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UTILIZATION OF GRADED LEVELS OF PEARL MILLET AS DIETARY ENERGY SOURCE BY JAPANESE QUAILS

[1]Garba, S. I., [2]Abubakar, M. and [2]Muhammad, A. S.
[1]Department of Animal Production, School of Animal Health and Production,
Federal College of Animal Health and Production Technology, Vom.
[2]Department of Animal Production, Faculty of Agricultural,
Abubakar Tafawa Balewa University, Bauchi.
Corresponding Authors' E-mail: sirajowase@gmail.com **Tel.:** 08036071717

ABSTRACT
The study was carried out to investigate the inclusion levels of pearl millet in the diets of quails (*Coturnix coturnix japonica*). A total number of 480 day-old quail birds were used in the study. Experimental diets contained 10, 20, 40, 60, 80, and 100% millet. Diets contained 24% CP, 2888 kcal/kg ME and 20% CP, 2778 kcal/kg ME for growing and laying phases, respectively. The experiment lasted for 119 days and data were collected on daily feed intake (DFI), total weight gain, daily water intake, egg weight, hen day egg production, egg quality, and haematological parameters. At growing phase (2-6 weeks), most of the parameters measured were significantly influenced by the dietary levels of millet except initial weight (20.50-21.755g/bird), age and weight at 1st lay, 39-43 days and 6.00-7.00 g, respectively. At the laying phase (6-17 weeks) all the parameters measured showed significant ($P<0.001$) differences except in DFI (26.70-30.60 g). In carcass characteristics, most of the parameters measured were not significantly ($P<0.05$) affected by the dietary levels except in live weight which is significantly ($P<0.01$) different; breast weight and back weight were significantly ($P<0.05$) different and thigh weight ($P<0.001$), respectively. The following egg quality parameters; albumen width and albumen weight were highly significantly ($P<0.01$) different while yolk weight was very highly significantly ($P<0.001$) different. The haematological indices showed that there were significant ($P<0.001$) differences among the white blood cell, red blood cell, mean corpuscular volume, and mean corpuscular haemoglobin concentration. It was concluded that pearl millet can be included at 100% levels in diets of Japanese quails without adverse effects on growth performance and hen day egg production. Since carcass yield, haematological parameters and prime cuts were not adversely influenced by the dietary levels of pearl millet, it was therefore, recommended as energy dietary source for Japanese quails.

Keywords: Diets, Energy, Feed intake, Growing phase, Quail.

INTRODUCTION
Cereal grains, especially maize which form the bulk of energy in poultry feeds are in short supply as a result of industrial and human needs (Nworgu *et al.,* 1999). In view of these, evaluation of millet as alternative energy feedstuffs to maize becomes imperative in areas where their uses are less common, for instance in South Western Nigeria (Odunsi *et al.,* 2002). Millet is the most widely grown cereal crop that has been successful cultivated in the semi-arid region of Africa and its cost is relatively less in the areas of cultivation. It has little industrial uses in Nigeria (Nyannor *et al.,* 2007). Millet (*Pennisetum glaucum)* is considered as a staple food in Africa and India where it is used to make flour, bread, porridge and "couscous". As a feedstuff it is mainly grown to produce silage, hay (FAO [Food and Agriculture Organization], 2002). Quails birds do very well on chick mash or broiler starter feed, flat chick trays, egg trays or

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cardboard paper could be used for feeding them (NVRI [National Veterinary research Institute], 1996). Feeds are the most expensive production input which accounts for 65-75% of the cost of poultry production. The best and major source of dietary energy for quail production is maize, which has a high competition between human and animal. It is therefore, necessary to search for suitable substitute for maize in a developing country such as Nigeria (Elangovan *et al.,* 2004).This study was designed to study the inclusion levels of millet on performance, carcass, egg quality and haematological profile of Japanese quails (*Coturnix coturnix japonica*)

MATERIALS AND METHODS

Experimental Design

The experiment was conducted at the College Farm Federal College of Animal Health and Production Technology NVRI Vom, Plateau State, located in the centre of the country. It lies between latitude 80º 24 'N and longitude 80º 32 'S and 100º 38'E. Plateau State has an altitude of about 4200 ft (1280 m) above sea level (Daure and Dalyop, 2010). It lies within the sub – tropics. It has an average daily temperature of 18ºC and 22ºC with mean monthly minimum temperature is 13.9ºC, while mean rainfall is between 50-60inches (1300 – 1500mm) and the raining season extends from late March or early April to early October: July and August being the most wet month (APF [African partnership forum], 2007).

