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Growth and laying performance of quail (*coturnix coturnix japonica*) under single phase feeding in Guinea savannah zone of Nigeria

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Abstract

Phases of feeding is the nutrient concentrations in a series of diet formulated to meet an animal's nutrient requirement at different stages of growth or production. Generally, poultry birds have three feeding phases namely: starter, grower and finisher. Starter feed has high crude protein content and decline with the age of the birds. The cost of poultry feed is high because of the cost of crude protein content of the feed which must be met to support optimum growth of the bird. Due to this cost effect, no uniform time of changing diet from one phase to the other is strictly adhered to and this affect the growth of poultry birds. This brought about the idea of single phase feeding to eliminate the problems of the effect of changing time of diet from one phase to the other. Adoption of single phase feeding necessitates determination of the best protein and energy levels that support optimum performance in growing and laying Japanese quails which this study carried out.

In an experiment to evaluate the growth and laying performance of quails fed single phase diets, a total of 180, 2-week old Japanese quail chicks were randomly divided into five treatments of 36 quail chicks per treatment. Each treatment was replicated thrice. Diet 1 (T_1) for both the growing and laying phases were the control diets (for growth and egg laying) while the remaining four diets (T_2-T_5) for each of the phases were the single-phase diets (same diets fed at both the growth and laying phases of the experiment). The control diets for both phases were formulated to contain 26 % and 22 % CP, and 2800 and 2750 kcal/kg ME for growing and laying, respectively. The four single phase diets had 20, 22, 24 and 26 % CP, and 2800, 3000, 3200 and 3400 kcal/kg ME, respectively for both phases. Completely randomized design was used for the experiment. Feed and water were served ad libitum. The parameters measured for growth were (body weight, body weight gain, feed intake and feed conversion ratio). The result showed that average daily weight gain of quails fed control diet (29.40g) was similar($P<05$) to the quails fed diets containing 22 % CP,3000 Kcal/ Kg ME (28.93g) and 24 % CP, 3200 Kcal /Kg ME (28.87g) but was significantly higher ($P<0.05$) than quails of the other diets.. Feed intake had no significant ($P>0.05$) difference but feed intake of quails decreased with the increase Metabolizable energy levels across the treatments. Quails fed control diet consumed higher than quails fed 22 % CP, 3000 Kcal /Kg ME, 24 % CP, 3200 Kcal/ Kg ME and 26 % CP, 3400 Kcal / kg ME. Feed conversion ration (FCR) showed significant ($P<0.05$) difference among the treatment groups with the values from $T_1 - T_5$

(4.97, 5.46, 5.00, 4.95 and 4.76 respectively). The parameters measured for laying were (hen-day and hen-house production, feed intake and feed conversion ratio). The results showed that quails fed the control diet was similar ($P>0.05$) to those fed diets containing 22 and 24 % CP and 3000, 3200 kcal/kg ME. Conclusively, the results of the study indicated that

feeding diet containing 26 % CP and 3400 kcal/kg ME led to below optimum growth and egg laying performance of Japanese quails.

Keywords: Japanese quail, crude protein, metabolizable energy, single phase, performance.

Croissance et performance de pose des cailles (*coturnix coturnix japonica*) sous alimentation monophasée dans la zone de Savane Guinée du Nigeria

Résumé

Les phases d'alimentation correspondent aux concentrations de nutriments dans une série de régimes formulés pour répondre aux besoins nutritionnels d'un animal à différents stades de croissance ou de production. Généralement, les volailles ont trois phases d'alimentation à savoir : démarrage, croissance et finition. L'aliment de démarrage a une teneur élevée en protéines brutes et diminue avec l'âge des oiseaux. Le coût des aliments pour volailles est élevé en raison du coût de la teneur en protéines brutes de l'aliment qui doit être couvert pour soutenir une croissance optimale de l'oiseau. En raison de cet effet de coût, aucun moment uniforme de changement de régime alimentaire d'une phase à l'autre n'est strictement respecté, ce qui affecte la croissance des volailles. Cela a donné naissance à l'idée d'une alimentation monophasée pour éliminer les problèmes liés au changement de temps de régime d'une phase à l'autre. L'adoption d'une alimentation monophasée nécessite la détermination des meilleurs niveaux de protéines et d'énergie qui soutiennent des performances optimales dans la croissance et la ponte des cailles japonaises, ce que cette étude a réalisé.

