Egg laying performance and economics of production of japanese quails fed diets containing peeled and cooked sweet potato meal

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Abstract

Japanese quails are small in size, early maturing, come to egg production between 5th and 6th week of life, hardy and prolific but requires local feeds for sustainability. Thus, a feeding trial which lasted for six months was carried out to investigate the effect of feeding peeled and cooked sweet potato tuber on hen-day egg production and economics of production of Japanese quails. Five isonitrogenous (20%CP) diets were compounded. The control diet (A) had zero sweet potato tuber meal. In the other four diets, 25, 50, 75 and 100% of maize was replaced with peeled and cooked sweet potato tuber meal. Three hundred point-of-lay female Japanese quail birds were randomly allotted to the diets in a completely randomized design. Feed and water were provided ad libitum for six months. Each diet was allocated to 60 quail chicks, which were further divided into three replicates of 20 birds each to determine the performance characteristics of the quails. Feed intake, body weight change, age at first eggs, age at 50% egg production, age at 75% egg production, hen-day egg production, hen-housed egg production and feed per dozen eggs were similar (pfi 0.05) across the diets. Water intake by birds on diet A was significantly (pfi 0.05) lower than the birds on the sweet potato diets. Water intake was significantly (pfi 0.05) higher by birds on diet D (51.93ml/bird/day) than those on diets A (42.60) and C (46.68mL/bird/day). Total cost of production did not differ significantly across the diets. Gross margin was significantly higher on diet C (N67, 227.64) than on the other diets except for diet D (N65, 795.52). Results showed that peeled and cooked sweet potato can completely replace maize in the diet of laying quails without adverse effects on performance or on economics of production.

Keywords: Feed intake, water intake, hen-day egg production, hen-housed egg production, economics of production.

Introduction

There are about 50 genera and more than 1000 species of sweet potato with the family name called convulvulaceae. Sweet potato (*Ipomoea batatas*), a member of this family, is the only crop plant whose large starchy, tasty tuberous root is an important root vegetable (Purseglove, 1991). It is widely cultivated in the tropics and the warmer temperate climates. The edible part is an enlarged tuberous root, varying from oblong to pointed ovalin shape. Neild (1992) reported that the solid root consists largely of starch and that the orange-fleshed varieties are high in carotene, vitamin A and

B₆ or pyridoxine. Studies by Oboh (1987) and Tewe (1992) have shown that sweet potato is utilized efficiently by poultry. Ladokun *et al.* (2007) reported that not more than 50% of maize should be replaced by sweet potato meal in the diet of laying chickens to maintain profitable performance. However, Aina and Fanimu (1997) reported that hen-day egg production, egg weight, feed intake and shell thickness did not differ significantly between birds fed maize-based diets and those fed sweet potato diets. Maphosa *et al.* (2003) and Afolayan *et al.* (2012) reported that addition of sweet potato to broiler diet

negatively affected their performance and that not more than 50% of maize should be replaced with sweet potato meal in finisher diet to avoid adverse effect on performance. Japanese quail are small-sized, come to egg production between the 5th and 6th week of life (Martins, 1987), are early maturing, hardy and prolific (Robbins, 1981). The eggs are small, multicolored and weigh between 8 and 10g each (Edache *et al.*, 2003a; Musa *et al.*, 2008). The meat and eggs are low in body fat and cholesterol which is of public health significance. Increased production of this bird with adequate nutrition will ensure constant availability to teaming consumers. Eighteen to twenty percent crude protein diet has been recommended for acceptable egg laying for Japanese quail (Edache *et al.*, 2003b).

The objective of this study was to determine the effect of replacing maize with peeled cooked sundried sweet potato tuber meal on hen-day egg production and economics of production of Japanese quails.

Materials and methods

Source and processing method of sweet potato tuber

The white-fleshed sweet potato tuber used in this study was purchased from Jos and from a border market between Plateau and Kaduna States. The sweet potato tubers were cleaned for processing. The sweet potato tubers were peeled, sliced (3mm), cooked (20 minutes) and sun-dried for seven days. The cooking was done by pouring the sliced sweet potato tubers into boiling water and left to boil for 20 minutes. A hammer mill fitted with an 8 mm sieve was used to mill the processed sweet potato tubers and thereafter incorporated into experimental diets. The diets were analyzed for proximate chemical components as outlined (AOAC, 2000).

Experimental birds

Three hundred point-of-lay Japanese quails purchased from Poultry Division, National Veterinary Research Institute, Vom were used in the study. They were healthy and uniform in body weight and size (of average of 155g per bird).