Experimental Management

A total of 480 one week old Japanese quail chicks were used for the study. The quail were counted and given a common ration for a day. Initial weight was recorded and the birds were randomly distributed into six treatment groups with four replicates of 20 chicks per replicate in a CRD. The quail birds were offered their respective experimental diets and water *ad-libitum* throughout the growing period and laying period, respectively.

During the growing phase, the quails were weighed on weekly basis on digital scale with the following parameters calculated; daily feed intake, daily weight gain, and feed conversion ratio using a digital scale to measure the left-over feed, weight of the bird using small basket to cover the quails inside. Age a first egg and average weight of eggs at point of lay was recorded using digital scale. Mortality was recorded as it occurred. All the chicks were subjected to similar management practices as required by quails (brooding, feeding and watering) throughout the experiment period. The brooding was done using chick guard with newspaper place on the ground 100 watt bulb were using as source of heat, chick tray and drinkers were used.

Experiment Diets

Six (6) experimental diets were formulated for the study (Tables 1 and 2). The diets contained 24% CP and 2800 kcal/kg ME, and 20% CP and 2600 kcal/kg ME for phase I and II, respectively. The Treatments contents were: (i). 100% maize as sole source of energy; (ii). maize 80%, millet 20% energy source; (iii). maize 60%, millet 40% energy source; (iv). maize 40%, millet 60% energy source; (v). maize 20%, millet 80% energy source; and (vi). 100% millet as sole energy source.

The diets for both experiments were formulated to meet the nutrient standard of quail, (NRC, 1994). While sample of formulated diets was analysed for proximate composition using the method described by AOAC [Association of Official Analytical Chemists] (2006) at Biochemistry Laboratory Department of National Veterinary Research Institute, Vom, Nigeria.

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Statistical Analysis

Data collected were subjected to analysis of variance appropriate to the completely randomized design. Significant differences among means were separated using Duncan's Multiple Range Test. SPSS statistical package (SPSS, 2012) for the analysis.

Table 1: Composition (%) of the Experimental Diets for Growth Phase (2-6 weeks)

	Diets					
Ingredients	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**
Maize	50.00	40.00	30.00	20.00	10.00	0.00
Millet	0.00	10.00	20.00	30.00	40.00	50.00
Maize offal	7.13	7.60	8.05	8.50	8.95	9.42
Groundnut cake	34.37	33.90	33.45	33.00	32.55	32.08
Fish meal	5.00	5.00	5.00	5.00	5.00	5.00
Limestone	0.50	0.50	0.50	0.50	0.50	0.50
Bone meal	2.00	2.00	2.00	2.00	2.00	2 .00
Salt (Nacl)	0.25	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated composition (%)						
ME (kcal/kg)	2888.00	2888.00	2888.00	2888.00	2888.00	2888.00
Crude protein	24.00	24.00	24.00	24.00	24.00	24.00
Crude fibre	4.60	4.60	4.60	4.60	4.60	4.60
Ether extract	4.98	4.98	4.98	4.98	4.98	4.98
Calcium	0.80	0.80	0.80	0.80	0.80	0.80
Phosphorus	0.29	0.29	0.29	0.29	0.29	0.29
Lysine	1.13	1.13	1.13	1.13	1.13	1.13
Methionine	0.83	0.83	0.83	0.83	0.83	0.83

