EFFECTS OF *MORINGA OLEIFERA* LEAF MEAL ON FERTILITY, EGG QUALITY AND HATCHABILITY OF JAPANESE QUAILS

Atuahene, C.C., Opoku, O., Benante, V., Quaye, B., Adu, M. A., Tamattey, B. B., and Kumah, G.
Department of Animal Science, Faculty of Agriculture,
Kwame Nkrumah University of Science and Technology (KNUST).
P. O. Box UP 244, Kumasi, Ghana.

ABSTRACT
This experiment was conducted to determine the effect of Moringa oleifera leaf meal (MOLM) on fertility, egg quality, and hatchability of Japanese quail eggs at the early stage of laying. One hundred and ninety-two (192) Japanese layer quails were randomly allocated to four (4) dietary treatments; T1, T2, T3 and T4 with 0%, 5%, 10% and 15% of MOLM **partially** ***replacing*** **similar amounts of** ***soybean meal respectively. There were 3 replicates for each treatment with 16 quails in each replicate, i.e. 4 males and 12 females in a completely randomized design. Both feed and water were provided ad-libitum each day. Eggs were collected two times daily (7am and 5pm). A total of 36 quail eggs were randomly selected and used for egg quality analysis, another batch of 480 eggs (40 eggs from each replicate) were incubated for 17 days, the hatched eggs were sorted out from unhatched eggs to determine fertility, hatchability and dead in shell. Unhatched eggs were then broken to check eggs that were unable to pip successfully. Data collected were organized in Excel and then analyzed using General Linear Model as described by Minitab (version 18.1). The means were separated using Tukey's pairwise comparison with probability value set at 5%. There were no significant (p>0.05) differences for fertility, hatchability, and dead in shell and there were no significant (p>0.05) differences in egg quality parameters studied except for yolk colour: as the MOLM levels increased, the yellow yolk colour became deeper. Moringa oleifera leaf meal can be added to Japanese quail diets up to 15% as partial replacement for soybean meal with no adverse effects on egg quality, fertility and hatchability of quail eggs.***

Keywords*: Japanese quail, Moringa oleifera leaf meal, fertility, hatchability, infertility, egg quality, dead in shell*

INTRODUCTION

Quail birds have, since introduction to Ghana, helped in diversifying the poultry sub-sector, supplemented conventional poultry production and also helped in bridging the gap of protein malnutrition (Omane *et al*., 2020). Quail farming has been growing in popularity in Ghana as the years went by. Quail birds possess the unique characteristics of fast growth (they can be sold at five weeks of age as table birds), early sexual maturity (they lay their first egg at 40 days of age), high rate of egg production (up to 250 eggs a year) and shorter incubation period (16-17 day) (Kaur *et al.*, 2008, Poynter *et al.,* 2009).

The expansion of the quail enterprise depends largely on the availability of good quality feed in sufficient quantities and at affordable prices (Odunsi, 2003). Availability of feed is very important especially for layers which are sensitive to nutritional factors such that inadequacies in nutrient supply often lead to fall in egg production (Adenjimi *et al.,* 2011). With the present rise in prices of feed ingredients especially protein sources, there is every need to get alternative protein sources that are less expensive but contains adequate protein to meet the requirement of poultry birds. Moringa plant happens to be one of the tropical leguminous plants that is rich in protein and has the potential of partially replacing soybean meal. The leaves of *Moringa oleifera* do not only provide protein but also essential vitamins such as Vitamin A, C and E (Sanchez-Machado *et al.*, 2006). Amaglo *et al.* 2010 noticed in their study that on dry matter basis, Moringa leaf contained 34.80% ether extract, 31.65% protein, 7.54% fiber, 8.9% moisture and 6.53% ash contents.

This experiment was conducted to determine the effects of *Moringa oleifera* leaf meal (MOLM) as a partial replacement for soya bean meal on fertility, egg quality and hatchability of quail eggs.

MATERIALS AND METHODS

Study Area

The experiment was conducted at Department of Animal Science, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi Ghana. The study area is located within the semi -deciduous humid forest zone of Ghana at Latitude 06° 41'N and longitude 01° 33W with altitude 261.4M above Mean Sea Level. This zone is characterized by a bimodal rainfall pattern with an average annual rainfall of 1300mm. The relative humidity varied from 83.3% in the early mornings to 57.6% in the afternoon. The trial lasted for 5 weeks

Experimental birds

A total of 192 four-week-old Japanese quails were purchased from EBY Quail Farms located at Onwe Edwenease in the Ejisu Municipal Assembly.

Experimental material

The experimental material was harvested from young *Moringa oleifera* trees from the Department of Horticulture, Kwame Nkrumah University of Science and Technology (KNUST). The harvested leaves were spread out on a concrete floor and allowed to dry for a period of seven (7) days under well-aerated shade. The dried leaves were then run through a hammer mill with 2mm diameter to produce the *Moringa oleifera* leaf meal.

