Nigerian J. Anim. Sci. 2018, 20 (2): 232-240

Growth performance and egg production of Japanese quail (*Coturnix coturnix japonica*) fed diets containing graded levels of sun-dried cassava (*Manihot esculenta*) peel meal

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Abstract

A two-phase research project was carried out to determine the growth performance and egg production of Japanese quails fed diets containing graded levels of sun-dried cassava (Manihot esculenta) peel meal (SCPM). A total of 360 two-week-old Japanese quails of mixed sexes with average initial weight of 32.09 ± 0.02 g were used for the study. The birds were randomly allotted to four treatment groups, with each treatment replicated thrice having a total of 90 birds per treatment. SCPM replaced maize at 0, 25, 50 and 75 % levels to form diets A, B, C and D respectively and were fed to the birds for six weeks during the growing phase. In the laying phase, a total of 180 female Japanese quails were randomly allotted to four dietary treatments replicated thrice with 45 birds per treatment, and fed layers diets (with the same levels of maize replacement by SCPM as done in the growing phase) for six weeks. Results showed significant ($p<0.05$) differences in daily feed intake and feed conversion ratio (FCR) among the treatments in the growing phase. In the laying phase, there were significant ($p<0.05$) differences in daily feed intake, hen day production (HDP), FCR and egg quality traits. Hence, it was concluded that dietary maize could be replaced with SCPM up to 50 % for optimum growth performance; while 25 % SCPM level of replacement is adequate for optimum egg production at the laying phase.

Key words: *Growth performance, egg production, cassava peel, Japanese quail.*

Description of Problem

The low level of animal protein consumption in Nigeria has generated a lot of concern as it affects both the physical and mental development of Nigerian youths and labour force (1). One way of solving this problem is by focusing on the production of farm animals with high rate of production such as poultry (2). Years back, chicken was the most recognized and acceptable poultry bird reared by farmers; however, other birds have come into limelight among which the Japanese quail (*Coturnix coturnix japonica*) is one of them (3).

Japanese quail has high prolific tendency, short gestation, rapid growth rate and short generation interval (4). Introduction of the Japanese quail to Nigeria was in 1992, and since then it has widened the scope for the availability of highly proteinous food and research (5). Successful quail rearing depends on many factors like availability of feed ingredients at reasonable costs, quality chicks and proper management. Out of all these identified challenges, feed costs and scarcity of feed is the major limiting factor of quail rearing in Nigeria. Feed accounts for over 70 % of the total cost of livestock production in Nigeria (6). The increasing cost of feed ingredients due to competition between humans and livestock, especially for protein and energy sources, makes research into agro-industrial by-products to poultry a necessity.

Cassava (*Manihot esculenta*) belongs to the family *Euphorbiaceae* and was introduced into West Africa from Brazil by the early Portuguese explorers. It is the most productive tuber crop in terms of energy yield per unit land area, but has an appreciable amount of cyanogenic glucosides present in it (7). Cassava peel is one of the agro-industrial by-products that is readily available in countries where cassava is cultivated and processed into food for man. When processed for inclusion in animal diets, it is referred to as cassava peel meal. Various researches have confirmed the suitability of cassava by-products for monogastric feeding (8, 9, and 10). This research study is aimed at determining the growth performance and egg production of Japanese quails fed diets containing graded levels of sun-dried cassava peel meal (SCPM) as a replacement for maize at both the growing and laying phases.

Materials and Methods

Experimental site

This research study was carried out at the Poultry Unit of the Department of Animal Production Teaching and Research Farm, Federal University of Technology, Minna, Niger State, Nigeria. Minna lies between latitude 9^0 28′ to 9^0 37′ North and longitude 6^0 23′ and 6^0 33′ East. The mean annual rainfall is between 1200 and 1500 mm while the mean annual temperature is between 38 and 42^0C. The vegetation type is Southern Guinea Savannah (11).