*Bio-mix premix supplied per kg diet-vitamin A, 10,000.00 i.u; vitamin D, 2,000.00 i.u; Vitamin E 23,000.00mg; Niacin 27.5mg; Vitamin B_1 1,800mg; Vitamin B_6 30mg; Vitamin B_{12} 0.015mg, Vitamin K_3 200mg; Pantothenic Acid 7,500; Biotin H_2 0.06; Folic Acid 0.75mg; Chlorine 300.00mg; Cobalt 0.2mg; Copper 30mg; Iodine 1.00mg; Iron 200.00mg; Manganese 0.04mg; Selenium 0.2mg; Zinc 30mg; Antioxidant 1.25mg. T1 100% maize, T2 – 80% maize, 20%millet, T3 – 60% maize, 40% millet, T4 – 40% maize, 60% millet, T5 – 20% maize, 80% millet and T6 100% millet.

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Table 2: Composition (%) of Experimental Diets for Egg Production Phase (6-17 weeks)

	Diets					
Ingredients	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**
Maize	50.00	40.00	30.00	20.00	10.00	0.00
Millet	0.00	10.00	20.00	30.00	40.00	50.00
Maize offal	18.90	19.36	19.80	20.27	20.71	21.19
Ground nut cake	22.60	22.14	21.70	21.23	20.79	20.31
Fish meal	5.00	5.00	5.00	5.00	5.00	5.00
Limestone	0.50	0.50	0.50	0.50	0.50	0.50
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00
Salt(Nacl)	0.25	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated composition (%)						
ME (kcal/kg)	2778.00	2778.00	2778.00	2778.00	2778.00	2778.00
Crude protein	20.00	20.00	20.00	20.00	20.00	20.00
Crude fibre	4.50	4.50	4.50	4.50	4.50	4.50
Ether extract	4.85	4.85	4.85	4.85	4.85	4.85
Calcium	2.39	2.39	2.39	2.39	2.39	2.39
Phosphorus	0.40	0.40	0.40	0.40	0.40	0.40
Lysine	1.14	1.14	1.14	1.14	1.14	1.14
Methionine	0.86	0.86	0.86	0.86	0.86	0.86

*Bio-mix premix supplied per kg diet-vitamin A, 10,000.00 i.u; vitamin D, 2,000.00 i.u; Vitamin E 23,000.00mg; Niacin 27.5mg; Vitamin B_1 1,800mg; Vitamin B_6 30mg; Vitamin B_{12} 0.015mg, Vitamin K_3 200mg; Pantothenic Acid 7,500; Biotin H_2 0.06; Folic Acid 0.75mg; Chlorine 300.00mg; Cobalt 0.2mg; Copper 30mg; Iodine 1.00mg; Iron 200.00mg; Manganese 0.04mg; Selenium 0.2mg; Zinc 30mg; Antioxidant 1.25mg. T1 100% maize, T2 – 80% maize, 20%millet, T3 – 60% maize, 40% millet, T4 – 40% maize, 60% millet, T5 – 20% maize, 80% millet and T6 100% millet.

RESULTS AND DISCUSSION

Performance of Quail Chicks Fed the Experimental Diets

The results of the daily feed intake at the starter phase (DFIs) in quail chick reported (Table 3) in the current study (12.05-13.54 g/day) can be compared to the 10.52 to 11.04 g/day reported by Abubakar *et al.* (2007) for quail chicks fed varying levels of rumen content in diets. However, the DFIs is contrary to an earlier report (NVRI, 1996), which observed a daily feed intake of 22.26 g per quail per day at the age of six weeks. Increased feed consumption on weekly basis as the quail grow older has been reported (Edache *et al.,* 2005). The DFI at finisher phase (26.70-30.60 g/day) were similar across the diets. This is similar to the observation of Café *et al.* (1999) reported similar feed intake for quails fed graded levels of millet in their diets. The results of water intake at both the starter (20.19 – 23.40 ml/day) and finisher (31.68 – 50.52 ml/day) indicated that the higher the feed intake the higher amount of water consumed. The results of daily weight gain (DWG) recorded during starter phase ranged from 2.59 to 3.29 g/day while that of the finisher period ranged from 0.30 to 0.65 g/day. This is similar to the reports of Abdel-Azeem *et al.* (2001) who evaluated the response of Japanese quails to diets containing three protein levels (20, 22 and 24% CP) and found that birds fed the high protein