Dans une expérience visant à évaluer la croissance et les performances de ponte de cailles nourries avec un régime monophasé, un total de 180 poussins de cailles japonaises âgés de 2 semaines ont été répartis au hasard en cinq traitements de 36 poussins de cailles par traitement. Chaque traitement a été répété trois fois. Le régime 1 (T_1) pour les phases de croissance et de ponte était le régime témoin (pour la croissance et la ponte), tandis que les quatre régimes restants (T_2-T_5) pour chacune des phases étaient les régimes monophasiques (mêmes régimes nourris aux deux phases de croissance et de ponte de l'expérimentation). Les régimes témoins pour les deux phases ont été formulés pour contenir respectivement 26 % et 22 % de CP, et 2 800 et 2 750 kcal/kg d'EM pour la croissance et la ponte. Les quatre régimes monophasés contenaient respectivement 20, 22, 24 et 26 % de CP et 2 800, 3 000, 3 200 et 3 400 kcal/kg ME pour les deux phases. Un plan entièrement randomisé a été utilisé pour l'expérience. La nourriture et l'eau étaient servies à volonté. Les paramètres mesurés pour la croissance étaient (le poids corporel, le gain de poids corporel, la consommation alimentaire et l'indice de conversion alimentaire). Le résultat a montré que le gain de poids quotidien moyen des cailles nourries avec un régime témoin (29,40 g) était similaire (P < 05) à celui des cailles nourries avec un régime contenant 22 % de CP, 3 000 Kcal/Kg ME (28,93 g) et 24 % de CP, 3 200 Kcal. /Kg ME (28,87 g), mais était significativement plus élevé (P < 0,05) que pour les cailles des autres régimes. La consommation alimentaire n'avait pas de différence significative (P > 0,05), mais la consommation alimentaire des cailles diminuait avec l'augmentation des niveaux d'énergie métabolisable à travers les traitements. Les cailles nourries avec le régime témoin ont consommé plus que les cailles nourries avec 22 % CP, 3000 Kcal/Kg ME, 24 % CP, 3200 Kcal/Kg ME et 26 % CP, 3400 Kcal/kg ME. La ration de conversion alimentaire (FCR) a montré une différence significative (P <0,05) entre les groupes de traitement avec les valeurs de T_1 à T_5 (4,97, 5,46, 5,00, 4,95 et 4,76

respectivement). Les paramètres mesurés pour la ponte étaient (la production journalière et au poulailler, la consommation alimentaire et l'indice de conversion alimentaire). Les résultats ont montré que les cailles nourries avec le régime témoin étaient similaires (P>0,05) à celles nourries avec des régimes contenant 22 et 24 % de CP et 3 000, 3 200 kcal/kg d'EM. En conclusion, les résultats de l'étude ont indiqué qu'un régime alimentaire contenant 26 % de CP et 3 400 kcal/kg de ME conduisait à une croissance et à une performance de ponte des cailles japonaises inférieures à l'optimum.

Mots-clés: Caille japonaise, protéine brute, énergie métabolisable, monophasé, performance.