Processing of cassava peel

Cassava peels were collected from cassava processing factories within Minna metropolis. The fresh peels were spread thinly and evenly on polythene sheets to sundry for three to four days, till a constant weight was attained. The peels were turned at regular intervals to allow for even drying. The sun-dried cassava peels were then milled using an attrition mill to produce sun-dried cassava peel meal (SCPM) and stored in polythene bags until needed for use.

Experimental diets

Experimental diets were formulated to contain 24 % crude protein at the growing phase, using feed ingredients purchased at feed ingredients depot within Minna metropolis. The SCPM were then incorporated into the diets as replacement for maize at 0, 25, 50 and 75 % levels to form Diet A, Diet B, Diet C and Diet D respectively (Table 1). The experimental diets for the laying phase were formulated to contain 21 % crude protein, with SCPM replacing maize at 0, 25, 50 and 75 % levels as in the growing phase (Table 1).

Management of the experimental birds at the growing phase

A total of 360 two-week-old Japanese quails were purchased from the National Veterinary Research Institute, Vom, Jos, Plateau State, and housed in brooder cages measuring 5 m by 3 m. One week before the arrival of the birds, the cages were cleaned, washed and disinfected with IZAL® disinfectant along with the drinkers, feeders and other equipment. 100 watt electric bulbs were installed in the cages to provide heat and illumination at night for continuous feed intake. Kerosene stoves and lamps provided additional heating. On arrival, the birds were gently unboxed into the cages in the brooder house that had previously been heated few hours to the arrival of the birds. 90 birds were randomly allotted to each treatment, with each treatment having three replicates of 30 birds per replicate. The birds were offered feed and water *ad libitum* for six weeks during the growing phase and data were collected on daily feed intake, weekly body weight gain and feed conversion ratio.

A digestibility trial was carried out on the growing quails at the end of the 5th week of the experiment. Two birds were randomly selected from each replicate and kept in specially constructed metabolism cages. The first three days were used as adjustment period for the birds, to allow them accustom to the conditions in the cages, while the remaining four days were used for faecal collection. Total droppings from each replicate were collected in aluminium foils, weighed and then oven dried at 65^{0}C for 36 hours. Thereafter, droppings from each replicate were pooled together and ground. Representative samples were analyzed for their proximate composition based on the procedures of (12); and the results obtained were used to determine apparent nutrient digestibility.

Management of the experimental birds at the laying phase

180 female Japanese quails from the growing phase were used for the laying phase. The males in each replicate were removed from the females such that the females maintained their original replicate position. Sexing was done by identification of the cloacal gland, which was a bulbous structure close to the vent in the male. When pressed, this gland brought out white foaming substances, which were absent in the females (3). The birds were fed the experimental diets *ad libitum* for six weeks and data were collected on daily feed intake and egg production. Hen day production (HDP), hen housed production (HHP) and mortality were determined based on the procedure of (13). The internal and external egg quality parameters were also determined using the procedures of (14). These included egg weight, egg length, egg width, egg shape index, egg density, egg shell thickness, yolk weight, yolk height, yolk width, yolk diameter, albumen weight, albumen height and Haugh Unit.

Proximate analysis

Proximate analysis to determine the amount of dry matter, crude protein, crude fibre, ether extract, ash and nitrogen free extracts in the test ingredient, the experimental diets (both at the growing and laying phases) as well as the collected faecal droppings obtained during the digestibility trial were carried out using the standard procedures of (12).

Statistical analysis

Data collected from the two experiments were subjected to analysis of variance (ANOVA) using Statistical Analysis Software Package (SAS, 2000, Version 6, SAS Institute, Cary, NC, USA) based on the Completely Randomized Design Model. Where treatment means were significant, they were separated using the Duncan's Multiple Range Test as contained in the Package.