Experimental design and housing

The three hundred point-of-lay quails were randomly allotted to five dietary treatments in a completely randomized design. Each treatment group had 60 quails and was replicated thrice. Each replicate had twenty quails which were housed in a standard deep litter poultry house spaced 150 sq cm per bird as recommended by Musa *et al.* (2008).

Experimental diets

Peeled cooked sundried sweet potato meal was used to replace maize in five isonitrogenous (20% CP) diets. Diet A without peeled and cooked sweet potato served as the control. In diets B, C, D and E, 25%, 50%, 75% and 100% of maize in the diets was replaced by peeled and cooked sweet potato meal, respectively. The diets were fortified with vitamins and minerals. The ingredient and nutrient composition of the experimental diets are presented in Tables 1 and 2, respectively.

Management of birds and data collection

Each treatment group of birds was fed one of the five experimental diets in which 0, 25, 50, 75 and 100% of maize was replaced by peeled and cooked sweet potato meal, respectively. The birds were fed the experimental diets daily and corresponding leftover weighed to determine feed intake. Water intake was measured daily using a calibrated cylinder. All birds were given feed and water ad libitum throughout the experimental. All birds in each replicate were weighed at the start of the feeding trial and once a week for the period of the feeding trial. Daily egg collection was carried and sample of eggs from each

Table 1: Percent ingredient composition of experimental diets for laying quails

Ingredients	Diets				
	A	B	C	D	E
Maize	40.23	29.26	18.27	7.25	0
Sweet potato meal	0	10.06	20.11	30.22	40.23
Ground nut cake	25.57	26.48	27.41	28.33	30.31
Wheat offal	10.00	10.00	10.00	10.00	10.00
Fish meal	1.00	1.00	1.00	1.00	1.00
Palm kernel cake	14.00	14.00	14.00	14.00	14.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Limestone	6.50	6.50	6.50	6.50	6.50
*Vit. Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Total	100	100	100	100	100
Calculated composition:					
C.P. %	20.00	20.00	20.00	20.00	20.00
M.E.					
(Kcal/kg)	2575.83	2521.79	2467.57	2413.24	2377.48
Ca. (%)	3.17	3.18	3.18	3.18	3.19
P (%)	0.47	0.47	0.47	0.46	0.45
C.F. (%)	4.63	5.05	5.48	6.90	6.17
Cost/kg Diet (₦)	63.72	62.99	62.26	61.53	61.04

* Bio Mix Layer premix supplied the following per 100kg of diet: Vitamin A, 850,000 I.U; Vitamin D₃, 150,000 I.U; Vitamin E, 1,000 I.U; Vitamin K, 1000 mg; Thiamin (B₁), 150 mg; Riboflavin (B₂), 450mg; Pyridoxine (B₆), 300mg; Niacin, 1500mg; Vitamin B₁₂, 1.5mg; Pantothenic acid, 450mg; Folic acid, 60mg; Biotin, 50mg; Choline chloride, 17,500mg; Anti oxidant, 125mg; Manganese, 4000mg; Zinc, 3000mg; Iron, 2000mg; Copper, 300mg; Iodine, 100mg; Selenium, 20mg; Cobalt, 20mg. Key: C.P, crude protein; M.E, metabolizable energy; Ca, calcium; P, phosphorus; C.F, crude fibre.

Table 2: Nutrient composition (%) of laying quail diets used in the experiment

Parameters (%)	A	B	C	D	E	SEM
Dry matter	94.70	94.50	94.39	94.04	94.22	±0.43NS
Crude Protein	20.10	20.10	20.08	20.11	20.10	±0.06NS
Ash	10.06	8.00	6.40	6.09	7.02	±4.11NS
Ether extract	5.07	4.78	5.54	4.92	4.98	±0.49NS
Crude fibre	8.01	8.06	8.70	9.06	8.53	±0.71NS
Nitrogen Free Extract	51.46	53.06	53.67	53.86	53.59	±2.23NS

Key: A = Control diet (with no cooked sweet potato tuber), B = Diet with 25% of maize replaced by peeled cooked sundried sweet potato meal, C = Diet with 50% of maize replaced by peeled cooked sundried sweet potato meal, D = Diet with 75% of maize replaced by peeled cooked sundried sweet potato meal, E = Diet with 100% of maize replaced by peeled cooked sundried sweet potato meal, SEM - Standard error of mean, N.S – not significant (P* 0.05).

replicate was weighed weekly to record mean egg weight.

Parameters measured

The initial weight of birds at point-of-lay and the final weight of the birds at the end of the experiment were taken.

