



Comparative Evaluation of Garlic (*Allium sativum*) Meal as Natural Feed Additives on Egg Production and Egg Quality of Laying Japanese Quails

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Abstract

This study was carried out to evaluate the effect of dietary levels of garlic (0, 250, 500, 750 g) meal on productive performance and egg quality of laying quails. Three hundred (300) birds were randomly allotted to four dietary treatments with seventy-five (75) birds per treatments and were replicated three times in a completely randomized design with twenty-five (25) birds per replicate. Egg production, feed intake, egg weight, number of egg per bird, egg mass, egg surface area, Haugh unit, albumen and yolk index were measured. Data obtained were subjected to analysis of variance using Statistical Analysis System and significant differences between treatment means were separated using Duncan Multiple Range Test. Results showed significant effects on feed intake, egg weight, number of egg per bird, egg mass, egg surface area, egg production, albumen and yolk index for birds fed diets containing 750 g garlic meal. Feed cost/crate for birds fed diets containing 750 g garlic meal decreased (better) significantly than other dietary treatments, birds fed diets containing 750 g garlic meal showed a higher egg mass than other treatments. No significant effect was observed for Haugh unit. It was concluded that adding 750 g garlic meal into a laying quail diets had positive effects on productive performance and egg quality parameters hence this level is recommended for adoption.

Keywords: Garlic meal, Egg production, Egg quality, Feed additive, Japanese quail

Introduction

In poultry production feed additives are used in feed to improve nutritive value and enhance their performance. Feed is the major component of total costs of poultry venture as 80% of the total expenditure is on procurement of feed. Antibiotic is intensively used in poultry's ration to improve productivity but it has got negative effects on animal and human health (Noman *et al.*, 2015). Although antibiotics are less frequently used in egg-laying chickens' husbandry systems compared to the meat type ones, antibiotics in poultry and its transfer to humans is a major concern. For these reasons, researchers have focused on the use of additives which preserve the desired features and do not have negative effects on health and environment. These products are

harmless to humans and animals with no undesired side effects. In addition, there is no complication of drug resistance due to their consumption also pressure from consumers of cheaper animal products have necessitated the assessment of local feed ingredients for possible utilization during periods of scarcity and soaring costs (Oluokun, 2001).

Previous research has shown that herbal plants and their extracts have different biological activities in poultry, ranging from antibacterial properties, anti-parasitic, anti-viral and antioxidant (Kamel 2001; Botsoglou *et al.*, 2005). Phytogetic feed additives have shown promising effects with regard to weight gain, feed efficiency, lowered mortality, increased

livability and increased egg production in poultry (Ahmad and Khan, 2008). Garlic, a member of the *Liliaceae* family, is used for centuries as a spice and also in the popular medicine. Garlic originated from Asia Minor and spontaneously grew into southern Europe, and is now found all over the world. It's a rich source of calcium, phosphorus and vitamin B1; it has a high content of carbohydrates and as a consequence a high nutritive value. Garlic (*Allium sativum*) has been used as a spice and a natural medicine for many years. This is an important spice in traditional cooking of curry in Indian sub-continent and is cheap and available (Huda *et al.*, 2008). Therefore, the present study was aimed to examine the effects of garlic meal on laying performance and egg traits of Japanese quails.

Materials and methods

Experimental Site

The experiment was conducted at the Poultry Unit, Kabba College of Agriculture, Division of Agricultural Colleges, Ahmadu Bello University, Zaria, Kaduna State. Kabba is located in the Southern Guinea Savannah Ecological Zone of Nigeria on the Latitude 7°53' N, Longitude 6°02' E with an average rainfall of about and 1200mm per annum, with average temperature ranges from 18°C -32°C . It is 427m above sea level (Kabba college of Agriculture Meteorological Station, (2015).

Source and Processing of Garlic bulb

Garlic bulbs were purchased from a local market in Kabba, Kogi State. The garlic bulbs were sliced, shade-dried for 7 days and milled before being incorporated into the experimental diets.

Design and management of experimental birds

Three hundred (300) six weeks old Japanese quails were used in this study. The quails were allotted to four dietary treatments with

seventy-five (75) quails per treatment. Treatments were replicated three times with twenty-five (25) quails each in a completely randomized design. The birds were housed in deep litter system of management. The basal diet was formulated according to National Research Council (NRC) (1994). Fresh feed were mixed weekly and not stored for more than one week. All birds had full access to feed and water. The photoperiod was 16 hours of light per day throughout the experimental period, which lasted for 16 weeks. Biosecurity measures were ensured throughout the experimental period.