Results and Discussion

The result of the proximate composition of SCPM (Table 2) show that it had an appreciable value of 8.50 % crude protein which is in agreement with the reports of (15) and (16) who obtained similar values; but contrary to the findings of (17) and (18) who reported lower values of 5.2 % and 4.81 % respectively. The crude fibre value of 16.93 % was obtained for cassava peel in this study. It is contrary to the reports of (15), (17) and (18) who reported 10.10, 12.20 and 10.00 % respectively. The variation in the composition of SCPM could be attributed to various factors such as the variety or cultivar of cassava planted, processing method employed as well as variations in the composition of the soil upon which they were cultivated.

The results of the growth performance and apparent nutrient digestibility of Japanese quails fed graded levels of SCPM are presented in Table 3. There were no significant ($p>0.05$) differences among the treatments in term of body weight gain and daily weight gain whereas there were significant ($p<0.05$) differences among the treatments when daily feed intake and feed conversion ratio (FCR) were considered. These findings are in consonance with the results of (19), who reported a linear decrease in feed intake as the level of dietary energy increased in Japanese quails diets; and conversely increased feed intake as the dietary energy decreased. At higher energy levels, quails tend to eat less and FCR is also better. This also agrees with the results of (20) who reported that birds tend to eat more of low energy diets than high energy diets. The significant difference in feed intake as the level of sun-dried cassava peel meal varied in the diets is similar to the findings of (21) when they fed breeding does with fermented cassava peel meal diets. The authors reported higher feed intake with increasing level of fermented cassava peel meal. Hence, the greater feed intake recorded in SCPM based diets in Japanese quails might be an attempt by birds to meet up with their metabolizable energy requirements thereby consuming more feed.

The results of apparent nutrient digestibility show that all the parameters were significantly ($p<0.05$) affected; however, Diet D (75 % SCPM replacement of maize) had the least values for apparent nutrient digestibility for most of the parameters. This observation is similar to the findings of (7), (22) and (23) that birds could only tolerate cassava peel at the level of 50 % replacement at the expense of maize beyond which it leads to reduction in weight gain, decrease in in feed efficiency and poor digestibility. This could be due to the high fibre content and powdery nature of cassava peel meal, as well as the presence of residual hydrocyanic acid (HCN). This might have affected the overall retention time of ingesta in the gastrointestinal tract and consequently their utilization.

The results of egg production and egg quality characteristics of laying Japanese quails fed graded levels of SCPM diets are presented in Table 4. There were significant ($p<0.05$) differences in hen day production (HDP), hen-housed production (HHP) and feed intake among the dietary treatments. This agrees with the findings of (17) who observed that Japanese quails fed diets containing varying levels of lye-treated cassava peel meal showed significant ($p<0.05$) differences in HDP. Increased feed intake did not lead to a corresponding increase in egg production in this study suggesting that increased fibre content and powdery nature of the feed could lead to poor digestibility, low nutrient utilization and lowered egg production. The results of both the internal and external egg quality characteristics show that yolk weight, yolk diameter, egg shell thickness, egg shell weight, egg length, egg shape index and Haugh Unit were not significantly ($p>0.05$) affected by the treatments. Haugh Unit values ranged between 86.82 and 90.36 % across the treatments indicating high quality eggs since those of inferior quality would have values of less than 40 % (24); and those with Haugh unit values of not less than 75 % indicate excellent quality eggs (25).

Revenue from sale of eggs and profitability index decreased considerably as the SCPM inclusion in the diets increased beyond 50 % replacement, though best result was obtained at 25 % maize replacement (Table 5). Similar trend was also observed in a study by (19). The decrease in revenue and profit beyond 50 % SCPM replacement of maize might have resulted from low feed utilization due to increasing high fibre content and residual HCN acid effect.

Conclusion and Application

1. It was concluded that dietary maize could be replaced with SCPM up to 50 % for optimum growth performance in growing

Japanese quails; while 25 % SCPM level of replacement is adequate for optimum egg production at the laying phase.

2. Considerably less revenue from sale of eggs and profit would be realized when laying Japanese quails are fed with diets containing more than 50 % SCPM as a replacement for maize; but the best result was obtained at 25 % replacement.