Body weight change

This was done by measuring the difference

between the final weight and the initial weight of the quail birds multiplied by 100.

Feed intake

The birds were offered weighed amount of feed daily and the corresponding left over weighed and recorded. The difference between the amount fed and the corresponding leftover divided by the

specified period was the daily feed intake.

Protein efficiency ratio (PER)

This was determined as a ratio of weight of egg produced to the protein consumed.

$$\text{PER} = \frac{\text{weight of eggs (g)}}{\text{Protein consumed (g)}}$$

Energy efficiency ratio (EER)

This was determined as ratio of weight of eggs produced to the energy consumed.

$$\text{EER} = \frac{\text{Weight of eggs (g)}}{\text{Energy consumed (kcal/g)}}$$

Water consumption

Daily water consumption was determined accounting for evaporative loss using the procedure outlined by Shoremi *et al.* (2001).

Mortality records: This was kept throughout the experimental period.

Production parameters measured

Hen day egg production

This was measured as the total number of eggs laid divided by the number of hens in the house multiplied by 100. This is given as;

$$\text{HDEP} = \frac{\text{number of eggs produced}}{\text{number of live birds}} \times 100$$

Hen housed egg production

This was measured as the total number of eggs laid divided by the number of hens originally housed (dead, culled etc inclusive) multiplied by 100. $\text{HHEP} = \frac{\text{number of eggs produced}}{\text{number of birds originally housed}} \times 100$

Feed conversion ratio

This was measured as the gram feed consumed per gram of dozen eggs produced.

Egg weight was measured as the average weight of individual egg.

Estimation of economics of production

The following parameters were used to estimate economics of production:

Cost of feed per kilogram (N/kg) -This was

computed using the prevailing market price of ingredients and it's indicated in the formula (Table 1).

Cost of feed per unit weight gain- This was computed as the feed conversion ratio multiplied by the unit price of feed.

Cost of production/bird: The cost of production was estimated as sum of cost of birds, feed, medications, kerosene, charcoal, wood shaving, electric bulbs, measuring cylinder, labour and housing divided by the number of birds in a treatment. Revenue: The revenue was calculated as price per mature bird plus eggs plus the manure harvested in that treatment.

Gross margin/bird: This was calculated as the total revenue generated minus the total cost of production.

Statistical analysis

Data obtained were subjected to one way analysis of variance (ANOVA) and where significant differences were observed, means were separated using Duncan's Multiple Range Test (Duncan, 1955) as described by Steel and Torrie (1980).

Results and discussion

Results on performance characteristics of laying quails are presented in Table 3. The final body weight decreased from 197.75g/bird for birds on the control diet to 194.43g/bird on the sweet potato diets. However, the differences were not significant. Values of 187.38 - 197.75g/bird obtained in this study were higher than the final body weight of 163-184.33g/bird reported by Edache *et al.* (2012), 187.55-192.67g/bird reported by Akinfenwa *et al.* (2011) and (180-186.50g/bird) reported by Akpa *et al.* (2008) and 141.30 -

154.00g/bird reported by Odunsi *et al.* (2007). Body weight change was not significantly affected by the diets. In the report of Ladokun *et al.* (2007) body weight changes was significantly higher in birds on the complete replacement with sweet potato than on other diets. The lack of significant effect of the diets on body weight change in the present report is in consonance with the report of Akinfenwa *et al.* (2011) for laying quail.

The feed intake ranged from 28.88g/bird/day (diet A) to 29.98g/bird/day (diet D) but was not significantly affected by the diets. This contradicts the report of Ladokun *et al.* (2007). In their report, feed intake decreased significantly as the levels of sweet potato increased. The report of Panigrahi *et al.* (1996) and Aina and Fanimu (1997), on the other hand, supports the present findings. They reported no significant differences between feed intake of chickens on maize-based diets and those on sweet potato diets. Shanaway (1994) had reported that at ambient temperatures of 20, 28 and 35°C, feed intake of laying Japanese quail was 20.8, 21.20 and 20.90g/bird/day but this was not observed in the present study. Values reported in his work Shanaway (1994) seem lower than reported in the present study. As can be observed from Table 1, the energy level of the diets decreased as the level of sweet potato increased. Since birds eat to satisfy the energy requirement (NRC, 1994), the increased effort at feed intake by birds on the various sweet potato meal diets must have led to the similarity in feed intake between the test diets and the control. Previous report by Vasco de Basilio *et al.* (1997) showed that feed intake was not affected as maize was replaced by sweet potato meal for laying Japanese quails up to 100% of the diet. Hen-day egg production decreased from 78.11 (diet A) to 73.09 %