Introduction

The livestock industry contributes largely to the animal protein demand of the ever-increasing population of the world. Poultry is a sub-sector of the livestock industry dealing with different kind of birds capable of converting plant protein feedstuff into high quality animal protein through provision of meat and eggs. Chickens are the most renowned and acceptable birds reared intensively and extensively by farmers. Recently, quails have come into lime light among recognised poultry birds. Quail has a short generation interval (Mendel, 2006) and are an economical source of animal protein (Babangida and Ubosi, 2006). Quail has proven to be the quickest and cheapest substitute to most expensive source of protein (Ayanwale and Arziki, 2005). Japanese quails have advantages of small size, short life cycle, rapid growth rate, good reproductive potential, high fecundity rate and shorter hatching periods when compared with the different species of poultry (El-katcha et al., 2015) and (Owen and Dike, 2013). The benefits of quail meat are known as having high protein, essential fatty acids, and minerals such as sodium, potassium and iron. Owing to high metabolic activity in this animal, the amount of glycogen stored in muscles increases and results in high quality meat (Gecgel et al., 2015). Japanese quail birds have short hatching period and mature in about six weeks and are usually in full egg production in 50 day of age (Bakoji et al., 2013). Japanese quail's meat and egg are very tasty and the meat is tender and low in cholesterol. Among other birds, the meat and eggs of quails have less fat and low cholesterol content which is of public health importance and has been suggested as a good quality meat source for diabetes patient and those with high blood pressure (Agwunobi and Ina-Ibor, 2007). and (Tuleum et al., 2011). The nutritional value of quail eggs is 3 to 4 times greater than that of chicken eggs (Tunsaringkam et al., 2013). Quail eggs are rich in vitamin D, antioxidants which according to Salim et al., (2008) improve quality of food from animal origin in term of colour, oxidative stability, tenderness and storage properties. Poultry birds have 3 feeding regimes or phases; Birds are fed with starter, grower and finisher diets formulated to meet their nutrient requirement levels for specific feeding programmes (Skimmer et al.,1993). The National Research Council (NRC, 1994) provides a single set of recommendation that include males and females, with dietary amino acid requirement segregated into three fixed periods; starter (0-3 weeks of age), grower (3-6 weeks of age) and finisher (6-8 weeks of age). Birds are also fed various nutrient requirement base on their ages. Silva and Costa (2009) recommended a similar value but differentiated quail feeding into four phases: 2900, 3050,2800 and 2850 kcal/kg ME from 1-21, 22-42 days of age, and in the first and second egg production phases respectively. The cost of feed generally reduces with the reduction in protein

content. The cost of poultry diets reduces linearly with age. Therefore, the optimum time at which diets are changed is of economic importance (Saleh et al., 1996). The increase in the prices of feed ingredients will lead to high cost of formulated feeds. A way of offsetting the financial implication on the poultry business is to tamper with nutrient specification or to reduce the changing time to finisher diets of less protein content. This study intended to eliminate the problem of inconsistency in changing period of diets from one phase to another which can affect performance of birds through adoption of single-phase feeding.

The objective of the study was therefore, to evaluate the growth and laying performance of Japanese quails fed single-phase diets in place of the commonly used two phase diets.

Materials and methods

The study was conducted at the Poultry Unit, Teaching and Research Farm, Department of Animal Production, Federal University of Technology, Minna, Niger State, Nigeria. Minna lies on latitude 9 28 to 90 37 N and longitude of 6.23 to 6.33 East. The mean annual rainfall is between 1000-1300mm. The vegetation is southern guinea savanna zone (FUTMIN,2012). Guinea savannah zone is characterized by tall grasses and few scattered deciduous trees with thick bark, long tap root and tiny leaves. It is the most extensive and luxuriant of all savanna vegetation found in the middle belt of Nigeria like Niger, Kogi, Kwara states among others. 180, 2-week old Japanese quail chicks were purchased from National Veterinary Research Institute (NVRI), Vom, Plateau State, Nigeria. The study lasted for 12 weeks. They were weighed and randomly distributed into 5 treatments with three replicates of 12 birds. The experimental diets were maize-groundnut cake based. The control diets T_1 for growing and laying phases were formulated to contain 26 and 22 % CP, and 2800, 2750 kcal/kg ME. The remaining four diets (T_2-T_5) were the single-phase diets for both phases containing 20, 22, 24 and 26 % CP, and 2800, 3000, 3200 and 3400 kcal/kg ME, respectively (Table 1). Birds in each treatment were weighed and feed intake measured on weekly basis to know the weight gain and feed intake. Data were collected for 4 weeks (from 2-6 weeks of age of quail birds) for growth phase and 8 weeks (from 7-14 weeks of age of quail birds) for laying phase. Feed and water were served *ad libitum* throughout the period of the experiment and the birds were subjected to the same management practices. Data collected on feed intake and weight gain were used to calculate feed conversion ratio. All data collected from the experiment were subjected to one-way analysis of variance using the SPSS version 16.0 (SPSS, 2011) software.