Experimental design, housing and management

The 192 Japanese quails were randomly allocated to four dietary treatments with 3 replicates for each treatment in a Completely Randomized Design. Each replicate comprised of 16 birds. The birds were housed in 12 cages which were kept in a ventilated room. The birds were given access to their respective diets and water *ad libitum.*

Dietary Treatments

The Japanese quails were allocated to four dietary treatments designated as T1, T2, T3 and T4 with MOLM partially replacing similar amount of soybean meal at 0%, 5%, 10%, and 15% respectively as shown in Table 1.

Table 1: Ingredient composition of the dietary treatments fed to quails

Ingredients (%)	Dietary Treatments			
	T1(0% MOLM)	T2(5% MOLM)	T3(10% MOLM)	T4(15% MOLM)
Maize	40.00	40.00	40.00	40.00
Wheat bran	7.00	7.00	7.00	7.00
Soybean meal	50.00	45.0	40.00	35.00
MLM	0.00	5.00	10.00	15.00
Lysine and Methionine (0.1% each)	0.20	0.20	0.20	0.20
Vitamin trace mineral premix	0.20	0.20	0.20	0.20
Salt	0.50	0.50	0.50	0.50
Oyster shell	2.10	2.10	2.10	2.10
Total	100	100	100	100

Egg quality

At the end of the experiment, 48 eggs were collected, 12 from each treatment. These eggs were used to measure egg quality traits such as egg weight, egg width, egg length, shell weight, yolk height, albumen height and yolk colour. The degree of yolk coloration was determined using the Roche colour fan. Egg weight was measured with electronic scale, shell thickness by micrometer screw gauge, egg width and length by Vernier caliper and the yolk and albumen heights were measured with a spheroid tripod.

Incubation

A total of 480 eggs were set in the setting trays and incubated in a forced-air incubator to test for fertility and hathability, 160 eggs for every set of hatch for three different weeks. Incubation temperature was 37.5^{o}C and relative humidity was 65%.

Fertility

The fertile eggs were obtained by candling after which the percentage fertility was determined by dividing the total number of fertile eggs by total number of eggs set multiplied by 100.

Hatchability

Percentage hatchability of the fertile eggs were computed by dividing the number of chicks hatched by the number of fertile eggs multiplied by 100.

Dead in shell

Percentage dead in shells were determined by dividing the number of dead in shells by the total number of fertile eggs multiplied by 100.

Statistical Analysis

Data collected were organized in Microsoft Excel (2016) and analysed using the General Linear Model procedure as described by Minitab (version 18.1). The means were separated using Tukey's pairwise comparison with a confidence level of 95%.

The decrease in the crude protein across the various treatments as seen in Table 2 was as a result of MOLM having lower protein level (30.3%) (Moyo *et al*., 2011) as compared to soya bean meal (40-49%) (Banaszkiewicz, 2011; Strzetelski, 2006). The increase in crude fat from T1 to T4 could be attributed to the fact that MOLM contains higher crude fat (13.40%) (Chatepa and Chidiwa-Mbewe, 2018) as compared to the 2.18% of soya bean meal (Banaszkiewicz, 2011). Crude fibre levels also increased as the inclusion level of MOLM increased, this could be attributed to the fact that the crude fibre content of MOLM (8.07%) (Chatepa and Chidiwa-Mbewe, 2018) is higher than that of soya bean meal (6.75%) (Banaszkiewicz, 2011). Total ash content of the treatments also increased linearly with increase in the inclusion level of the MOLM which was attributable to the higher ash content (11.24%) in MOLM (Chatepa and Chidiwa- Mbewe, 2018) as compared to soya bean meal with just 5.6% ash (Strzetelski, 2006). The moisture contents however decreased as the inclusion level of MOLM increased because the moisture content of soybean meal 10.8% (Karr-Lilienthal *et al*., 2004) is higher than that of MOLM (6.9%) (Debebe and Eyobel, 2017). The decrease in metabolizable energy across the various treatments, from T1 to T3 could be attributed to the fact that the energy content of soya bean meal (3496.06 kcal/kg) is higher than that of MOLM (3249 kcal/kg) according to Etalem *et al*., 2013.

RESULTS AND DISCUSSION

The analysed chemical composition of the experimental diets is presented on the Table 2 below.