Experimental Diets

Four experimental diets were formulated for the experiment

Treatment 1- 0 inclusion of experimental material (Control)

Treatment 2 –250g inclusion of garlic meal per 100kg

Treatment 3 –500g inclusion of garlic meal per 100kg

Treatment 4 –750g inclusion of garlic meal per 100kg

Diets were formulated to contain 22% crude protein

Chemical analyses

Proximate analysis of the garlic meal and diets were conducted using standard methods (AOAC, 1995) to determine their chemical compositions.

Data collection

Records were kept for egg production, feed consumption, egg weight, average body weight change and mortality. Eggs were collected once daily (8:00 – 9:00am), counted, weighed and recorded per replicate pen. Ten eggs records representing the average weight of the eggs from each replicate were used forth-nightly to determine the egg quality

parameter throughout the 16 weeks experimental period.

Determination of Egg Production

The following were determined:

Hen day production (HDP) = $\frac{\text{Total number of eggs produced on a day} \times 100}{\text{Total number of hens present on that day}}$

present on that day

Hen housed production (HHP) = $\frac{\text{Total number of eggs produced on a day} \times 100}{\text{Total number of hens housed at the beginning of laying period}}$

Egg Mass = $\frac{\text{Egg number} \times \text{Average egg weight}}{1000}$

Feed cost/dozen egg = Feed cost x cost/12 eggs

Income above feed expenses at crates = Cost /crate of egg – Feedcost/crate of eggs

Determination of Internal and External Egg Parameters

The external quality characteristics of eggs measured were; Egg weight (g) measured using a sensitive scale by weighing the eggs individually to nearest 0.01g. Shell thickness (mm) measured with a micrometer screw gauge (which is the thickness of dried egg shell, the mean of the three points: narrow, broad and middle).

The eggs were broken with the aid of a scapel and the content emptied into a Petri-dish to measure their internal quality parameters as follows; Egg yolk height and width were measured using vernier callipers and the values obtained were used to calculate the yolk index.

YI = YW/YH Where: YI = Yolk index, YW = Yolk width (cm), YH = Yolk height

Albumen index was calculated as the ratio of the albumen height to egg width. Haugh unit was calculated from the measured height of albumen and weight of egg using the formula outlined by Haugh (1937).

Haugh unit (HU): $100 \log (H+ 7.5- 1.7W^{0.35})$ where H- height of thick albumen (mm), W- egg weight (g)

Statistical Analysis

All data generated were subjected to analysis of variance (ANOVA) using completely randomized design (CRD) while the mean difference were separated using the Duncan Multiple Range Test (Duncan, 1955).

Experimental Model

The linear model for the experiment is:

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

Where Y_{ij} = the j^{th} observation in the i^{th} levels of garlic meal

μ = overall mean

M_i = fixed effect of garlic meal levels (0, 250g, 500g and 750g).

e_{ij} = random error (All error terms were assumed to be random, normally distributed and independent with expectation equal to zero).

Results and Discussion

The gross composition of experimental diets are presented in Table 1. It indicated that the nutrient needed for egg production and development were well balanced and utilized by the experimental birds, thus leading to better egg grading which would attract better price. The proximate compositions of test material (garlic) are presented in Table 2. The results showed that the crude protein (CP), crude fibre (CF), ether extracts (EE), nitrogen free extracts (NFE) and ash content of garlic (*Allium sativum*) meal were 14.24%, 6.36%, 5.77%, 67.81% and 5.82% respectively. This indicates that the plant contains some considerable levels of nutrients other than their phytochemical values and it agrees with the reports of Otunola *et al.* (2010).

Laying Performance and Economic Benefits of Japanese Quails Fed Diets Containing Garlic Meal.