(diet E) but did not differ significantly between the diets. The values reported in this study are higher than those (77.02 - 62.71%) reported for laying Japanese quail fed toasted mucuna seed meal (Tuleun and Dashe, 2010) and higher than 66.80-59.40% reported by Aggoor *et al.* (2006) for laying quail fed rice bran or broken rice at two different energy levels and higher than that (75.78-68.60%) reported by Akinfenwa *et al.* (2011) for laying Coturnix quail and higher than the 59.00 - 49.80% reported by Odunsi *et al.* (2007) for laying Japanese quail. Aina and Fanimu (1997) reported that egg production did not differ significantly between birds fed maize and sweet potato diets and attributed it to adequacy of dietary protein and metabolizable energy of the diet. This is in agreement with the result of this work.

Hen-housed egg production reported in this study increased from 69.02% (diet A) to 73.44% for birds on diet C but the differences were not significant which agrees with the report of Tuleun and Dashe (2010) and Kaya and Yildirim (2011) who fed laying chickens with sweet potato vines and may still be due to the adequacy of dietary protein and metabolizable energy.

Water intake of birds on the test diets was significantly higher than those on the control (42.60mL/bird). Significant differences also exist between water intake of birds on diets C and D (51.93mL/bird) only. Ezieshi *et al.* (2003) reported that water intake for chicken increased as egg production increased to peak production which is similar to what was observed in the present study. They reported that average water intake per bird was about 300ml/day in the tropics which was much higher than earlier report (Savory, 1978) for laying birds in temperate countries. Water to feed ratio for chicken was about 2.5 but a lack of published data from tropical zones could

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not allow for comparison (Ezieshi *et al.*, 2003). According to Rajput (2006), daily feed and water consumption for young quail was observed to be 16.25g/bird and 33.07ml/bird respectively as compared to 29.98g/bird and 51.93ml/bird in the present study. This may be due to differences in climate where the studies were carried out since birds under higher environmental temperatures must consume more water to maintain body temperature. Birds have been reported to consume more water in the tropics in order to control their body temperature (Ezieshi *et al.* 2003).

Feed per dozen eggs increased linearly from control (0.45kg; diet A) to 0.49kg (diet D) but did not differ significantly. This is similar to the report of Aina and Fanimio (1997) for laying chickens. They reported that there were no significant differences either in feed per dozen eggs or feed per kilogram egg between maize –based diets

and sweet potato diets. Similar results have been reported by Ladokun *et al.* (2007) for laying birds and Vasco de Basilio *et al.* (1997) for laying Japanese quails fed sweet potato meal diets and by Kaya and Yildirim (2011) for laying chickens fed sweet potato vines. However, this report is contrary to that reported for Japanese quail (Aggoor *et al.*, 2006) and may be due to differences in diets utilized.

Feed cost per dozen eggs ranged from N28.89 (diet A) to 30.15 (diet D) with increasing content of sweet potato but the differences were not significant. The values for feed cost per dozen eggs obtained in this study is similar to the cost of feed/egg (2.62-2.23) reported by Tuleun and Dashe (2010). The result of feed cost per dozen eggs in this study followed similar trend with feed conversion ratio. This is in agreement with the feed intake values in the present work.

Table 3: Effects of replacing maize with peeled and cooked sweet potato meal diets on egg laying performance of Japanese quails

Parameters	A	B	C	D	E	SEM
Initial weight (g/b)	155.00	155.67	155.33	155.00	155.00	0.85NS
Final weight (g/b)	197.75	187.38	192.85	194.43	187.48	6.32NS
Weight change (%)	27.57	20.39	24.15	25.44	20.96	3.94NS
Feed intake (g/b/d)	28.88	29.39	29.22	29.98	29.11	1.23NS
Water intake (ml/bird/day)	42.60	48.32	46.68	51.93	49.19	1.81*
Hen-day egg prodn (%)	78.73	76.68	73.83	74.83	73.09	3.75NS
Hen-housed egg prodn (%)	69.02	66.73	73.44	73.00	72.12	5.48NS
Feed/doz. Eggs	0.45	0.47	0.48	0.49	0.48	0.03NS
Feed cost/doz. Eggs (N)	28.89	29.90	30.09	30.15	29.50	1.88NS
Energy intake (kcal/kg/bird)	74.49	73.97	72.19	72.24	69.20	3.09NS
Protein intake (g/b/d)	5.78	5.88	5.85	6.00	5.79	0.26NS
Energy efficiency ratio	0.15	0.15	0.16	0.15	0.16	0.007NS
Protein efficiency ratio	2.03	1.86	1.89	1.86	1.87	0.099NS
Mortality (%)	2.20	2.49	0.28	0.55	0.54	1.40NS

a, b, means with same superscripts letters within rows are not significantly ($p > 0.05$) different. SEM, standard error of mean. NS = not significant, A, control (no sweet potato tuber meal); B, diet with 10.06% peeled cooked sweet potato meal; C, diet with 20.11% peeled cooked sweet potato meal; D, diet with 30.22% peeled cooked sweet potato meal; E, diet with 40.23% peeled cooked sweet potato meal.