Data collection for growing phase

Body weight (g)

The quails in each replicate were weighed with weighing balance at the beginning of the experiment and subsequently at weekly intervals throughout the 12 weeks of the experiment.

Feed intake

Feeds were weighed daily for quails in each replicate and the quantity consumed per day were obtained by difference between the quantity supplied and the left over. Weekly record of average feed consumption per bird was obtained for each replicate by dividing the total quantity of the feed consumed by the number of quails in each replicate.

Body weight gain (g)

The body weight gain was obtained by calculating the difference between the body weight of the previous week and current week.

Feed conversion ratio

The feed conversion ratio was determined by dividing the quantity of feed consumed by the body weight gain of the birds in each replicate in grams.

Data collection for laying phase

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Average daily feed intake (g)}}{\text{Average daily weight gain (g)}}$$

Feed Consumed/ dozen eggs: The feed consumed per dozen eggs laid was calculated using the formula:

$$\text{Feed consumed (kg)/ dozen eggs} = \frac{\text{Kg of feed consumed x 12}}{\text{Total eggs p}}$$

The feed consumed per dozen eggs was calculated by using the formula above according to (Oladunjoye et al., 2010)

Hen-day production (HDP): The Hen-day production was calculated as the number of eggs laid per replicate on daily basis using the formula below

$$\text{Hen-day production} = \frac{\text{No. of eggs produced x 100}}{\text{No. of birds that will survive x No. of days in lay}}$$

Hen-House Egg Production (HHEP): The HHEP was calculated for each replicate using the formula

$$\text{HHEP} = \frac{\text{No. of egg produced x 100}}{\text{No. of birds stock initially x Number of days in lay}}$$

Proximate analysis

Proximate analysis to determine the dry matter (DM), CP, crude fibre (CF), ash and ether extract (EE) of the experimental diets for the 2 phases was carried out according to AOAC (2000) standard procedure. Nitrogen free extract (NFE) were calculated by simple difference. Metabolizable energy were also calculated with the use of Pauzenga. (1984) formula below;

ME (kcal/ kg ME) =37 x % CP + 81.8 x % EE + 35.5 x % NFE

Statistical analysis

Data collected from the two experiments were subjected to analysis of variance (ANOVA) using the computer software SPSS (2011) Version 17.0. Significant differences among treatment means were separated using Duncan's multiple range test (Duncan, 1955)

Table 1: Composition of experimental diets fed to Japanese quails during g rowing and laying phases (%)

Ingredients	**T_{1G}**	**T_2**	**T_3**	**T_4**	**T_5**	**T_{1L}**
Maize	46.00	50.00	52.70	54.00	59.00	47.95
Maize Offal	13.20	8.00	1.00	0.00	0.00	2.00
Groundnut cake	20.00	15.70	20.00	25.70	19.00	26.00
Soya bean meal	12.00	12.00	12.00	6.00	2.45	11.80
Fish meal	3.00	3.00	3.00	3.00	5.00	2.50
Limestone	0.50	5.00	5.00	5.00	5.00	6.50
Bone meal	2.50	3.50	3.50	3.50	3.50	2.50
Palm oil	2.00	2.00	2.00	2.00	5.00	0.00
Common salt	0.30	0.30	0.30	0.30	0.30	0.25
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.15	0.15	0.15	0.15	0.4	0.15
*Vit Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**	**100**	**100**
Calculated nutrients						
Crude Protein %	25.60	20.00	22.00	24.00	25.80	22.00
Metabolisable Energy Kcal/ Kg	2800	2800	3000	3200	3400	2750
ME: CP	107.69:1	140.00:1	136.36:1	133.33:1	130.77:1	1124.49:1
Crude fibre	4.10	4.07	3.57	3.50	3.10	3.70
Calcium (Ca)	1.20	3.42	3.43	3.29	3.67	3.20
Avail. Phosphorus	0.61	0.79	0.78	0.79	0.84	0.52
Ca: Phosphorus	1.97	4.33	4.40	4.16	4.16	1:6.15
Lysine	1.18	0.94	0.90	1.00	0.09	1.07
Methionine	0.88	0.70	0.73	0.78	0.74	0.88

