2019 Journal of Agricultural Production and Technology ISSN: 2360-9364

# PERFORMANCE AND EGG QUALITY TRAITS OF LAYING JAPANESE QUAIL (*Coturnix coturnix japonica*) FED CEREAL GRAINS AND CASSAVA FLOUR AS ENERGY SOURCES

***Abu, O.A. and Judah, F.I.**

*Agricultural Biochemistry and Nutrition Unit, Department of Animal Science, Faculty of Agriculture, University of Ibadan, Ibadan, Nigeria.*

***Corresponding author's e-mail: ohiahmed@yahoo.com**

## ABSTRACT

*A study on the comparative effect of maize, sorghum, millet and cassava flour as energy sources in the diets, and their effects on egg production, egg quality characteristic and economic efficiency of laying Japanese quail (Coturnix coturnix japonica) was studied. In a 56-day feeding trial 180 15-week old laying Japanese quails were randomly allocated to four dietary treatments. Each treatment was replicated three times each having 15 birds using completely randomized design (CRD). Quails fed sorghum based diet (T2) had the highest feed consumption followed by birds fed cassava based diets. Birds on maize based diet recorded the highest hen day production and egg mass. Quail hens fed sorghum based diet had the highest egg weight, yolk weight and yolk height. Egg shape index and yolk index were highest in birds fed millet based diets group. It is more profitable to feed millet to laying quails as substitutes for maize or cassava root. The economic parameters of quails fed millet based diet had lowered economic efficiency by 3.17% compared to 53.05% in cassava based diets while that of sorghum was reduced by 38.61%. . The overall economic efficiency showed that maize and millet are both economically efficient as energy sources for laying quails.*

**Key words:** Maize, Sorghum, Millet, Cassava, Energy, Japanese quails, Hen day production.

J. Agric. Prod. & Tech.2019; 8:1-9

## INTRODUCTION

The Japanese quails (*Coturnix coturnix japonica*) are small birds of the *galliforme* family and are highly prolific and hardy. Since the introduction of Japanese quails into the Nigerian poultry industry in1992 (Haruna *et al*., 1997),production of the birds has gained popularity among poultry keepers especially because of their short generation interval, fast growth rate and less susceptibility to common poultry diseases (Odunsi *et al*., 2007). Maize remains the chief energy source in compounded diets in Nigeria and constitutes about 50% of poultry ration (Ajaja *et al.,* 2002). However, the pressure on maize, wheat and recently cassava has been on the increase worldwide with emphasis being placed on export and other diversified uses mostly in flour based foods and ethanol production as an alternative source of fuel (Persson, 2009; Doki, 2007).

Feed alone accounts for 70 – 80% of the recurrent production input in intensive monogastric animal production (Mtimuni, 1995), therefore there is need to seek for energy alternatives that can be diversified into poultry which include Japanese quail

production (Etuk, 2008).To this end, it is expedient to evaluate the nutritional values of maize, sorghum, millets and cassava flour and their effects on the productive performance of ~~the~~ Japanese quail. Thus, in this study a comparative effect of feeding maize, sorghum, millet and cassava flour as energy sources as they individually affect egg production, egg quality characteristics and cost efficiency of Japanese quail hens were evaluated.

## MATERIALS AND METHODS

**Study area:** The research was carried out at the Quail Unit, Teaching and Research Farm, University of Ibadan, Oyo state, Nigeria.

**Source of Test Ingredients:** Maize and other ingredients were purchased from a reputable commercial feed mill in Ibadan while millet, sorghum and cassava flour were obtained from a local market in Ibadan, Nigeria.

**Experimental Diets:** Four experimental layer diets were formulated to be isocaloric and isonitrogenous 20% CP and 2900 kcal/kg ME such that diets 1, 2, 3 and 4 are maize, sorghum, millet and cassava flour based, respectively. The compositions of the experimental diets are presented in Table 1.

**Table 1: Compositions of experimental diets containing maize, sorghum, millet and cassava flour meal as major energy sources.**

