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Growth performance, nutrient digestibility and carcass quality of Japanese quail (*Coturnix coturnix japonica*) fed diets containing graded levels of garlic (*Allium sativum*) meal

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Target Audience*: Nutritionists and Researchers*

Abstract

This study was carried out to investigate the growth performance, nutrient digestibility and carcass characteristics of Japanese quails fed graded levels of garlic meal The birds were randomly allocated to four dietary treatments of one hundred twenty four (124) birds each, and were replicated three times in a completely randomized design with thirty one (31) birds per replicate. They were fed four experimental diets containing 0, 250g, 500g and 750g garlic meal. Feed and water were provided ad libitum. 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. There were significant differences ($p<0.05$) in final weight, weight gain, average daily weight gain, total feed intake, feed conversion ratio, feedcost/kg gain and mortality across the treatment groups. It was observed that quails fed dietary level of garlic meal at 750g had the best results in terms of all the parameters for performance and nutrient digestibility, except for crude protein that compared favourably at 500g and 750g inclusion. However, it was observed that Japanese quails fed garlic meal at 750g had the best live weight and no significant difference ($p<0.05$) was observed for dressed weight and dressing percentage. For optimal productivity 750g inclusion of garlic meal is therefore recommended.

Keywords: *Japanese quails, garlic meal, performance, nutrient digestibility, dietary levels.*

Description of problem

Garlic, a member of the Allium family (Liliaceae), has been used traditionally for ages to treat a wide array of diseases, namely, respiratory infections, ulcers, diarrhea and skin infections (1). Garlic (*Allium sativum*) gained the trust of many scientists and cultural believers as remedies all over the world for the prevention and treatment of many diseases and is broadly dispersed and consumed as a spice and herbal medicine for thousands of years. Recent studies have validated the medicinal properties attributed to garlic and its potential to lower the risk of diseases. (2,3) reported garlic as a plant with antibiotic, anticancer,antioxidant, immunomodulatory, anti inflammatory, hypoglycaemic and cardi ovascular protecting effects. Garlic has been shown to have anti-thrombotic activity (4), lower blood lipids, blood tension, and had a cardio-protective effect (5; 6), antibacterial properties and a potent inhibitor of food pathogens (7; 8). The mechanisms of garlic have been accredited to its effective antioxidants action (9), and its ability to

stimulate immunological responsiveness (10).

In addition to nutritional substances necessary for growth and development of chicks, the feed is regularly supplemented with pharmacological products, either for preventive purposes, as prevention against certain diseases (e.g coccidiostat) or as growth stimulators (antibiotics), primarily in case of young chicks (11). The application of such treatment reduces the number of chicken deaths and the costs of medical treatment. In addition, garlic has a positive effect on growth, feed conversion and meat quality. Moreover, garlic is very rich in aromatic oils, which enhance digestion and positively influenced respiratory system being inhaled into air sacs and lungs of birds. Also, it was found that garlic has strong antioxidative effects (12).

Japanese quail (*Coturnix coturnix japonica*) are hardy birds, more tolerant to poor managemental condition and also to common poultry diseases like Marek's disease and New Castle disease among others (13). Quail is a highly nutritive and rich source of animal protein. In the present study Japanese quail diets were supplemented with graded levels of garlic meal to evaluate the effect of garlic supplemented quail diets on performance, nutrient digestibility and carcass characteristics.

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 $7^{o}53'$ N, longitude $6\ ^{o}02$ E with an average rainfall of about 1200mm per annum with an average temperature range from $18^{o}C$ -$32^{o}C$. It is 427m above sea level (14).

Source and Processing of Garlic bulb

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

Design and management of experimental birds

A total of 372 (three hundred and seventy-two) two weeks old Japanese quails of mixed sexes (*Coturnix coturnix japonica*) were obtained from National Veterinary Research Institute, (NVRI) Ikire, Osun State and were used for the experiment. The chicks were weighed and allotted to four dietary treatment groups. Treatments were replicated three times with thirty-five (35) quails each in a completely randomized design. The birds were reared on deep litter system. Kerosene stove and coal pots were used to provide heat while electricity bulbs were installed in each pen to provide light and heat during the brooding period (two weeks). Feed and water were provided *ad libitum*. The feeding trial lasted for four weeks.