All the parameters measured for production were significant ($p < 0.05$) across the dietary treatments for final weight, % weight change,

feed intake, number of egg per bird. Birds fed 750g garlic meal (GM) had the best final weight (148.67g/b), feed intake (240.00g/b) and number of eggs per bird (54.33). The laying quails weighed from 120–160 g at 5-6 weeks of age. The body weight at 42 days were taken to represent average body weight for quails at sexual maturity or the age average of first egg laying based on existing references. The result of the average body weight of the birds at 42 days old was higher at 750g GM than other treatments. The result obtained from this study agrees with the observations Dauda *et al.*(2014) and Kaharuddin *et al.*(2008) who reported 100.34 - 138.91 g/b as weight of female Japanese quail at 42 days. Body weight has considerable variation depending on the type of animal, sex, age, strain, management, ambient temperature, quality and quantity of feed (North *et al.*1999). Age at first egg reported in this study for garlic meal (34.33-35.33g/d) was lower than the findings of Minvielle *et al.* (2000) who reported that the age at first egg ranged from 36.9 to 44.1 d in 8 genetic groups, this might be due to environmental condition, season at the period of the experiment, breeds and management. Age at 50% egg (day) reported in this study (46.54- 50.21d) is in agreement with the results of 46.9d found in an unselected control group reported by Sezer *et al.*, (2006). Weight of first egg reported in this study (6.00-7.67g) corresponds with 7.28g reported by Lawani (2015) in quails fed phyto-genic additives. Feed conversion ratio obtained in the study ranged from 1.96 – 2.40 which is in agreement with Aduku (1993) who reported the value of 2.65 in the tropics. Feed conversion ratio in 250g and 500g garlic meal (2.00 and 1.96) respectively showed most superiority over other dietary treatments and efficiency of FCR decreased with increased levels of garlic meal in the diet and then increased at 750g GM. This may be due to the garlic meal contributory effect of higher fibre content as seen in Table 2 which necessitates the need for consumption

of more feed to meet the energy requirement since birds eat to meet their energy needs (Lesson and Summers, 1997).

In the current study, birds fed garlic meal at 750g produced more eggs though had the highest FCR (2.40) while birds fed 250g and 500g are statistically the same both for FCR and number of eggs produced, this is due to utilization of feed more efficiently than other dietary treatments. In contrast to our results, Botsoglou *et al.* (2005) reported that addition of phyto-genics to a layer diet had no significant effect on egg production, feed intake and feed conversion ratio. In this study, egg weights vary among different treatments, these findings are not in accordance with those of Bozkurt *et al.*, (2012). All the parameters measured were significant across the dietary treatments and may be due to good nutrient utilization of garlic meal. HDP-Peak, HHH-Peak, egg mass, weight at 1st egg and weight of 1st egg showed a significant ($p \leq 0.05$) improvement and were better in birds fed diets supplemented with 750g/100kg garlic meal. The egg weight from this study varied from 10.00 – 11.67g. According to Abeke (1997) egg weight is more of a function of the age of birds and the quality of feed. The improved egg and yolk weight recorded in plant herbs based diets is suggestive of enhanced nutritional quality of the diets. It is of interest to note that egg weight did not decline by the increase of egg production for birds fed 750g GM during the experimental period, this result is in agreement with Elnagar *et al.* (2005) that garlic increased the levels of serum and insulin hormones, these hormones are responsible for increasing the metabolic rate in the body. HDP (68.30-90.00%) reported at peak of lay in this study is lower than values (94.56%) reported by Ajide (2011) and Ehoche (2010) who also reported that Japanese quails reached their peak of production 7 weeks from point of lay with 91.86% hen day production. Income above feeding expenses per crate were in birds fed diets containing 0g , 250g/100kg

and 750g/100kg garlic meal diet and are statistically similar respectively. This implies that feeding Japanese quails with garlic meal at 250g and 500g per 100kg diets increases income above expenses on feeding Lin *et al.* (2004). The use of garlic meal in poultry nutrition was reported by Carrijo *et al.*, (2005) to improve immunity, hence increasing survivability and reducing mortality rate. The diets may have been nutritionally adequate to sustain the quail's health and production despite the high level of crude fibre in the garlic meal.