T_{1G} (control diet for growth phase); T_2-T_5 (single phase diet for both phases); T_{1L} (control diet for laying phase)

Results

Proximate composition of the experimental grower diets

The results of the proximate composition of the experimental diets fed to Japanese quails during the growing and laying phases is shown in Table 2. The dry matter in the diets of growing and laying Japanese quails were 95.40 % and 96.00 %; the crude protein were 27.38 % and 23.40 %; crude fibre were 6.29 % and 5.54 %; ether extract were 15.34 % and 7.39 %; ash were 13.62 % and 12.50 % and Nitrogen free extract were 37.37 % and 51.17 % respectively. The

single phase diets ($T_2 – T_5$) for both growing and laying Japanese quails had dry matter within the range of 95.20 % to 96.80 %, the highest being that of T_4 (96.80 %). T_5 and T_2 have the lowest value of 95.20 % respectively.. The crude protein of the diets ranges between 22.24 % and 27.65 %, the highest being that of T_5 (27.65 %) and T_2 (22.24 %) has the lowest value. The crude fibre of the diets were within the range of 4.13 % to 5.96 %, the highest being that of T_2 (5.96 %) and T_4 has the lowest value of 4.13 %. The ash content of the diets were within the range of 12.67 % to 14.71 %. T_2 has the highest value (14.71 %) while T_5 has the lowest value (12.67 %). Ether extract of the diets were within the range of 17.19 % and 14.72 % with T_5 having the highest value (17.19 %) and T_3 with the lowest value (14.72 %). Nitrogen free extract values range between 38.26 % and 42.09 %. T_2 has the highest value of 42.09 % and T_5 has the lowest value (38.26 %).

Table 2: Proximate composition of the experimental diets fed to Japanese quails during the growing phase (%) DM

Components (%)	T_{1G}	T_2	T_3	T_4	T_5	T_{1L}
Dry matter	95.40	95.20	95.40	96.80	95.20	96.00
Crude protein	27.38	22.24	24.78	26.07	27.65	23.40
Crude fibre	6.29	5.96	5.56	4.13	4.23	5.54
Ether extract	15.34	15.00	14.72	15.00	17.19	7.39
Ash	13.62	14.71	13.63	14.46	12.67	12.50
Nitrogen free extract	37.37	42.09	41.31	40.34	38.26	51.17
Metabolizable energy (Kcal/kg)	3612.51	3544.08	3587.47	3623.66	3787.42	3286.90

T_{1G} (control diet for growing phase), T_1- T_4 (single phase diets for both phases), T_{1L} (control diet for laying phase)

Performance of growing Japanese quails

Quails fed the control diet had comparative performance indices (final body weight and body weight gain) as those fed diets containing 20-24 % CP, and 2800-3200 kcal/kg ME as shown in Table 3. The result showed that the final body weight range between 1250.00 g to 1333.33 g. The result showed that there was significant ($P < 0.05$) among the treatment means with quails fed T_1 having the highest final body weight (1333.33 g). Quails fed diet T_5 is having the lowest final body weight (1250.00 g). Daily weight gain showed significant ($P<0.05$) difference among the treatment means with quails fed diet T_1 recording the highest weight gain (29.40 g), while quails fed diet T_5 has the lowest weight gain (26.55 g). Daily feed intake per bird showed significant ($P<0.05$) difference among the treatment means with the quails fed diet T_2 having the highest daily feed intake (14.07 g), while the quails fed diet T_5 had the lowest daily feed intake (11.46 g). Feed conversion ratio showed significant ($P<0.05$) difference among the treatment means with quails fed diets T_1, T_3, T_4 and T_5 had similar results while those fed diet T_2 had poor feed conversion ratio.