| **Treatments** | **T1** | **T2** | **T3** | **T4** |
|---|---|---|---|---|
| **Ingredients** | **Maize** | **Sorghum** | **Millet** | **Cassava flour** |
| Maize | 54.7 | 0.00 | 0.00 | 0.00 |
| Sorghum | - | 56.2 | - | - |
| Millet | - | - | 56.7 | - |
| Cassava flour | - | - | - | 44.9 |
| Soybean meal | 30.8 | 29.4 | 27.8 | 39.1 |
| Wheat offal | 3.50 | 2.91 | 3.65 | 4.80 |
| Fish Meal | 2.00 | 2.00 | 2.00 | 2.00 |
| Palm oil | 1.80 | 2.29 | 2.65 | 2.00 |
| Limestone | 6.00 | 6.00 | 6.00 | 6.00 |
| Dicalcium phosphate | 0.50 | 0.50 | 0.50 | 0.50 |
| L-Lysine | 0.10 | 0.10 | 0.10 | 0.10 |
| DL-Methionine | 0.10 | 0.10 | 0.10 | 0.10 |
| *Premix | 0.25 | 0.25 | 0.25 | 0.25 |
| Table Salt | 0.25 | 0.25 | 0.25 | 0.25 |
| **Total** | **100** | **100** | **100** | **100** |
| *Calculated nutrients:* | | | | |
| Crude Protein (%) | 20.37 | 20.35 | 20.38 | 20.44 |
| Energy Kcal/Kg | 2908 | 2901 | 2908 | 2943 |
| Crude Fibre (%) | 3.41 | 3.47 | 3.27 | 3.78 |
| Methionine | 0.43 | 0.37 | 0.41 | 0.39 |
| Lysine | 1.22 | 1.24 | 1.23 | 1.36 |
| Available Phosphorus | 0.39 | 0.52 | 0.39 | 0.40 |
| Calcium | 2.47 | 2.48 | 2.47 | 2.48 |

*Premix Contained/2.5kg): Vit. A,*12,500,000.00 IU; $D_3$, 2,500,000.00 IU; Vit. E, 40,000.00mg; Vit. $K_3$, 2,000.00mg;Vit. $B_1$, 3,000.00mg; Vit.$B_2$, 5,500.00mg; Niacin, 55,000.00mg; Calcium pantothenate,*

*11,500.00mg;Vit. $B_6$, 5,000.00mg; Vit. $B_{12}$, 25mg; Choline Chloride; 500,000.00mg; Folic Acid; 1,000.00mg; Biotin, 80.00mg; Manganese, 120,000.00mg; Iron,100,000.00mg; Copper, 8,500.00mg; Iodine, 1,500.00mg; Cobalt, 300.00mg; Selenium, 120.00mg; Anti-Oxidant, 120,000.00mg.*

**Experimental Design:** The design of the experiment was Completely Randomized Design (CRD) with four experimental groups that were replicated three times and each replicate contained fifteen quails and were housed in a pen on a deep litter. Feed and water were offered *ad libitum*. The birds were allowed to stabilize for 14days before data collection. Data collected include daily feed-intake, hen-day production, body weight and internal and external egg quality characteristics.

**Proximate analysis of the test ingredients:** The samples of the test ingredients were analysed for their proximate composition (AOAC, 2002) in the laboratory of Department of Animal Science.

**Management of Experimental Birds:** One hundred and eighty 15-weeks old laying Japanese quails from Poultry Unit, Teaching and Research Farm University of Ibadan were allotted to a four experimental groups and maintained on a commercial layers diet until egg laying pattern stabilized. The birds were offered feed and water *ad libitum*. Neither medication nor vaccination were given to the birds throughout the duration of the experiment. Data were collected on the following parameters:

**Production Performance:** Data on feed-intake, body weight changes or gain, egg production were collected. Feed intake was obtained by weighing a known quantity of feed to the birds and remnant subtracted the following day to obtain daily feed consumed. The birds were individually weighed at the start of the feeding trial and weekly thereafter. Eggs were collected on daily basis.

**Egg Quality Parameters:** At the end of every week, six eggs (two from each replicate) from each treatment were randomly selected for examination of egg quality characteristics (egg weight, egg length, egg diameter, egg shell thickness, yolk diameter, yolk height, albumen height). The egg length, diameter, shell thickness and heights were measured in millimeters using Venier calliper. Individual egg weight was measured using 0.0001g sensitive electronic balance. Eggs were cracked open on a plate and yolk was separated from the albumen and the two constituents weighed separately on electronic scale. Shells were air dried for 24hours. The dried shells were weighed together with the shell membranes. Average shell thickness was measured for individual dry egg shells to the nearest 0.001mm using a digital micrometer screw gauge. The interior egg quality traits were measured in terms of yolk index, yolk ratio, albumen ratio and high unit as described by Kul and Seker (2004).The egg shape index is the ratio of the length and width of the egg. The yolk index was calculated as the proportion of the yolk height to diameter. The yolk albumen ratio is the ratio of yolk weight to that of albumen weight. The Haugh unit was calculated using the formula below according to Haugh (1937). All chemical analyses were carried out at the Nutrition Laboratory, Department of Animal Science, University of Ibadan, Ibadan, Nigeria.

$$Hu = 100\log (h+7.57-1.7w^{0.37})$$

Were *h* is the height of the albumen (in mm); *w* is the egg weight; Hu is the Haugh unit.