Experimental Diets

Four experimental diets were formulated for the experiment

Treatment 1- 0.00% inclusion of experimental diet (Control)

Treatment 2 –0.25% inclusion of garlic meal

Treatment 3 –0.50% inclusion of garlic meal

Treatment 4 –0.75% inclusion of garlic meal

Performance parameters

Performance parameters measured include initial body weight, final body weight, weight gain, feed intake, feed

conversion ratio and feed cost/kg gain. Feed intake and body weight gain were taken weekly and were calculated thus:

Feed intake (g) = feed given (g) – left over feed (g) on daily basis.

Body weight=

$$\frac{\text{Total weight of quails (replicate) (g)}}{\text{Number of quails (replicate)}}$$

Weight gain= weight of the current week - weight of preceded week (g). This was used to calculate average or daily feed intake and weight gain.

Feed conversion ratio (FCR) was calculated on the basis of unit of feed consumed to unit of body weight gain.

FCR= $\frac{\text{Feed consumed (g)}}{\text{Weight gain (g)}}$

Digestibility trial

Digestibility trial was carried out at the last week of the growing phase (6 weeks of age). Four birds from each replicate were taken to a clean, separate and dis-infected metabolic cage with polythene bag attached to the beneath of the cage. They were allowed 3 days for acclimatization before the commencement of the study. A known weight of feed was fed to the birds morning and afternoon during the digestibility trial. Faeces were collected daily for a period of four days. The dried feacal samples were weighed and ground after which feacal samples along with the sample of the feed given were taken to the Biochemical Laboratory, Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria, to determine the proximate composition according to the methods described by (15). Nutrient retention was determined for crude protein, crude fibre, ether extract, ash, and nitrogen free extract.

Nutrient Retention=

$$\frac{\text{Nutrient intake – Nutrient output}}{\text{Nutrient intake}} \times 100$$

Carcass analysis

At the end of the 6th week, five birds from each pen were used. The birds were fasted overnight in order for emptying of the gastro-intestinal tract (GIT) and weighed. The selected birds were slaughtered for carcass analysis by severing the neck with a sharp knife and allowed to bleed completely. They were defeathered and eviscerated. The liver, gizzard, thigh and breast were weighed and expressed as percentages of live body weight and other carcass cuts were expressed as percentage of dressed. The intestinal length was measured in centimetres.

Chemical analysis

The proximate composition of the test ingredient (Garlic meal) and experimental diets were determined using the procedures of the Association of Analytical Chemist (16).

Statistical Analysis

All data obtained were subjected to analysis of variance (ANOVA) and treatment means which differed significantly ($p < 0.05$) were separated using Duncan's New Multiple Range Test as outlined (17).

Results and discussion

Effect of garlic meal on growth performance

The growth performance of Japanese quails fed diets supplemented with garlic meal is presented in Table 2. Significant differences ($p<0.05$) were observed for all parameters measured except for initial weight. Final weight, total weight gain, average daily weight gain and total feed intake were significantly ($p<0.05$) higher in