Table 3: Performance of growing Japanese quails fed with single phase di ets with varying crude protein and metabolizable energy levels

Parameters	T_1	T_2	T_3	T_4	T_5	SEM
Initial body weight (g)/rep	510.00	505.00	506.67	508.33	506.67	1.88
Final body weight (g)/rep	1333.33^{a}	1300.00^{ab}	1316.67^{ab}	1316.67^{ab}	1250.00^{b}	11.41
Body weight gain (g)/rep	823.33^{a}	795.00^{ab}	810.00^{ab}	808.33^{ab}	743.33^{b}	11.30
Daily weight gain (g)/rep	29.40^{a}	28.39^{ab}	28.93^{ab}	28.87^{ab}	26.55^{b}	0.40
Daily feed intake/bird (g)	13.28^{b}	14.07^{a}	13.14^{b}	12.98^{b}	11.46^{c}	2.53
Feed conversion ratio	4.97^{a}	5.46^{b}	5.00^{a}	4.95^{a}	4.76^{a}	0.81

^{abc} = Means on the same row with different superscripts were significantly (P<0.05) different,

SEM = Standard error of mean, LOS = Level of significance, CP = Crude Protein, ME = Metabolizable Energy, FCR = Feed Conversion Ratio, T_1 = 26 % CP, 2800 Kcal/ Kg ME, T_2 = 20 % CP, 2800 Kcal/ Kg ME, T_3 = 22 % CP, 3000 Kcal/ Kg ME, T_4 = 24 % CP, 3200 Kcal/ Kg ME, T_5 = 26 % CP, 3400 Kcal/ Kg ME

Laying phase

Feed intake and egg laying performance of Japanese quails

The results of feed intake and egg laying performance of laying Japanese quails fed single phase diets with varying levels of protein and energy is shown in Table 4. Total feed intake showed significant (P<0.05) difference among the treatment means with quails fed diet T_5 recording the least feed intake (0.85 kg) and those fed diet T_1 had similar value (1.02 kg) as those fed T_2, T_3 and T_4. Hen- day production showed significant (P<0.05) difference among the treatment means with quails fed diet T_4 had similar value (58.33 %) as those fed diets T_1,T_2 and T_3 while quails fed diet T_5 had the least result (43.93 %).

Hen-house production showed significant (P<0.05) difference among the treatment means with the quails fed diet T_1 had similar value (57.26 %) as those fed diets T_2 ,T_3 and T_4 while the quails fed diet T_5 had the least value (43.93 %).

Total number of eggs produced showed significant (P<0.05) difference among the treatment means with quails fed diet T_1 had similar value (171) as those fed diets T_3 and T_4 while those fed diet T_2 had similar value with those fed diet T_5 that had the least value (123). .Feed conversion ratio showed no significant (P<0.05) difference among the treatment means.