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Table 1: Composition of the experimental diets (at both the growing and laying phases) fed to Japanese quails (%)

	Growing phase				Laying phase			
Ingredients	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Maize	44.40	32.63	21.18	10.38	54.27	39.87	25.88	12.69
SCPM	0.00	10.87	21.18	31.14	0.00	13.29	25.88	38.06
Groundnut cake	38.90	39.80	40.94	41.78	28.03	29.14	30.54	31.55
Maize offal	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Fish meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Bone meal	2.50	2.50	2.50	2.50	3.00	3.00	3.00	3.00
Limestone	1.50	1.50	1.50	1.50	2.00	2.00	2.00	2.00
DL-Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
L-Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
*Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Calculated values								
ME (Kcal/kg)	2566	2406	2252	2105	2629	2434	2245	2066
Crude protein (%)	24.81	24.70	24.73	24.63	20.87	21.48	20.86	20.76
Crude fibre (%)	3.77	4.51	5.19	5.95	3.62	4.53	5.40	6.24
Methionine (%)	0.30	0.29	0.26	0.24	0.27	0.25	0.22	0.21
Lysine (%)	0.88	0.86	0.86	0.84	0.72	0.69	0.69	0.67
Calcium (%)	0.60	0.61	0.61	0.61	1.75	1.75	1.75	1.75
Phosphorus (%)	0.82	0.79	0.73	0.74	0.87	0.83	0.80	0.77

*1 kg of the premix supplied the following: Vitamin A (7,500 IU), vitamin D (500,000 IU), vitamin E (1,000 IU), vitamin B_1 (375 mg), vitamin B_2 (125 mg), vitamin B_3 (500 mg), vitamin B_6 (150 mg), vitamin B_{12} (2.5 mg), vitamin K (15 mg), vitamin C (10 mg), folic acid (150 mg), pantothenic acid (14.4 mg), Ca (12.5 mg), Cu (8.0 mg), Fe (32 mg), I (0.8 mg), Se (100 mg), Mg (0.25 mg), Cl (250 mg).

A = 0 % FCPM; 100 % maize; B = 25 % FCPM; 75 % Maize; C = 50 % FCPM; 50 % maize
D = 75 % FCPM; 25 % maize; SCPM = Sun-dried cassava peel meal; ME = Metabolizable energy

Table 2: Proximate composition of sun-dried cassava peel meal (SCPM) fed to the experimental birds

Parameter	% Composition
Dry matter	91.61
Crude protein	8.50
Crude fibre	16.93
Ether extract	1.20
Ash	6.90
Nitrogen free extracts	58.08

Table 3: Growth performance and apparent nutrient digestibility of Japanese quails fed graded levels of sun-dried cassava peel meal

Parameter	A	B	C	D	SEM
Initial body weight (g)	32.20	32.23	31.70	32.23	1.43ns
Final body weight (g)	131.44	135.33	137.22	134.44	4.63ns
Body weight gain (g)	99.24	103.10	105.52	102.21	4.56ns
Daily weight gain (g)	2.16	2.25	2.34	2.23	0.12ns
Daily feed intake (g)	13.87^{d}	15.87^{c}	18.06^{b}	19.57^{a}	0.66*
Feed conversion ratio	6.45^{a}	7.09^{ab}	7.72^{bc}	8.76^{c}	1.28*
Apparent nutrient digestibility coefficient (%)					
Dry matter	89.99^{a}	90.93^{a}	93.37^{a}	80.36^{b}	1.60*
Crude protein	84.40^{c}	85.65^{b}	87.26^{a}	80.68^{d}	0.74*
Crude fibre	83.55^{ab}	84.68^{a}	81.32^{b}	52.26^{c}	2.77*
Ether extract	93.26^{c}	93.50^{b}	95.31^{a}	87.27^{d}	0.91*
Ash	83.41^{b}	82.57^{b}	85.52^{a}	79.86^{c}	0.64*
Nitrogen free extracts	90.23^{c}	91.57^{b}	94.71^{a}	80.80^{d}	1.57*

[abcd] Means on the same row with different superscripts were significantly ($p<0.05$) different