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diet (24% CP) exhibited the best growth performance, as measured by live body weight. This also agreed with the reports of Gheisari *et al.* (2011) which indicated that increasing dietary protein in different stages of growth increased body weight gain in Japanese quail. Result of feed conversion ratio showed a range of values (4.09-4.90) is similar to the observation of Al-Hanafy (2012) who reported that during the starting phase (1-6weeks) a significant improvement in feed conversion ratio was recorded.

Table 3: Performance of Quail Birds Fed the Experimental Diets (2 - 6 weeks)

	Diets						
Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**SEM**
Daily Feed Intake (g)	12.05^{b}	13.29^{a}	13.45^{a}	13.54^{a}	13.46^{a}	13.43^{a}	0.15^{***}
Daily Water Intake (ml)	22.54^{a}	22.33^{a}	21.26^{ab}	20.19^{b}	23.40^{a}	22.68^{a}	0.27^{***}
Daily Weight Gain (g)	90.75^{c}	100.5^{b}	115.25^{a}	113.75^{a}	101.00^{b}	95.75^{b}	0.52^{***}
Initial Weight (g)	20.75	20.50	21.25	21.75	20.50	21.00	0.53^{NS}
Final Weight (g)	111.50^{b}	121.00^{ab}	136.50^{a}	135.50^{a}	121.50^{ab}	116.75^{ab}	0.54^{***}
Feed Conversion Ratio	4.65^{b}	4.63^{b}	4.09^{a}	4.17^{a}	4.66^{b}	4.90^{c}	0.06^{***}
Age at 1st egg (days)	39	43	39	39	41	40	1.04^{NS}
Av. Wt. 1st egg (g)	6.00	7.00	5.50	6.75	6.50	6.75	0.49^{NS}
Mortality (Number)	4	3	2	1	4	2	-

^{abc} = means with different superscript on the same row are significantly different, ***significant (P<0.001), NS = Not Significant; SEM = Standard Error of Mean.

Feed Cost Benefit Analysis of the Experimental Diets (2 - 6 Weeks

The results obtained in Table 4 shows no significant difference in cost of daily feed intake, total feed intake and weight gain in naira, which agreed with the report of Abubakar *et al.* (2007), in contrary to report of Edache *et al.* (2005) which reported a significant difference in cost analysis of feed intake of Japanese quails.

Table 4: Feed Cost Benefit Analysis of the Experimental Diets (2 - 6 Weeks)

	Diets						
Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**SEM**
Feed intake (g)	12.05^{b}	13.29^{a}	13.45^{a}	13.54^{a}	13.46^{a}	13.43^{a}	0.15***
Total feed intake (g)	337.4^{b}	372.12^{a}	376.6^{a}	379.12^{a}	376.88^{a}	376.04^{a}	1.07***
Cost of daily feed intake (₦)	1.00	1.02	1.04	1.02	1.03	1.00	0.02^{NS}
Cost of total feed intake (₦)	28.00	28.56	29.12	28.56	28.84	28.00	0.22^{NS}
Cost/kg weight gain (₦)	10.59	10.87	11.29	11.25	10.89	10.74	0.22^{NS}
Gross profit margin (₦)	9.59^{c}	9.85^{ab}	10.25^{a}	10.23^{a}	9.86^{ab}	9.74^{b}	0.03^{***}

^{abc} = means with different superscript on the same row are significantly different, ***significant (P<0.001), NS = Not Significant; SEM = Standard Error of Mean.

Growth Performance of Japanese Quail Layers Fed The Experimental Diets

The results of Table 5 revealed that the is significant difference among the parameters on growth performance of Japanese quail during the growing stage except the daily feed intake

(DFI) which show no significant difference among the treatment diets. This result agreed with the report of Edache *et al.* (2005), reported a significant P<0.001 among the daily water intake, total weight gain and hen day egg production of Japanese quail birds.