Energy intake of laying quail decreased from 74.49 (diet A) to 69.20kcal/kg (diet E) but the differences were not significant. This observation was contrary to the report

of Aina and Fanimio (1997) for laying chickens fed sweet potato meal for they observed a significant reduction in energy intake between birds fed the maize diet and

those fed sweet potato diets. The Japanese quail has been reported to be able to adjust feed intake within a wide range of dietary energy levels of between 1700 and 2400kcal/kg (Weber and Reid, 1967). This is perhaps responsible for the similarity in energy intake in this study.

Daily protein intake of birds in the present study increased from 5.78g/bird (diet A) to 6.00g/bird (diet D). However, the differences were not significant. This is in consonance with earlier report (Aina and Fanimu, 1997) for laying chicken.

Economics of production of laying quails fed peeled and cooked sweet potato meal diets (Table 4) showed that birds on the control diet consumed less feed (28.88g/bird/day) and had the lowest total feed intake (4.85kg/bird) compared to

those on the sweet potato diets. This is contrary to report by Ladokun *et al.* (2007). They reported that feed intake, total feed intake and price of eggs produced were higher on the control than on sweet potato diets. Moreover, final body weight of birds in their work was higher on the control than on the sweet potato diet, which agreed with the report of the present study. In this study, birds on diet C (66, 840.00) were superior in revenue and gross margin compared to the control and other test diets. However, gross margin on diets D and E are similar to diet C. Similar results have been reported by Ladokun *et al.* (2007) for laying chicken on sweet potato meal diets. There is a cost saving of 4.21% on the diet with complete replacement with sweet potato as compared to the maize-based diets.

Table 4: Economics of production of laying Japanese quails fed peeled and cooked sweet potato meal diets

Parameters	A	B	C	D	E	SEM
Feed intake(g/bird/day)	28.88	29.39	29.22	29.98	29.11	±1.23NS
Price/tray of egg (₦)	300	300	300	300	300	
Total feed intake (kg/bird)	4.85	4.94	4.91	5.04	4.89	±0.13 NS
Feed cost/doz. eggs (₦)	28.89	29.90	30.09	30.15	29.50	±0.03 NS
Final body weight (g/bird)	197.75	187.38	192.85	194.43	187.48	±6.32 NS
Total price of egg produced (₦)	75980 ^a	72690 ^a	81100 ^b	79920 ^a	78970 ^a	±187.98*
Total no. eggs produced	7598	7269	8110	7992	7897	±594.45NS
Total cost of production (₦)	29,521.45	29,629.08	29,622.36	29,874.25	29,202.48	±425.28NS
Revenue (birds/eggs/manure)	91,480.00 ^a	88,190.00 ^a	96,850.00 ^b	95,670.00 ^a	94,720.00 ^a	±194.92*
Gross margin (₦)	61,920.00 ^a	57,027.00 ^b	66,840.00 ^c	65,495.00 ^c	65,559.00 ^c	±1110*

Key: a, b, means with same superscripts letters within rows are not significantly ($p > 0.05$) different. SEM, standard error of mean. N.S = not significant, A, control (no sweet potato meal); B, diet with 10.06% peeled cooked sweet potato meal; C, diet with 20.11% peeled cooked sweet potato meal; D, diet with 30.22% peeled cooked sweet potato meal; E, diet with 40.23% peeled cooked sweet potato meal.

Conclusion

The optimal inclusion level of peeled and cooked sweet potato root meal as a replacement for maize for laying Japanese quail showed a comparable performance in most measured parameters; (feed intake, water intake, hen-day egg production, hen-housed egg production, feed/dozen eggs, feed cost/dozen eggs, protein intake, protein efficiency ratio, energy intake, energy efficiency ratio,) with the control. Gross margin for raising Japanese quail on these diets was higher on the 50, 75 and 100% of maize replaced by sweet potato

diets than on the control. From the results of this study, peeled and cooked sweet potato meal may completely replace maize in growing and laying Japanese quail diets because there were no adverse effects on performance at this level.

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