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Growth Performance and Carcass Merit of Japanese Quails (*Coturnix japonica*) Fed with Sorghum as an Energy Source Substitute for Maize in North Western Nigeria

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ABSTRACT

A feeding trial was conducted to determine the growth performance and carcass characteristics of Japanese quails fed diets containing sorghum. A total of ninety of one-week old Japanese quail chicks were used for the experiment. Five diets were formulated in which sorghum was included at graded levels 0, 15, 30, 45 and 60% dietary levels designated as treatment 1, 2, 3, 4 and 5 respectively. The experimental period was five weeks when the birds reach six weeks of age. The results of the growth performance showed significant differences ($P<0.05$) in the final body weight (161.70 – 180.10 g) and daily feed intake (21.34–25.12 g). Significant ($P<0.05$) differences was also observed in all carcass parameters measured except for dressing percentage. Liver weight and large intestine with T_5 (65% total replacement) recorded the highest means value of 6.00 g and 6.66 g. Non-significant high values of feed conversion ratio were also obtained among the treatments. Treatment 1 (0%) and Treatment 5 (60%) showed better results in all parameters measured compared to other treatments. In conclusions, sorghum grain can play a significant role in formulating quail feed and can completely (60%) be used to replace maize without affecting the performance and carcass yield of the quails.

Keywords: Carcass merit, *Coturnix japonica*, Growth performance, *Sorghum bicolor*

INTRODUCTION

Japanese quails (*Coturnix japonica*) are small-bodied size birds of the Galliform family with a widespread distribution in the Palaearctic. They were introduced to Nigerian poultry in 1992 and attracted huge attention among the poultry farmers in the country, mainly because of their medicinal benefits and short generation interval to attain market size (Kumbashi et al., 2013; Onyewuchi et al., 2013). The demand for quail products, especially meat, is currently increasing, thus becoming the consumer's second choice after chicken, especially in developing countries (Jeke et al., 2018). This is because quail meat provides more nutritional value than chicken

meat as it has low fat and cholesterol value (Hubrecht & Kirkwood, 2010). Quail meat has excellent taste and texture rather than chicken meat and hence, believed in providing several advantages to human health for their low cholesterol value in meat and rich in high-density lipoprotein (HDL) cholesterol in the egg (Bakoji et al., 2013; Imchen, 2013). Their meat contains a lot of minerals (iron, potassium and sodium) and micronutrient, with a wide range of vitamins including folate, B complex, vitamin E and K (Mohammed & Ejiofor, 2015; Nursobihah et al., 2019).

The feed is the most important and costly part of the entire cost of raising poultry (70-80%), and the price is magnified by the fact that most farmers feed their poultry with ground mash or pelleted diets (Ong, 2010; Maidala & Bilkisu, 2016). Akinola and Sese (2011) described the energy level of the feed as the key factor affecting feed intake because birds must absorb feed to fulfil their energy requirement under normal conditions. Inaku et al. (2011) added that energy is being used to provide body heat, growth, maintenance and production in poultry nutrition. In Nigeria, maize has been the main source of energy for poultry feeds and accounts for 50-70% rations of broiler feeds (Ojewola & Olugbemi, 2011; Akintunde et al., 2017). Maize is the most essential energy source in the poultry diet, with relatively high starch content and metabolisable energy and considerable carotenoids levels (Kufel et al., 2019). However, insufficient production of this grain and strong competition for maize between humans, industries and livestock has rendered poultry rations more expensive, particularly in drier and low precipitation areas of the tropics (FAO, 2006; Maidala & Bilkisu, 2016; Tamburawa et al., 2018; Ashiru et al., 2020). In order to alleviate from such threat, alternative energy source like sorghum should be tried as an energy substitute.