Japanese quails fed diet containing 750g of garlic meal (172.57g/b, 119.20g/b, 4.26g/b/d, 487.45g/b, respectively) while feed conversion ratio and feed cost per kg weight gain were significantly ($p<0.05$) better in Japanese quails fed diet containing 750g of garlic meal (4.09, 33.24₦/kg respectively) above the other treatments. Final weight, weight gain and total feed intake increases as levels of garlic meal increases in the experimental diets indicating that as levels of garlic meal increases there was a corresponding increase in weight gain by the birds. The increase in body weight gain observed may be partly due to the increased feed intake as garlic meal increased. The result is in agreement with the report of (18) who suggested that replacing garlic meal for antibiotic as growth promoter could maintain productive performance of quails up to 1.3%. Natural feed additives had beneficial effect for stimulation and activity of digestive system by improving the palatability and enhancing appetite of poultry, thus increasing the amount of feed consumed (19). The observed increase in body weight and total weight gain of the birds with garlic supplementation is similar to the finding of (20) who reported that garlic as a natural feed additive, improved quail growth, feed conversion ratio (FCR) and decreased mortality rate. The results of feed conversion ratio showed improvement in feed efficiency utilization by the garlic level in the diet as compared to the control treatment. Feed conversion ratio and feed cost per kg weight gain were best for birds fed diets containing garlic meal at 750g (4.09 and ₦33.24/kg respectively), this improvement may be attributed to the properties of these materials that could act not only as antibacterial, antiprotozoa and antifungal but also as antioxidants (21: 22). This result could be compared with the findings of (23) who reported higher feed intake of broilers on diet supplemented with ginger at 0.75g/kg. FCR obtained in this study contradicts the findings of (24) who reported FCR value at 7.09 in Japanese quails. Percentage mortality was significantly reduced as level of garlic meal was increased. (25), however reported significant reduction in mortality rate in broilers fed feed additives, whereas, (26) observed no effects on survivability rate following garlic and turmeric supplementation. (27) indicated that medicinal plant contains natural substances that can promote health and alleviate illness. Phytogenics such as garlic, ginger, turmeric et.c has long been used as traditional medicine for alleviating the symptoms of gastrointestinal diseases (28 and 29), antimicrobial (30: 31 and 32) and some pharmacological effects (29 and 33).

Apparent nutrient digestibility of quails containing graded levels of garlic meal

The nutrient digestibility of Japanese quails fed diets containing garlic meal is presented in Table 3. The result shows that significant ($p<0.05$) differences were observed for all measured parameters. It was observed that percentage digestibility of dry matter, crude protein, crude fibre, ether extract and ash by birds across the treatments followed a similar trend such that the digestibility increased as the garlic inclusion increased. These were significantly ($P<0.05$) higher for birds fed diet containing 750g of garlic meal compared to other dietary treatments. Dry matter, crude protein, crude fibre, ether extract and ash digestibility were higher in quails fed 750g of garlic meal ($p<0.05$) with values of 68.55%, 80.62%, 68.01%, 68.17%, 75.85% and 76.88% respectively. Quail chicks fed 750g had the best value for dry matter, crude protein, ether

extracts, nitrogen free extract and ash retention. This result disagreed with (34) who reported that the digestibility for birds given dietary garlic meal were similar to the control. Although, it is well known that plant extracts improve the digestibility of the feeds in poultry, (35) revealed that the effect of different additives on digestibility had slightly improved performance and the differences were not significant ($p>0.05$). The results showed significantly higher ($p<0.05$) dry matter, crude protein, ether extract, ash retention and nitrogen free extracts digestibility. The positive response in protein digestibility was due to supplementing the dried garlic and this could be explained by regulation of the microbial environment of the intestines, decrease digestive disturbances, inhibit pathogenic intestinal microorganisms and improve feed conversion efficiency.

The significant effect observed in the digestibility may be attributed to high nutrient profile in terms of balanced protein (amino acid profile) as more amino acids and other nutrients in the diet were consumed and efficiently used for the improved higher weight gain observed in the birds. However, digestibility coefficients increased as levels of experimental materials increases in the diets. This implies that the use of garlic meal in Japanese quail diets increases their nutrient utilization which may also be translated to higher growth performance.