Table 4: Feed intake and egg laying performance of Japanese quails fed single phase diets with varying levels of crude protein and metabolizable energy levels

Parameters	T_1	T_2	T_3	T_4	T_5	SEM
Total feed intake/ bird (kg)	1.02^{b}	0.97^{ab}	0.98^{ab}	0.97^{ab}	0.85^{a}	0.14
Hen-day production (%)	57.26^{ab}	47.38^{ab}	59.91^{a}	58.33^{a}	43.93^{b}	2.34
Hen-house production (%)	57.26^{a}	47.38^{ab}	55.12^{ab}	55.12^{ab}	43.93^{b}	1.94
Total No. of egg produced	171^{a}	132^{bc}	154^{ab}	163^{a}	123^{c}	0.05
Feed conversion ratio	4.43	4.64	4.11	3.65	4.54	0.29

[abc] = Means on the same row with different superscripts were significantly different (P<0.05), SEM =Standard Error of Mean, NS =Not significant, LOS =Level of Significance, FCR = Feed Conversion Ratio, CP=Crude Protein, ME = Metabolizable energy, T_1 = 26 % CP, 2800 Kcal/ Kg ME, T_2 = 20 % CP, 2800 Kcal/ Kg ME, T_3 = 22 % CP, 3000 Kcal/ Kg ME, T_4 = 24 % CP, 3200 Kcal/ Kg ME; T_5 = 26 % CP, 3400 Kcal/ Kg ME, FCR = Feed consumed to produce one dozen eggs(kg)/ wt of one dozen eggs (kg)

Discussion

Proximate composition of experimental diets fed to growing and laying Japanese quails

The range of crude protein values of the experimental diets fed to growing and laying Japanese quails (27.38 % and 23.40 %) respectively were within the protein requirement for growing and laying Japanese quails. The crude protein obtained in this study for the growing Japanese quails is similar to the values obtained by Babatunde *et al*. (2016) who worked on the protein and energy requirements of Japanese quails (*Coturnix coturnix japonica)* during the rearing period with diets of crude protein range of 20 – 26 % while the crude protein (23.40 %) obtained for laying Japanese quails was within the range that can support good egg production performance.

This is similar to the findings of Bawa *et al.* (2011) who reported that, dietary protein level of 22 % CP is required for optimum production, egg quality characteristics and reproductive performance of breeder quails in the tropics. The crude fibre values (6.29 % and 5.54 %) obtained in this study falls within the crude fibre content that poultry birds can tolerate and is in agreement with Ijaiya. (2012) whose experimental diets for laying quails had 4.55 % crude fibre. The values are in agreement with Makinde. (2012) who compared the response of Japanese quails fed palm kernel meal and brewers dried grains based diets supplemented with maxigrain enzyme and obtained values for crude fibre which ranged between 5.18 – 6.08 %.

The result obtained in laying quails for nitrogen free extract (42.09 – 51.17 %) is slightly higher than (34.63 -.39.98 %) obtained by Ijaiya et al. (2012) while evaluating egg production and egg quality characteristics of Japanese quails *(Coturnix coturnix japonica*) fed graded levels of cooked Tallow (*Detarium microcarpum*) seed meal.

Performance of growing Japanese quails

Quails fed the control diet (26 % CP, 2800 kcal/ kg ME) had comparative performance indices in terms of final body weight and body weight gain as those fed diets containing 20 – 24 % CP and 2800 – 3200 kcal/ kg ME. This might be due to their similarities in total feed intake which apparently resulted in similar growth performances. The result of this study is in agreement with the findings of Aremu (2011) who reported that broiler chicks fed on low protein –medium energy (20 % CP and 3200 ME) and high protein –low energy (24 % CP and 2600 ME) diets with caloric to protein ratio of 145:1 and 108:1 performed best in growth performance parameters. The result is also in agreement with the reports of Jahanian and Edriss (2015) who observed similar result when they worked on the effect of different levels of dietary metabolizable energy and crude protein on performance and carcass characteristics of Japanese quail (*Coturnix coturnix japonica*) and Brown quails (*Coturnix ypsilophorus*) and concluded that, Japanese quails need diets containing 3000 kcal/kg ME and 26 % CP during the first weeks of age to achieve optimum growth performance, and that dietary CP level can then be reduced to 24 % CP for the

older birds. The result is however contrary to the findings of Abbasali *et al.* (2011) who in their study of the effect of feeding different levels of metabolizable energy (2900 and 2700 kcal/kg ME) and crude protein (high, medium, low, very low) on performance of Japanese quail observed that, feeding Japanese quails during the starter, grower and finisher periods using diets containing 2700 kcal/ kg ME and low levels of protein which were 22, 20 and 18 % is recommendable to achieve a suitable performance in quails.