Sorghum '*Sorghum bicolor*' is an African-native cereal crop and belong to Poaceae family (De Morais Cardoso et al., 2015). The semi-arid condition of West Africa having a high ambient temperature of >38 ^{o}C during dry season periods, poor distribution of rainfall makes it more suitable for sorghum production (Medugu et al., 2010). Sorghum in Nigeria is grown on an estimated area of 4.5 million ha with an annual production output of about 6 million tons (National Agricultural Extension and Rural Liaison Services, 2007; Mohammed, 2012). Sorghum provides sufficient nutritional properties and is being used as a substitute for maize, especially in semi-arid and tropical regions in which sorghum crops have higher nutritional yields per area and a cheaper price compared to maize (Ligeiro et al., 2009; Freitas et al., 2014; Maidala & Bilkisu, 2016). The crude protein content of sorghum is slightly higher than maize but has similar lipid and starch content (Johnston & Moreau, 2017). Recently, several researches were focused on maize substitution alternative in different species of poultry sector. The current analysis was therefore, focused on the impact of the partial and complete substitution of maize with sorghum on the growth efficiency of Japanese quails and their carcass characteristics.

MATERIALS AND METHODS

Study area

The experiment was conducted at the Teaching and Research Farm of the Department of Animal Science, Faculty of Agriculture and Agricultural Technology, Kano University of Science and Technology, Wudil. It is located within the Sudan savannah region of Nigeria; the farm is on latitude 11^{0}37 N, longitude 8^{0}53 E at an altitude of 403m above the sea level with the annual rainfall range from 850-870 mm (Olofin et al., 2008). The experiment was conducted for a period five weeks during rainy season with an average temperature of 30.1 ^{o}C.

Experimental animals and their management

A total of 90 of one-week old Japanese quails (all males) were purchased from the National Veterinary Research Institute (NVRI), Plateau State. Antibiotic prophylaxis was given using oxytetracycline powder at the dose rate of 500 mg L^{-1} via drinking water for three days consecutively. Anti-stress (glucose D) powder was given orally to reduce the stress incurred. Anti-protozoan's (Amprolium) powder at a dose of 500 mg L^{-1} was administered via drinking water. The birds were housed in deep litter pens equipped with conical feeders and drinkers. The floor was covered with wood shaving. Feed and water were provided *ad-libitum*.

Experimental Diet and Design

Five experimental diets were formulated at a different levels of inclusion where sorghum replaced maize at 0, 15, 30, 45 and 60%. The diets were designated as treatments 1, 2, 3, 4 and 5, respectively (Table 1). Ninety (90) quails were randomly allotted to five dietary treatments with 6 birds per treatment, and each treatment was replicated three times in a completely randomized design.

Table 1. Composition of experimental diet

	Treatments				
Ingredients	**T_1** (0%)	**T_2** (15%)	**T_3** (30%)	**T_4** (45%)	**T_5** (60%)
Maize	63.46	47.59	31.73	15.87	00.00
Sorghum	00.00	15.87	31.73	47.59	63.46
Soybean meal	22.49	22.49	22.49	22.49	22.49
Fish meal	03.50	03.50	03.50	03.50	03.50
Wheat offal	06.00	06.00	06.00	06.00	06.00
Bone meal	03.50	03.50	03.50	03.50	03.50
Salt	00.30	00.30	00.30	00.30	00.30
Methionine	00.30	00.30	00.30	00.30	00.30
Lysine	00.20	00.20	00.20	00.20	00.20
Premix	00.25	00.25	00.25	00.25	00.25
Total	100	100	100	100	100
Determined Analysis					
Dry Matter (%)	91.12	91.12	91.05	91.01	90.95
Crude Protein (%)	15.35	16.74	17.46	18.63	19.84
Ether Extract (%)	04.69	5.21	5.48	5.84	6.00
Crude Fibre (%)	03.23	3.36	3.58	3.89	4.13
Ash (%)	03.71	3.82	3.96	4.34	4.72
Moisture (%)	08.88	8.90	8.95	8.99	9.05
Nitrogen free extract (%)	64.28	61.99	60.59	59.05	56.31
Calculated Analysis					
Crude protein (%)	25.10	25.20	25.36	25.40	25.50
Metabolisable Energy Kcal/kg	3100	3075	3038	3022	3016
Crude fibre (%)	3.004	3.639	4.268	4.897	5.532
Ether extract (%)	4.343	4.048	3.749	3.450	3.150
Calcium (%)	1.564	1.569	1.602	1.578	1.583
Phosphorus (%)	0.830	0.870	0.910	0.940	0.980
Lysine (%)	0.980	0.990	1.010	1.020	1.040
Methionine (%)	0.300	0.290	0.280	0.270	0.250
Cysteine (%)	0.400	0.410	0.420	0.410	0.420