Table 5: Growth Performance of Japanese Quail Layers Fed The Experimental Diets (6-17 Weeks)

	Diets						
Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**SEM**
Daily Feed Intake (g)	30.60	29.22	26.70	28.72	30.50	28.12	0.98^{NS}
Daily Water Intake (ml)	39.17^{b}	47.25^{ab}	45.57^{ab}	42.09^{ab}	50.52^{a}	31.68^{c}	0.64^{***}
Initial Weight (g)	111.50^{b}	121.00^{ab}	136.50^{a}	135.50^{a}	121.50^{ab}	116.75^{b}	0.54^{***}
Final Weight (g)	154.53^{b}	164.63^{a}	159.82^{b}	169.97^{a}	167.00^{a}	166.60^{a}	2.94^{***}
Total Weight Gain (g)	43.03^{a}	43.63^{a}	23.32^{b}	34.47^{ab}	45.50^{a}	49.85^{a}	1.01^{***}
Daily Weight Gain (g)	0.56^{a}	0.57^{a}	0.30^{b}	0.45^{ab}	0.59^{a}	0.65^{a}	0.01^{***}
Hen Day Egg Production	59.77^{ab}	86.10^{a}	91.50^{a}	79.01^{a}	80.00^{a}	68.50^{b}	2.35^{***}
Mortality (number)	6	7	7	7	7	11	-

^{abc} = means with different superscript on the same row are significantly different, ***significant (P<0.001), NS = Not Significant, SEM = Standard Error of Mean.

Feed Cost Benefit Analysis of the Experimental Diets (6 - 17 Weeks)

It was revealed in Table 6 that there was no significant difference in feed intake, total feed intake, cost of daily feed intake and cost of total feed intake and highly significant in cost/kg weight gain and significant in cost/kg feed. This report agreed with the report of Abubakar *et al.* (2007) that cost benefit analysis of Japanese quail has no significant difference among the parameter.

Table 6: Feed Cost Benefit Analysis of the Experimental Diets (6 - 17 Weeks)

	Diets						
Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**SEM**
Feed intake (g)	30.60	29.22	26.70	28.72	30.50	28.12	0.98^{NS}
Total feed intake (g)	2570.40	2454.48	2242.80	2412.48	2562.00	2362.08	0.93^{NS}
Cost of daily feed intake (₦)	1.20	1.22	1.24	1.22	1.23	1.20	0.05^{NS}
Cost/kg feed (₦)	85.38	97.05	97.05	97.05	97.05	85.38	-
Cost of total feed intake (₦)	100.80	102.48	104.16	102.48	103.32	100.80	2.02^{NS}
Cost/kg weight gain (₦)	1.11^{c}	0.67^{c}	6.86^{ab}	7.65^{a}	4.62^{b}	4.14^{b}	1.28^{***}

^{abc} = means with different superscript on the same row are significantly different, ***significant at P<0.01, NS = Not Significant; SEM = Standard Error of Mean.

Carcass and Gut Characteristics

The results (Table 7) of final live weight of birds (154.53-169.97 g) obtained are lower compared to the findings of Edache *et al.* (2005) who reported a final body weight (FBW) of 197.70 g at 9 week of age for *cortunix* and range quails. This could be attributed to the different strains of quails used in the two experiments. The results of FBW in the current study is

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comparable to the 154.84 to 187.32 g reported by Abubakar *et al.* (2007) for quails fed rumen contents in their diets. Carcass weight was similar across the diets.

