997. Nutrient and quality factors on different morphological parts the Moringa tree. J. Agric. Sci **128,** 311-322.

Makkar HPS, Singh B, Negi SS. 1990. Tannin levels and their degree of polymerization and specific activity in some agro-industrial by-products. Biolog. Wastes **31,** 137-144. Kieg and Fox (1978)

Moreki JC, Gabanakgosi K. 2014. Potential Use of *Moringa oleifera* in Poultry Diets.

Nautiyal BP, Venhataraman KG. 1987. Moringa (Drumstick) an ideal tree for social forestry. 1: Growing conditions and uses. Myforest **23,** 53-58.

Nouala FS, Akinbamijo OO, Adewumi A, Hoffman E, Muetzel S, Becker K. 2006. The influence of *Moringa oleifera* leaves as substitute to conventional concentrate on the *in vitro* gas production and digestibility of groundnut hay. Livestock Research for Rural Development. 18(121). Article available at www.lrrd.org/lrrd18/9/noua18121.htm

Olugbemi TS, Mutayoba SK, Lekule FP. 2010. Effect of *Moringa oleifera* inclusion in cassava based diets fed to broiler chickens. Int. J. Poult. Sci **9,** 363-367.

Onu PN, Aniebo AO. 2011. Influence of *Moringa oleifera* leaf meal on the performance and blood chemistry of starter broilers, Nigeria. International Journal of Food Agriculture and Veterinary Science **1(1),** 38-44.

Onyimonyi AE, Adeyemi O, Okeke GC. 2009. Performance and economic characteristics of broilers fed varying dietary levels of neem leaf meal (*Azadirachta indica*). Int. J. Poult. Sci **8,** 256-259.

Opara CC. 1996. Studies on the Use of *Aklchornia cordifolla* Leaf Meal as Feed Ingredient in Poultry Diets. MSc Thesis. Federal University of Technology, Owerri, Nigeria.

Paguia HM, Paguia RQ, Flores RC, Balba CM. 2012. Utilization and evaluation of *Moringa oleifera* as poultry feeds.

Appendix

T3R1	T2R2	T1R1	T2R1	T0R1
T1R2	T3R3	T4R1	T1R3	T4R2
T4R3	T0R2	T2R3	T0R3	T3R2

Fig. 1. The Experimental Lay-out.

T0 – Control - 100% SOM
T1 – 25% MOLM substitution of SOM
T2 – 50% MOM substitution of SOM
T3 – 75% MOLM substitution of SOM
T4 – 100% MOLM