*Premix supplied per kg of diet: Vit A, 10,000 IU; Vit D, 2,800 IU; Vit E, 35,000 IU; Vit K, 1,900 mg; Vit B_{12}, 19 mg; Riboflavin, 7,000 mg; Pyridoxine, 3,800 mg; Thiamine, 2,200 mg; D-Pantothenic acid, 11,000 mg; Nicotinic acid, 45,000 mg; Folic acid, 1,400 mg; Biotin, 113 mg; Cu, 8,000 mg; Mn, 64,000 mg; Zn, 40,000 mg; Fe, 32,000 mg; Se, 160 mg; I, 800 mg; Co, 400 mg; Cl, 475,000 mg; Methionine, 50,000 mg; BHT, 5,000 mg; Spiramycin, 5,000 mg (purchased from Sovet International Nigeria Limited, Kano, Nigeria)

Data collection and carcass yield

The birds were initially weighed at the onset of the research and further weighed on weekly basis as described by Tamburawa et al. (2018). The feed offered daily, and leftover of feed was weighed daily, and the feed consumption was determined by subtracting the daily leftover from the daily feed offered. The feed offered daily, and leftover of feed was weighed daily, and the feed consumption was determined by subtracting the daily leftover from the daily feed offered. The final live weight was also recorded at the end of the experiment. The

feed conversion ratio (FCR) was calculated as the ratio of daily feed consumed per unit weight gain. The final live weight was recorded before slaughtering. At the final phase of the experiment (6 weeks), carcass analysis was performed with three (3) randomly selected quails from each replication and starved for 24 hrs prior to slaughter. The birds were killed by slicing the jugular vein until completely bled, then soaked in hot water for easy removal of feathers and evisceration. The carcass was then disjointed by making a forequarter cut and hindquarter cut. For the forequarters, a longitudinal cut was made starting from the first thoracic vertebra and extending posteriorly through the sixth thoracic vertebra cutting the keel into half. Meanwhile, the hindquarter was obtained by cutting from the seventh thoracic vertebra and extending posteriorly splitting the lumbar-sacral vertebra into half (Hudspeth et al., 1973). The data collected were subjected to the analysis of variance (ANOVA) using SPSS v17. Where a significant difference observed, means were separated using Duncan multiple range test at $P<0.05$.

RESULTS AND DISCUSSIONS

Growth performance of Japanese quails

A summary of the growth performance of Japanese quail fed graded levels of sorghum replace maize is presented in Table 2. Significant differences ($P<0.05$) were observed among the treatments means for final body weight and daily feed intake with T_1 and T_5 having the highest mean values of 180.1 g & 24.30 g and 178.96 g & 25.12 g respectively. Similar performance for quails fed with different proportions of sorghum can be related to the proximity of nutritional values of sorghum and maize (Moraes et al., 2016). Similar authors added that diets formulation is possible with closely related nutritional values for both crude protein and metabolizable energy for such two grains. No significant difference ($P>0.05$) were observed in daily weight gain and feed conversion ratio in the current finding. However, high FCR was recorded across the treatments used. Moraes et al. (2016) reported the higher FCR value of 4.60 which is higher than results obtained in this study. The recorded values in this study were within the range reported by Odunsi et al. (2007) that fed quails with maize, millet, sorghum, and biscuit waste meal-based diets. Also, no effect observed on the performance of laying Japanese quails fed with low-tannin sorghum replacing maize (Moura et al., (2010). Similar results obtained in the current study confirm the nutritional efficiency of sorghum with maize and indicate the ability of sorghum for complete use in quail feeds. Also, the mortality rate of 0% recorded throughout the research is supported by previous findings on quails (Ragab et al., 2002) fed with different varieties of sorghum, and broiler chickens (Diarra et al., 2014) fed cassava copra meal-based or commercial finisher diets in Samoa. Good management practices also helped in minimizing the occurrence of mortality in a flock.