A = 0 % FCPM; 100 % maize B = 25 % FCPM; 75 % Maize C = 50 % FCPM; 50 % maize
D = 75 % FCPM; 25 % maize SEM = Standard error of means ns = not significant ($p>0.05$)

Table 4: Egg production and egg quality characteristics of Japanese quails fed diets containing graded levels of sun-dried cassava peel meal

Parameter	A	B	C	D	SEM
Hen day production (%)	22.43^{c}	29.56^{a}	26.67^{b}	20.67^{c}	1.10*
Hen housed production (%)	19.90^{c}	27.37^{a}	23.79^{b}	18.98^{c}	1.02*
Daily feed intake (g)	20.21^{c}	24.98^{a}	25.40^{a}	23.34^{b}	0.64*
Yolk weight (g)	2.90	3.32	3.27	2.99	0.50ns
Yolk width (mm)	22.42	22.90	22.81	22.81	0.81ns
Yolk height (mm)	9.42^{c}	9.99^{b}	10.45^{a}	9.94^{b}	0.11*
Yolk index	0.41^{b}	0.44^{ab}	0.46^{a}	0.46^{a}	0.01*
Albumen weight (g)	3.31^{ab}	3.79^{a}	3.41^{ab}	3.15^{b}	0.10*
Albumen height (mm)	3.62^{b}	4.36^{a}	4.01^{ab}	3.68^{b}	0.11*
Shell thickness (mm)	0.24	0.25	0.25	0.25	0.00ns
Egg weight (g)	7.72^{ab}	8.52^{a}	8.17^{ab}	7.43^{b}	0.17*
Egg length (cm)	2.76	2.94	2.88	2.82	0.03ns
Egg width (cm)	2.25^{ab}	2.30^{a}	2.26^{ab}	2.18^{b}	0.02*
Egg shape index	0.82	0.78	0.79	0.77	0.01ns
Egg volume (mm^3)	7.22^{b}	8.55^{a}	8.00^{ab}	7.20^{b}	0.21*
Egg density (g/cm^3)	1.07^{a}	0.99^{b}	1.02^{b}	1.02^{b}	0.04*
Haugh Unit	86.82	90.36	89.45	87.69	6.30ns

[abc] Means in the same row with no superscripts were not significantly ($p<0.05$) different

A = 0 % FCPM; 100 % maize B = 25 % FCPM; 75 % Maize C = 50 % FCPM; 50 % maize
D = 75 % FCPM; 25 % maize SEM = Standard error of means ns = not significant ($p>0.05$)

Table 5: Profitability index of Japanese quails fed diets containing graded levels of sun-dried cassava peel meal

Parameter	A	B	C	D	SEM
Cost of feed (₦ /kg)	120.15	107.07	94.27	82.24	-
Total feed intake (g)	1808.89^{c}	2260.44^{ab}	2351.67^{a}	2115.00^{b}	67.45*
Daily feed intake (g)	20.21^{c}	24.98^{a}	25.40^{a}	23.34^{b}	0.64*
Cost of feed consumed (₦)	217.86^{b}	242.54^{a}	222.96^{ab}	174.97^{c}	7.93*
Total egg production	22.44^{b}	27.94^{a}	24.83^{b}	19.78^{c}	0.96*
Price/crate (₦)	400.00	400.00	400.00	400.00	-
Revenue from egg sale (₦)	299.26^{b}	372.60^{a}	348.89^{a}	263.71^{b}	43.10*
**Profitability index (₦)	81.40^{b}	130.14^{a}	124.72^{a}	88.73^{b}	8.90*

[abc] Means on the same row with different superscripts were significantly ($p<0.05$) different

**Profitability index was determined by subtracting cost of feed consumed from revenue from egg sale

A = 0 % FCPM; 100 % maize   B = 25 % FCPM; 75 % Maize   C = 50 % FCPM; 50 % maize
D = 75 % FCPM; 25 % maize   SEM = Standard error of means   ns = not significant ($p>0.05$)