Egg Quality Parameters of Japanese Quails Fed Diets Containing Garlic Meal

The effect of garlic meal supplementation on the egg quality parameters of quails is given in Table 5. There were improvements in all internal and external quality of quail eggs fed garlic meal except for Haugh unit which was similar for all treatments. The observed values of egg weights, shell weight, shell thickness, albumen index, yolk index, egg surface area and haugh unit in Table 5 ranged from 8.23 to 8.95g, 0.43 to 0.50mm, 17.91 to 25.82%, 49.76 to 68.26%, 38.49 to 45.45 and 67.35 to 68.63% respectively. Egg weight, egg shell thickness and shell weight values showed that there were significantly ($p < 0.05$) difference across the treatment group this could be due to high minerals and vitamins in test ingredients. The higher shell weight values observed in quails fed diets containing 750g garlic meal compared to other dietary treatments might be due to increase in feed intake across the dietary treatments. The improvement in eggshell thickness strength in current study is supported by the findings of Kaya *et al.*, (2013) who reported that phyto-genic feed additives enhanced eggshell thickness. Yolk and albumen index percentages were significantly higher for birds fed 750g GM compared to other treatments, these results agreed with Osawa *et al.*, (1995) who reported that allicin stimulate protein synthesis by bird enzymatic

system which in turn can lead to improved internal egg quality. The means obtained for Haugh unit in this study supported the report of Yalcin *et al.*, (2006) that supplementation of garlic powder had no effect on Haugh unit when laying hens were fed 5 and 10 g/kg garlic powder for 22 weeks, the reason for these differences might be the low level of garlic powder used. In the present study, the Haugh unit decreased with an increasing level of garlic meal supplementation. In contrast, Lim *et al.* (2006) reported that with increasing dietary garlic powder, the Haugh unit linearly increased after two weeks of storage. However, they found that egg weight increased with increasing the different dietary levels of garlic meal, this can be as a result of storage, handling, room temperature and air movement. Ramirez-Tortosa *et al.*, (1999) suggested that certain natural herb such as garlic, turmeric, ginger, etc. and their active compounds such as allicin have beneficial effects on external and internal quality of quail eggs due to their antioxidant properties. The variations in the effects of adding garlic meal into laying quail diets among the different studies might be attributed to differences in the percentages, grams, periods of supplementation, garlic sources, the stability of active compounds, age and strains, preparation methods for garlic used (drying method, organic solution or alcohol extraction, et.c), garlic products used and experimental methods used.

Conclusion

Based on the results obtained in this study, it was concluded that addition of 750 g garlic meal in 100kg diet improves production performance, external and internal egg quality parameters of Japanese quails.

Recommendations

For optimum performance and production of laying quails, 750 g garlic meal in 100 kg diet is recommended for farmers and feed millers.



Table 1: Gross Composition of Experimental Diets (%)

Ingredients	Inclusion levels of garlic meal (g)			
	0	250	500	750
Maize	56.65	56.40	56.16	55.90
Soyabean cake	14.50	14.50	14.50	14.50
Groundnut cake	20.50	20.50	20.50	20.50
Bone meal	3.00	3.00	3.00	3.00
Limestone	3.00	3.00	3.00	3.00
Garlic Meal	0.00	0.25	0.50	0.75
Common salt	0.30	0.30	0.30	0.30
Lysine	1.30	1.30	1.30	1.30
Methionine	0.50	0.50	0.50	0.50
Vitamin Premix	0.25	0.25	0.25	0.25
Total (%)	100.00	100.00	100.00	100.00
Calculated Analysis				
ME Kcal/kg	2772	2767	2761	2756
Crude Protein (%)	22.00	22.00	22.00	22.00
Crude fibre(%)	3.71	3.71	3.71	3.71
Ether extracts (%)	4.35	4.42	4.36	4.37
Calcium (%)	1.94	1.94	1.94	1.94
Phosphorus (%)	0.51	0.51	0.51	0.51
Meth + cys (%)	0.62	0.62	0.62	0.62
Lysine (%)	1.61	1.61	1.61	1.61
Feedcost #/kg	130.02	136.40	139.70	142.90

^AVitamin-mineral premix provide per kg of diet; Vit. A, 10,000,000 IU; Vit. D₃, 2,000,000 IU; Vit. E, 40,000mg; Vit. K₃, 2000mg, Vit B₁, 1500mg; Vit. B₂, 5,000mg, Vit.B₆, 4,000mg; Vit. B₁₂, 20mg; Niacin, 40,000mg; Folic acid, 1,000mg; Biotin, 100mg; Choline Chloride, 30,000mg; Cobalt, 300mg; Copper, 80,000mg; Iodine, 800 mg; Iron, 40,000mg; Manganese, 80,000 mg; Selenium, 200 mg; Zinc, 60,000mg; ME = Metabolisable Energy, Meth + cys, =Methionine + cysteine

Table 2: Proximate Composition of Garlic meal

Parameters (%)	Garlic Meal
Dry matter	82.07
Crude protein	14.24
Crude fibre	6.36
Ether extracts	5.77
Ash	5.82
Nitrogen free extracts	67.81