Effects of garlic meal on carcass characteristics of Japanese quails

The effect of feeding level of garlic meal on carcass characteristics of Japanese quails on Table 4 showed a significant increase ($p<0.05$) in live weight, slaughtered weight, gizzard, back, shank, thigh, drum stick, intestine and breast muscle weight. There were no significant differences ($p>0.05$) in dressed weight, dressing percentage, head, neck. Back, leg, wings and breast muscle among different groups. The result of the present study is in line with (36) who reported that dietary inclusion of garlic did not affect dressing percentage in Japanese quails. This study disagreed with (37) who observed no significant difference in the final live weight in rabbits fed ginger waste meal as energy substitute for maize. The value for the live weight of Japanese quails in this study does not agree with (38) who reported a range of 100 – 140 g as the live weight for adult male Japanese quails. In the present study, there was no significant ($p>0.05$) influence on carcass parameters like dressing yield and giblet yield (gizzard and liver) in all dietary groups. The report of (39 and 40) was contrary with these findings, a significant increase in average dressing percentage with supplementation of garlic and neem.

These findings are in harmony with (41) and (42) studies which reported that carcass characteristics in term of dressing percentage and edible parts were not significantly affected by enzyme supplementation in Japanese quail diet. Result of the study agreed with the reports of (43), (44) and (45) which showed that supplementation of herbal growth promoters did not influence the relative liver weight, spleen weight, intestinal weight and gizzard weight of the quails and broilers. However, (46) observed that supplementation of garlic-turmeric and kalongi exhibited a significant effect on relative intestinal weight of the broilers.

The dressed weight and dressing percentage were not significantly ($p >0.05$) different across the treatment groups. This present study is similar to the findings of (47) who observed that there was no significant difference on dressed weight and dressing percentages of quails fed 1.0%

ginger powder up to six weeks of age. The findings of this experiment contradict the result of (48). (49) and (50) reported higher relative weight for breast and thigh meat in quails and broilers fed garlic powder at 0.5g kg^{-1} in diet. This result is in agreement with (51) who stated that dietary garlic meal at the rate of 2.05g kg^{-1} in diet had no effect on carcass production.

Table 1: Composition of Experimental Diets for Japanese Quails Containing Different Inclusion level of garlic meal (2 -6 weeks)

	Treatments			
Ingredients	**0**	**250g**	**500g**	**750g**
Maize	50.40	50.15	49.90	49.65
Soyabean cake	30.00	30.00	30.00	30.00
Groundnut cake	15.00	15.00	15.00	15.00
Bone meal	0.70	0.70	0.70	0.70
Limestone	2.00	2.00	2.00	2.00
Garlic Meal	0.00	0.25	0.50	0.75
Common salt	0.15	0.15	0.15	0.15
Lysine	1.30	1.30	1.30	1.30
Methionine	0.10	0.10	0.10	0.10
Vitamin Premix	0.25	0.25	0.25	0.25
Total (%)	100.00	100.00	100.00	100.00
Calculated Analysis				
ME Kcal\kg	2844	2838	2833	2828
Crude Protein (%)	25.00	25.00	25.00	25.00
Crude fibre (%)	4.52	4.56	4.59	4.62
Ether extracts (%)	4.87	4.88	4.88	4.88
Calcium (%)	1.00	1.00	1.00	1.00
Phosphorus (%)	0.23	0.23	0.23	0.23
Meth + cys (%)	0.75	0.75	0.75	0.75
Lysine (%)	1.27	1.27	1.27	1.27

ME = Metabolisable Energy, Meth + cys, =Methionine + cysteine

Table 2: Growth performance of quails fed graded levels of turmeric meal (2-6 weeks)

	Inclusion levels of Garlic meal				
Parameters	**0**	**250g**	**500g**	**750**	**SEM**
Initial weight(g/b)	53.36	53.33	53.36	53.38	0.05
Final weight (g/b)	148.43^{d}	154.07^{c}	164.37^{b}	172.57^{a}	1.30
Total weight gain(g/b)	95.07^{d}	100.73^{c}	111.00^{b}	119.20^{a}	1.29
Average daily weight gain (g/b/d)	3.39^{d}	3.59^{c}	3.96^{b}	4.26^{a}	0.05
Total feed Intake (g/b)	396.56^{d}	467.03^{c}	479.49^{b}	487.45^{a}	1.62
Daily feed Intake (g/b/d)	14.16^{d}	16.68^{c}	17.13^{b}	17.41^{a}	0.06
Feed conversion ratio	4.17^{a}	4.67^{c}	4.32^{b}	4.09^{a}	0.04
Feedcost/Kg weight gain(₦/kg)	36.59^{b}	36.14^{b}	34.24^{a}	33.24^{a}	0.45
Mortality (%)	9.09^{c}	4.04^{b}	3.03^{b}	0.00^{a}	0.94