The decrease in the crude protein across the various treatments as seen in Table 2 was as a result of MOLM having lower protein level (30.3%) (Moyo *et al*., 2011) as compared to soya bean meal (40-49%) (Banaszkiewicz, 2011; Strzetel-ski, 2006). The increase in crude fat from T1 to T4 could be attributed to the fact that MOLM contains higher crude fat (13.40%) (Chatepa and Chidiwa-Mbewe, 2018) as compared to the 2.18% of soya bean meal (Banaszkiewicz, 2011). Crude fibre levels also increased as the inclusion level of MOLM increased, this could be attributed to the fact that the crude fibre content of MOLM (8.07%) (Chatepa and Chidiwa-Mbewe, 2018) is higher than that of soya bean meal (6.75%) (Banasz-kiewicz, 2011). Total ash content of the treatments also increased linearly with increase in the inclusion level of the MOLM which was attributable to

Table 2: Analysed chemical composition of the experimental diets (As fed bases)

Components (%)	Dietary Treatments			
	T1(0% MOLM)	T2(5% MOLM)	T3(10% MOLM)	T4(15% MOLM)
Crude protein	31.92	30.77	30.42	28.95
Fat	1.98	1.99	1.99	2.00
Crude fibre	2.61	2.93	3.22	3.33
Total Ash	3.06	4.09	5.13	6.25
Moisture	10.79	10.53	10.30	10.05
*M.E, kcal/kg	3,062.25	3,031.25	3001.22	2969.90

**Calculated*

the higher ash content (11.24%) in MOLM (Chatepa and Chidiwa-Mbewe, 2018) as compared to soya bean meal with just 5.6% ash (Strzetelski, 2006). The moisture contents however decreased as the inclusion level of MOLM increased because the moisture content of soybean meal i.e. 10.8% (Karr-Lilienthal *et al*., 2004) is higher than that of MOLM (6.9%) (Debebe and Eyobel, 2017). The decrease in metabolizable energy across the various treatments, from T1 to T3 could be attributed to the fact that the energy content of soya bean meal (3496.06 kcal/kg) is higher than that of MOLM (3249 kcal/kg) according to Etalem *et al*., 2013.

Egg weight, length and width

There were no significant (p>0.05) differences in egg weight, length and width across the treatments, but there were numerical difference among the treatments, with the treatment groups (T2, T3, T4) recording higher mean values as compared to the control (T1) (Table 3). This finding is consistent with the findings of Ebenebe *et al*. (2013) who reported no significant (P>0.05) differences in the egg weight, length and width of Isa brown breed of layer's (chicken) eggs when they fed them with varying levels of MOLM. Sarwatt *et al*. (2004) observed that birds on treatment diets recorded higher mean values for egg weight, length and width than those of the control group and attributed it to the higher nutritive value of Moringa leaves.

Shell thickness, shell moist weight and dry matter of shell

Shell thickness, moisture and dry matter also showed no significant (p>0.05) differences across the various treatments, however the treatment groups (T2, T3 and T4) numerically rec-

Table 3: Effects of MOLM on mean external parameters of Japanese quail eggs

External traits	Dietary Treatments				P-Value
	T1(0% MOLM)	T2(5% MOLM)	T3(10% MOLM)	T4(15% MOLM)	
Egg weight(g)	10.860	11.037	11.047	11.080	0.525
Egg length(cm)	3.200	3.200	3.210	3.267	0.244
Egg width (cm)	2.533	2.567	2.583	2.600	0.363
Shell thickness(mm)	0.260	0.273	0.273	0.263	0.574
Shell moisture weight(g)	1.257	1.270	1.277	1.280	0.283
Dry matter of shell (g)	0.967	0.950	0.947	0.943	0.633

[ab]Mean values within the same row with different superscript are significantly (p<0.05) different.

orded higher mean values for shell thickness and moisture weight as compared to the control (T1). Dry matter on the other hand, numerically decreased as the inclusion of MOLM increased among the treatments. The high mean value recorded for shell thickness among the treatment groups as compared to the control group could be attributed to the elevated calcium content of Moringa leaves (870mg/100g) (Ming-Chih *et al*., 2011) as compared to that of soybean meal (300.36mg/100g) (Etiose *et al*., 2017). The observation made for moisture and dry matter content of the eggs in the present study is consistent with the observation made by Narayanankutty e*t al.* (1989) who noted an increase in the moisture content of the eggs of brown leghorn chicken when they included MOLM at varying levels in their diets, and a decline in the dry matter content as the inclusion levels of the MOLM increased in the diet.