Quails fed the control diet had similar feed intake as those fed diets containing 22 % and 24 % CP; 3000 and 3200 kcal/kg ME. This might be due to the closeness of the crude protein and metabolizable energy content of these diets. Meanwhile, quails fed the diet with the highest energy level of 3400 kcal/ kg ME had the least feed intake. This might be because birds eat to meet up with their energy need. Singh and Panda (2018) reported that birds usually eat with the aim of satisfying their energy requirement and once this aim is achieved, the birds will stop eating. Since the energy content of the diet was very high, the energy need of the birds was met quickly thereby discouraging further feed intake. As Metabolizable energy of the diet increased feed intake decreased. This is also in agreement with the findings of Bawa (2012) who evaluated the response of Japanese quail chicks fed various dietary energy levels in a tropical environment and observed that feed intake decreased non-significantly as the levels of energy increased in the diets.

The value of feed conversion ratio for the control diet is similar to the values obtained from diets containing 22 %, 24 % and 26 % CP and 3000 kcal/ kg ME, 3200 kcal/ kg ME and 3400 kcal /kg ME. Feed conversion ratio is a function of feed consumed to weight gain. The FCR obtained in this study for quails in T_4 and T_5 were numerically lower than for quails in T_1, the control group. Comparing these FCR trend with the final body weight and body weight gain; it was apparent that feeding quails with diets of different CP and ME in the range of 20 % CP and 2800 kcal/ kg ME, 22 % CP and 3000 kcal/ kg ME, 24 % CP and 3200 kcal/ kg ME and 26 % CP and 3400 kcal/ kg ME would give same growth performance as quail fed the control diet containing 26 % CP and 2800 kcal/ kg ME. This is in agreement with the findings of Babangida and Ubosi (2006) who reported on the effects of varying dietary protein levels on the performance of laying Japanese quails (*Coturnix coturnix japonica*)

Feed intake and egg laying performance of Japanese quails

The quails fed diets containing 26 % CP and 3400 kcal/kg ME had the least feed intake as a result of high energy content of the diet. This is reflected in the low performance of the quails fed this diet in Hen-day and Hen-house production while, quails fed the control diet had similar values with quails fed diets containing 22, 24 % CP and 3000,3200 kcal/ kg ME, respectively in these parameters. Similarity in the nutrients content of these dietary treatments, the quails most probably determine the comparative egg laying performance of quails in diets T_1, T_3 and T_4. The hen-day egg production obtained in this study was lower than the values of 73.70 % – 76.88 % obtained by Makinde (2012) and higher than 30.28 % – 36.39 % obtained by Babangida and Ubosi (2006). Hen-house egg production of 43.99 % – 57.26 % was also lower than 73.70 % -76.88 % reported by Makinde (2012) and much higher than 16.81 % – 29.50 % reported by Ijaiya (2012)

The values for FCR (3.65 – 4.64) kg of feed to produce weight of one dozen of eggs in kg were not significant across the dietary treatments with the quails fed diet

containing 24 % CP and 3200 Kcal/ Kg ME consuming least diet to produce weight of one dozen of eggs. The result obtained in this study is in agreement with the findings of Babangida and Ubosi (2006) who reported that the result of this study is contrary to the findings of Ijaiya (2012) who reported significant but lower values of 3.34-3.56 than the values obtained in this study.

Conclusion

It was concluded from the results of the study that, the feeding of diets containing 20, 22 and 24% CP, and dietary metabolizable energy of 2800-3200kcal/kg could lead to optimum growth and egg laying performance in Japanese quails; feeding of diet containing 26.00 % CP and 3400 kcal/ kg ME had led to decreased growth and egg laying performance of the Japanese quails.

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