Table 3: Proximate Composition of Japanese Quail Experimental Diets

Parameters (%)	Levels of garlic meal (g)			
	0	250	500	750
Dry Matter	92.05	92.67	92.36	92.31
Crude protein	21.37	21.76	21.89	21.91
Crude fibre	4.00	4.09	4.12	4.19
Ether extract	6.21	6.27	5.63	5.47
Ash retention	8.46	7.64	7.25	8.28
Nitrogen Free Extract	59.96	60.24	61.11	60.15

Table 4: Laying Performance of Japanese Quails Fed Diets Containing Garlic Meal

Parameters	Levels of garlic meal (g)				SEM
	0	250	500	750	
Production performance					
Initial weight(g/b)	148.43 ^d	154.07 ^c	164.37 ^b	172.57 ^a	1.80
Final weight (g/b)	141.33 ^c	143.00 ^c	146.67 ^b	148.67 ^a	0.67
%Weight change(g/b)	-4.76 ^a	-7.15 ^b	-10.76 ^c	-13.37 ^d	1.16
Total Feed Intake (g/b)	215.00 ^c	223.00 ^b	227.00 ^b	240.00 ^a	0.03
Daily Feed Intake (g/b/d)	13.99 ^c	14.51 ^b	14.76 ^b	15.59 ^a	0.16
Number of eggs/b	43.67 ^b	44.67 ^b	44.67 ^b	54.33 ^a	2.53
Age and Egg laying production					
Age @ 1 st egg	27.00 ^c	27.67 ^b	28.00 ^a	28.33 ^a	0.14
Weight@1 st egg (g/b)	147.90 ^d	153.10 ^c	163.53 ^b	172.23 ^a	1.26
Weight of 1 st egg (g/b)	7.00 ^c	7.67 ^b	8.33 ^a	8.67 ^a	0.48
Age @ 50% egg(days)	50.21 ^a	49.41 ^b	48.37 ^c	46.54 ^d	0.72
% egg @ peak	68.33 ^b	76.67 ^a	76.67 ^a	81.67 ^a	4.25
Average egg weight(g)	10.00	10.47	10.67	11.67	0.37
HHP-Peak (%)	68.33 ^b	76.67 ^b	76.67 ^b	81.67 ^a	4.25
HDP-Peak (%)	68.33 ^b	76.67 ^b	76.67 ^b	81.67 ^a	4.25
Egg mass (g/b)	466.67 ^b	446.6 ^b	445.67 ^b	577.00 ^a	30.74
Economic benefits					
FeedCost/crate(₦/kg)	197.81 ^a	206.60 ^a	213.64 ^a	191.19 ^b	9.41
Cost/crate (₦)	300.00	300.00	300.00	300.00	0.00
Inc. abvfdexp/crate	102.19 ^a	93.40 ^a	86.36 ^b	108.8 ^a	9.42
FCR	2.17 ^b	2.00 ^a	1.96 ^a	2.40 ^c	0.06
Mortality (%)	0.00	0.00	0.00	0.00	0.00

^{abcd} means in the same row with different superscripts are significant (P<0.05), Inc. abvfdexp/crate= Income above feed expenses/crate, FCR= Feed conversion ratio, SEM= Standard error of mean.

Table 5: Egg Qualities Parameters of Japanese Quails Fed Diets Containing Garlic Meal

Parameters	Levels of garlic meal (g)				SEM
	0	250	500	750	
Egg weight(g)	8.65 ^b	8.23 ^c	8.83 ^a	8.95 ^a	0.24
Shell weight (g)	1.18 ^c	1.23 ^b	1.23 ^b	1.25 ^a	0.01
Shell thickness (mm)	0.47 ^b	0.43 ^d	0.45 ^c	0.50 ^a	0.01
Albumen index (%)	17.91 ^c	20.17 ^b	17.79 ^c	25.82 ^a	3.67
Yolk index (%)	49.76 ^d	59.62 ^b	55.75 ^c	68.26 ^a	6.00
Egg surface area	44.27 ^b	38.49 ^c	45.45 ^a	43.81 ^b	2.15
Haugh unit	68.25	68.63	67.91	67.35	3.21

^{abcd} means in the same row with different superscripts are significant (P<0.05). SEM= Standard error of mean

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