Albumen height, yolk height and dry matter of yolk

There were no significant differences (p>0.05) in egg albumen height, yolk height and dry matter of yolk (Table 4), but there were numerical difference in these traits among the various treatments with the control group (T1) recording higher mean value for albumen height and dry matter weight as compared to the treatment groups (T2, T3 and T4), notwithstanding, the treatment groups (T2, T3 and T4) recorded higher mean value for yolk height as compared to the control group(T1). Keshavarz (2003) observed that, reducing dietary protein from the diet, drops egg production, egg weight, and egg quality traits such as albumen size, so it is only natural that the albumin height of the control group perform was better than that of the treatment group, because the protein content of soybean meal (40-49%) (Banaszkiewicz, 2011; Strzetelski, 2006) is higher than that of MOLM (30.3%) (Moyo *et al*., 2011). The effect of MOLM on egg yolk height as seen in the present study might be due to the presence of lysine and methionine in Moringa leaves as reported by (Bunchasak and Silapasort, 2005). The higher mean value recorded by the control group as compared to the treatment groups for dry matter of yolk could be attributed to the higher moisture content of the eggs among the treatment groups.

Yolk colour and yolk weight

There were significant differences (P<0.05) in yolk colour among the various teatments. Yolk colour was deeper in treatments with MOLM compared to the control (T1) in the order T1<T2<T3<T4. This observation could be attributed to pigmenting agents that may be present in Moringa leaves. Though the present study did not carryout any analysis on pigment seperation but the findings of Tesfaye *et al*. (2013) and Olugbemi *et al.* (2010) suggests that moringa leaves contains *xanthophylls* and other pigmenting agents. A similar trend was observed by Kakengi *et al.* (2007); Olugbemi *et al.* (2010) and Abou-Elezz *et al*. (2011) when they included MOLM at 5 and 10% levels in layer ration. With the current rise in consumer appetite and preference for eggs with golden yellow to orange coloured yolk (Hasin *et al*., 2006; Amerine *et al.,* 2013; Jacob *et al.,* 2000), it is only advisable that famers incorporate pigmenting agents of

Table 4: Effects of MOLM on mean internal parameters of Japanese quail eggs

Internal traits	Dietary Treatments				P-Value
	T1(0% MOLM)	T2(5% MOLM)	T3(10% MOLM)	T4(15% MOLM)	
Albumen height(mm)	3.440	3.290	3.270	3.267	0.878
Yolk height(mm)	10.240	10.337	10.340	10.453	0.329
Yolk colour	1.000[a]	5.000[b]	6.000[c]	7.000[d]	0.013
Yolk weight(g)	3.4833[b]	3.7767[a]	3.5667[ab]	3.8100[a]	0.019
Dry matter of yolk(g)	2.8700	2.8167	2.8233	2.8410	0.938

[ab]*Mean values within the same row with different superscript are significantly (p<0.05) different.*

Table 5: Effects MOLM on fertility, hatchability and dead in shell of Japanese Quail eggs

Parameters(%)	Dietary Treatments				P-Value
	T1(0% MOLM)	T2(5% MOLM)	T3(10% MOLM)	T4(15% MOLM)	
Hatchability	60.7	79.3	63.4	65.9	0.525
Fertility	72.5	80.8	57.5	68.3	0.375
Dead in shell	28	16	20	23	0.525

which MOLM is an example in the diets of layer birds.

There were signficant differences (P<0.05) in yolk weight where the treatment groups (T2, T3, T4) recorded a higher mean weight compared to the control (T1). This trend may be attributed to the presence of lysine and methionine in *Moringa* leaves. *Moringa oleifera* leaf meal contains lysine, methionine and a combination of other amino acids, which could supply the required amount of essential nutrients for better production of eggs and improvement of yolk weight (Sohail *et al*., 2003). According to Gunawardana *et al*. (2008) and Fakhraei *et al*. (2010), increased methionine and lysine in the feed improves egg production and increases egg yolk weight.

Fertility, hatchability and dead in shell of Japanese quail eggs

Moringa oleifera leaf meal did not significantly (p>0.05) affected fertility, hatchability and dead in shell of Japanese quail eggs. However the values recorded for fertility and hatchability were numerically low among the control group compared to the treatment groups. This result is consistent with the finding of Tesfeye *et al.* (2013) who recorded no significant difference in fertility and hatchability of layers when they included MOLM in their diets. Park *et al*. (2004); Mahmood and Al-Daraji (2011) and Moyo *et al.* (2011) reported that MOLM contains higher levels of zinc and vitamin E, which can play a beneficial role in increasing percentage hatchability of eggs, because zinc plays a key role in protecting the structure of the genetic material or the DNA chromatin in the sperm nucleus, a structure important for successful fertilization (Amen and Aldaraji, 2011). However, the relatively poor hatchability and higher dead in shell observed in the control group of the present study might be due to a deficiency in critical nutrients, such as zinc, and vitamin E which are important for better hatchability (Park *et al.,* 2004; Mahmood and Al-Daraji, 2011).

CONCLUSION

Moringa oleifera leaf meal can be added to Japanese quail diet up to 15% as partial replacement for soybean meal with no adverse effects on egg quality, fertility and hatchability.

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