Table 2. Growth performance of Japanese quails fed graded levels of sorghum in place of maize

	Treatments					
Parameters	**T_1** (0%)	**T_2** (15%)	**T_3** (30%)	**T_4** (45%)	**T_5** (60%)	**SEM**
Initial body weight (g)	30.00	30.00	30.00	30.00	30.00	0.53
Final body weight (g)	180.10^a	176.20^b	161.70^c	176.83^b	178.96^a	5.09
Daily feed intake (g)	24.30^a	22.11^b	25.46^a	21.34^b	25.12^a	1.92
Daily weight gain (g)	7.03	6.98	6.58	6.97	7.08	0.24
Feed conversion ratio	3.45	3.16	3.86	3.06	3.54	0.73
Mortality (%)	0.00	0.00	0.00	0.00	0.00	0.00

abc = Means within the same rows with different superscript are significantly different ($P<0.05$);
SEM = Standard Error of Means

Carcass analysis of Japanese quails

Significant ($P<0.05$) differences were observed in all parameters measured except for dressing percentage (Table 3). Despite starving the quails before slaughtering, feed remains were still observed in some quails after slaughtering, which might cause the differences. These results are in agreement with the previous research where sorghum replaced maize (Maidala & Bilkisu, 2016; Akintunde et al., 2017). Carolino et al. (2014) reported

contrarily with no differences in carcass yield and cut yields. Hence, differences might be due to different environmental conditions as well as bird management. Similarly, the current result is in disparities with the report of Mahmud et al. (2015) who reported no effects among treatments of Japanese quails fed graded level of neem leaves. The disparities may be attributed to the fact that a neem leaf has low energy values due to its high fibre contents which had an energy dilution effect on the diet.

Table 3. Carcass analysis of Japanese quails fed graded levels of sorghum in place of maize

	Treatments					
Parameters	**T_1** (0%)	**T_2** (15%)	**T_3** (30%)	**T_4** (45%)	**T_5** (60%)	**SEM**
Live weight (g)	180.10^{bc}	176.20^{ab}	161.70^{a}	176.83^{abc}	178.96^{c}	6.75
Slaughtered weight (g)	174.33^{a}	170.33^{b}	157.00^{ab}	171.66^{ab}	174.00^{a}	6.50
Dressed weight (g)	162.10^{c}	159.30^{a}	142.66^{bc}	158.66^{ab}	159.68^{a}	5.29
Carcass weight (g)	134.66^{b}	127.66^{a}	117.20^{a}	128.33^{a}	133.80^{b}	4.25
Dressing (%)	50.69	46.31	44.82	47.63	49.69	2.56

abc = Means within the same rows with different superscript are significantly different (P<0.05);
SEM = Standard Error of Means

Organs weight of Japanese quails fed graded level of sorghum in place of maize was shown in Table 4. Significant ($P < 0.05$) difference was observed in liver weight, and large intestine with T_5 recorded the highest means value of 6.00g and 6.66g. The result of organs weight shows no effects (P>0.05) among treatments on the lungs, heart, small intestine and gizzard, this result is similar to the report of Onu et al. (2011) who reported no difference among the parameters mentioned above of broiler chicks raised on different litter materials. Also, the result of the small intestine was reaffirmed by Diarra et al. (2014) and was at variance with the values reported by Rougière, and Carré (2010) that reported high means value for small and large intestine fed high energy diet. The result of this study was earlier supported by the findings of Erener et al. (2003) who reported that inclusion of hazelnut kernel oil meal in the diet of quails has no effects (P>0.05) on liver, heart and gizzard weight.

Table 4. Organs weight of Japanese quails fed graded levels of sorghum in place of maize

	Treatments					
Weight (g)	**T_1** (0%)	**T_2** (15%)	**T_3** (30%)	**T_4** (45%)	**T_5** (60%)	**SEM**
Liver	4.66^{b}	6.00^{a}	4.00^{b}	4.66^{b}	6.00^{a}	0.66
Lung	2.66	2.66	2.00	2.66	2.00	0.51
Heart	3.33	2.66	2.00	3.33	2.66	0.78
Large intestine	4.66^{ab}	4.66^{ab}	4.00^{b}	4.00^{b}	6.66^{a}	0.73
Small intestine	4.66	4.66	4.66	4.00	4.00	0.51
Gizzard	7.33	6.66	6.66	6.00	6.66	0.78

ab = Means within the same rows with different superscript are significantly different (P<0.05)

CONCLUSIONS

The current research has shown that sorghum grain can play a significant role in formulating quail feed and can completely be used to replace maize. Replacement is viable and does not affect the performance, nutritional quality indices or final yield of carcasses.

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