ab-means in the same row with different superscripts are significant (P<0.05). SEM=Standard Error of means

Table 3: Nutrient digestibility of Japanese quails fed graded levels of garlic meal (2-6weeks)

Parameters (%)	0	250g	500g	750g	SEM
Dry matter	55.31^{c}	54.73^{c}	73.13^{b}	75.67^{a}	0.06
Crude protein	76.13^{c}	75.77^{d}	80.62^{b}	85.64^{a}	0.13
Crude fibre	67.61	67.88	67.76	68.25	0.82
Ether extract	43.31^{d}	62.80^{b}	60.59^{c}	63.44^{a}	0.71
NFE	70.19^{a}	65.63^{b}	64.00^{b}	71.76^{a}	1.68
Ash retention	64.71^{d}	71.10^{c}	76.18^{b}	76.84^{a}	0.29

a,b- Means in the same row with different superscripts are significant (P<0.05). NFE=Nitrogen free extracts, SEM=Standard error of means.

Table 4: Effect of inclusion levels of garlic meal on carcass characteristics of Japanese quails (2-6weeks)

	Inclusion levels of Garlic meal				
Parameters	**0**	**250g**	**500g**	**750g**	**SEM**
Live weight (g)	140.74^{e}	146.49^{c}	160.82^{a}	154.85^{b}	1.31
Slaughter weight (g)	138.24^{d}	144.32^{c}	158.48^{a}	152.52^{b}	1.95
Dressed weight (g)	113.33	113.67	117.67	108.50	11.28
Dressing (%)	80.52	77.60	73.17	70.07	7.02
Prime cut expressed as % of dressed weights					
Leg (%)	10.64	10.36	10.67	10.75	0.60
Head (%)	5.23	5.62	5.49	5.22	0.41
Neck (%)	5.72	6.02	5.55	5.84	0.50
Back (%)	16.23	18.05	17.25	16.51	0.98
Gizzard (%)	4.38^{a}	3.98^{a}	3.73^{a}	3.55^{b}	0.35
Blood weight	2.50	2.17	2.33	2.33	0.69
Shank (%)	1.20^{b}	0.89^{b}	1.87^{a}	1.36^{a}	0.22
Wings (%)	3.98	3.87	4.12	3.68	0.22
Thigh (%)	5.71^{a}	5.65^{a}	5.01^{b}	5.55^{a}	0.33
Drumstick (%)	3.18^{c}	3.82^{b}	3.79^{b}	3.83^{b}	0.26
Organs Express as Percent of Live weights (%)					
Liver (%)	2.14^{a}	1.93^{a}	2.06^{a}	1.61^{b}	0.44
Intestine (cm)	46.08^{a}	44.13^{a}	41.22^{b}	39.83^{b}	1.33
Breast (%)	26.80	27.10	28.73	29.38	1.79

a,b-means in the same row with different superscripts are significant (P<0.05). SEM=Standard error of means

Conclusion and Application

It can be concluded in this study that Japanese quail farming is one of the important income sources to the farmers as these birds are hardy.

1. Garlic supplement can be used for better growth and performance of quail birds. This could be attributed to the inherent biological functions of garlic

meal as stimulant, digestibility enhancer and anti-oxidant.

2. So, it would provide a better alternative to the commercial feed additive for better performances of the quail birds. This study concludes that 750g garlic meal should be included in diet for improved Japanese quail growth performance and nutrient digestibility**.**

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