Table 7: Carcass Characteristics of Quails Fed Experimental Diets

	Diets						
Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**SEM**
Live weight (g)	154.53^{b}	164.63^{a}	159.82^{a}	169.97^{a}	167.00^{a}	166.60^{a}	2.94*
Eviscerated (g)	134.72	136.88	133.25	131.20	135.03	136.13	2.94^{NS}
Carcass weight (g)	108.97	108.78	110.45	113.00	108.50	110.80	3.10^{NS}
Dressed (%)	70.50	66.25	69.00	66.50	64.75	66.75	1.86^{NS}
Body components and Organs expressed as percentage (%) body weight							
Heart weight	1.15	1.23	1.14	1.15	1.06	1.25	0.06^{NS}
Liver weight	3.29	2.75	2.96	3.11	3.25	3.04	2.45^{NS}
Breast weight	25.75^{a}	23.75^{ab}	24.56^{a}	22.03^{b}	22.68^{ab}	24.26^{a}	0.61**
Thigh weight	7.51^{a}	7.10^{a}	6.94^{b}	6.65^{b}	6.89^{b}	6.91^{b}	0.11***
Gizzard weight	3.29	3.07	2.99	2.97	3.07	3.06	0.12^{NS}
Back weight	32.77^{a}	30.66^{a}	31.19^{a}	27.57^{b}	29.99^{b}	29.84^{b}	0.75**
Intestine weight	4.41	4.52	4.60	4.62	4.32	4.60	0.19^{NS}
Intestine length (cm)	53.03	53.65	53.18	57.15	54.23	56.55	1.50^{NS}

^{abc} = means with different superscript on the same row are significantly different, ***significant (P<0.001), NS = Not Significant; SEM = Standard Error of Mean.

Across Table 7, the dressing percentage reported in the current study which is similar across the diets (64.75-70.50 %) is higher compared to 50.44 to 64.95% recorded by Abubakar *et al.* (2007) but comparable to the 60.08 to 66.02% reported by Babangida and Ubosi (2006) for *coturnix* quails fed diets containing varying levels of protein to growing quails. The following weight of the organs and parts as percentage of body weight indicated ranges of 1.06-1.25% for heart, 22.03 – 25.75% for breast, 6.65 – 7.51% for thigh and 2.97 – 3.29% for gizzard. The intestinal weight and length recorded range of values of 4.32 – 4.60 and 53.03 – 57.15%, respectively.

Egg Quality Characteristics

The results (Table 8) of egg weight (EW) 9.92-11.19 g and egg content (EC) 7.71 – 9.20 g in the current study are much higher than the 7.04 g and 6.76 g, respectively, reported for EW and EC by Tabeekh (2011) for quails. However, egg length 1.81-1.98 cm and egg width, 1.16 – 1.30 cm, in current study were lower than the 2.83cm and 2.25, respectively for length and width reported by same author.

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Table 8: Egg Quality Characteristics of Quail Fed Experimental Diets

	Diets						
Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**SEM**
Egg weight (g)	10.16	11.19	9.92	10.32	10.72	10.75	0.35^{NS}
Egg content (g)	8.02	9.20	7.71	8.32	8.54	8.75	0.35^{NS}
Egg length (cm)	1.81	1.98	1.80	1.92	1.93	1.94	0.07^{NS}
Egg width (cm)	1.30	1.23	1.16	1.20	1.19	1.23	0.08^{NS}
Albumen weight (g)	4.42^{a}	4.55^{a}	4.29^{b}	4.45^{a}	4.77^{a}	4.59^{a}	0.01^{***}
Albumen width (cm)	1.70^{ab}	1.83^{b}	1.90^{b}	1.93^{b}	1.78^{ab}	2.01^{a}	0.17^{*}
Albumen length (cm)	2.65	2.60	2.61	2.75	2.52	2.80	0.07^{NS}
Yolk weight (g)	3.44^{b}	3.54^{b}	3.62^{ab}	3.64^{ab}	3.68^{ab}	4.16^{a}	0.02^{***}
Yolk width (cm)	0.87	1.21	1.01	0.86	1.17	1.14	0.10^{NS}
Yolk length (cm)	1.00	1.21	1.08	1.16	1.24	1.17	0.08^{NS}

^{abc} = means with different superscript on the same row are significantly different, ***significant (P<0.001), (P<0.05), NS = Not Significant; SEM = Standard Error of Mean.

Further to Table 8, other qualities such as albumen and yolk length reported were similar across the diets. However, albumen and yolk weights were different across the treatments and the values were higher when compared to those of Tabeekh (2011).

Haematological Profile of Japanese Quails Fed Millet as a Source of Energy Diets

Blood parameters are good indicators of physiological changes. The values of packed cell volume (PCV) in the current study (Table 9) ranged from 51.75-57.00%. This range is much higher than the normal range of 27 - 42%. The higher values of PCV observed here may be an indication of some level of dehydration in the birds.

Table 9: Haematological Profile of Japanese Quail Fed Experimental Diets

	Diets						
Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**SEM**
PCV (%)	54.25	57.00	54.00	51.75	53.25	56.00	2.01^{NS}
WBC (10^{9}/L)	5.20^{a}	3.55^{b}	4.53^{ab}	5.73^{a}	4.70^{ab}	5.55^{a}	0.14^{***}
Hb (g/dl)	17.70	18.70	18.28	17.50	17.23	17.73	0.55^{NS}
RBC (10^{12}/L)	2.73^{c}	3.58^{b}	3.15^{b}	3.75^{b}	3.53^{b}	4.10^{a}	0.25^{***}
Hetrophils (%)	71.75	75.00	83.25	73.75	74.50	80.75	2.84^{NS}
Lymphocytes (%)	25.75	23.00	15.25	24.00	27.00	23.25	0.71^{NS}
MCV (fl)	184.25^{a}	167.50^{a}	170.50^{a}	144.00^{b}	144.25^{b}	135.50^{b}	3.27^{***}
MCH (pg)	33.55	33.65	33.45	33.53	33.60	33.48	0.11^{NS}
MCHC (g/dl)	60.48^{a}	53.65^{a}	55.98^{a}	47.43^{b}	48.73^{b}	45.05^{b}	1.01^{***}

^{abc} = means with different superscript on the same row are significantly different (P<0.001), NS = Not Significant; SEM = Standard Error of Mean. PCV = Packed Cell Volume, WBC = White Blood Cell, Hb = Haemoglobin, RBC = Red Blood Cell, MCV = Mean Corpuscular Volume (femtolitres), MCHC = Mean Corpuscular Haemoglobin Concentration (gram/decilitre), MCH = Mean Corpuscular Haemoglobin (pictogram).

The white blood cell (WBC) values (Table 9) which ranged from 3.55-5.73x10^{9}/l to 5.73x109^{9}/dl fall within the range of value 3.0-12.0x10^{9}/l for healthy birds and the values agreed with those reports by Tanwar and Mishra (2001) for quails. Haemoglobin (Hb) values in the current study ranged from 17.23 to18.70 g/dl. These values are higher than the normal

range of value (7.0 to 11.0 g/dl). Kumar *et al.* (2003) revealed that higher Hb values might be due to metabolic disturbance caused by worms rather than direct blood loss. Red blood cell (RBC) values in the current study ranged from 2.73-4.10x10^{12}/l to 4.10x10^{12}/l and are comparable to 2.2 to 4.0x10^{12}/l for healthy birds. The values for hetrophils (71.75-83.2%) were higher than the normal values of 40-70%. However, Lymphocytes (15.25-27.00%) fall within the normal values of 20-50%. Mean corpuscular volume (MCV) values ranged from 144.00 to 184.25fl. This is a very wide range compared to the normal value of 174fl. MCV determines the average volume of RBC. Mean corpuscular haemoglobin (MCH) and Mean corpuscular haemoglobin concentration (MCHC) values reported in current study; 33.45 to 33.65 pg and 45.05 to 60.48 g/dl are similar to normal values of MCH and MCHC reported for healthy birds. It means millet can replace maize 100% in Japanese quails diets.

CONCLUSION AND RECOMMENDATION

Results obtained in the present study suggest that millet can replace 100% of maize in the diets of Japanese quails without adverse effects on growth performance and egg production. Since carcass yield, haematological parameters and prime cuts were not adversely influenced by the dietary levels of pearl millet, it was therefore, recommended as energy dietary source for Japanese quails.

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