**Economics of Production:** Indices of total feed intake, cost of feed/gram, total egg produced and cost of egg were used to

calculate total revenue and net revenue using the following formulae.
Feed intake (g/bird/day) = (*a);* Cost of feed/g (₦), (*b); C*ost of feed intake/day (₦) *a x b = c;* Price/ egg (₦) = *d;* Cost of feed/egg produced (₦) = c/e; Egg number/bird/day), *e;* Total revenue (₦), *d x e = f;* Net revenue (₦) *f - c = g;* Economic efficiency = *g/c.*

**Statistical Analysis:** The data obtained were subjected to analysis of variance and treatment means were compared with Duncan Multiple Range Test (Duncan 1955) at 5% probability level.

## RESULTS AND DISCUSSION

The proximate compositions of maize, sorghum, millet and cassava are shown in Table 2. Numerically, the proximate contents indicated that sorghum, maize and millet had higher crude protein and ash than maize based diet. Cassava flour contained higher NFE than maize, millet and sorghum based diets. The values obtained conformed to the values in the literature.

**Table 2: Proximate composition (%) of test ingredients**

| Test Ingredients | Maize | Sorghum | Millet | Cassava flour |
|---|---|---|---|---|
| *Parameters (%):* | | | | |
| Dry matter | 91.1 | 90.3 | 90.3 | 92.3 |
| Crude protein | 9.10 | 10.85 | 11.60 | 2.50 |
| Crude fibre | 2.60 | 2.80 | 2.30 | 1.80 |
| Ether extract | 3.80 | 2.70 | 3.20 | 1.50 |
| Ash | 1.30 | 1.90 | 2.21 | 0.50 |
| Nitrogen free extract | 83.2 | 81.8 | 80.6 | 93.7 |

Results in Table 3 show the effect of three major dietary energy sources on performance of the layers. The highest feed intake observed in sorghum based diets was in agreement with (Nyachoti and Atkinson, 1995). Also in an experiment conducted on layers by Issa (2009) it was observed that birds on sorghum based diets ~~was~~ consumed more feed when compared to birds fed maize based diets. However in contrast Ibrahim *et al.* (1988) reported significant reduction in feed intake and Incidence of locomotor disorders in chicks fed sorghum based diets. However observations by Ibrahim et al. (1988) were not observed in this study. The quail hens may perhaps not be influenced by the presence of phytate.

The lower weight gain despite higher feed intake in sorghum based diets might be attributed to the presence of anti-nutritional factors present in sorghum grain that makes it less digestible than other grain (Chen *et al.,* 1994; Etuk *et al.,* 2012). This confirms the report of (Nyachoti *et al.,* 1997) when layers fed high tannin sorghum exhibited highest loss in body weight. The highest daily weight gain observed in maize based diet confirms the reports of NcNab and Shannon (1974); Longe (1987) that other energy sources do not support similar growth rate when used to completely replace maize. The best FCR observed in millet based diet group was due to high egg weight and low feed intake recorded in the diet~~s~~ hens fed millet based group. Better FCR in millets fed birds was also earlier reported (Serna- Saldivar *et al.,* 1990; Sullivan *et al.,* 1990; Bramel-Cox *et al.,* 1992).

Higher egg production in maize-based diet was also in agreement with report of Longe (1987).Lower egg production observed in cassava flour based diet wassimilar to findings of Aina and Fanimo (1997) and Salami and Odunsi(2003) who

observed a decrease in hen day production with cassava meal whereas feed intake was not affected. Similar findings were also reported by Aderemi*et al.* (2006). However Akinola and Oruwari (2007) reported an increase in egg production as level of cassava root meal increased and similar observation had also been reported. Kana *et al.* (2013) report indicated that local barred layers could tolerate up to 100% replacement of maize with cassava meal without any adverse effect on hen day egg production.

**Table 3: Performance of laying Japanese quail fed maize, sorghum, millet and cassava flour-based diets**

| **Treatments** | **T1** | **T2** | **T3** | **T4** | |
|---|---|---|---|---|---|
| **Energy sources** | **Maize** | **Sorghum** | **Millet** | **Cassava flour** | **SEM** |
| *Parameters:* | | | | | |
| Initial Body weight (g) | 181.55 | 181.33 | 172.00 | 179.33 | 1.14 |
| Final Body weight (g) | 200.00 | 193.33 | 186.66 | 195.55 | 1.25 |
| Av. daily weight gain (g) | $0.32^{a}$ | $0.21^{d}$ | $0.26^{dc}$ | $0.28^{b}$ | 0.01 |
| Av. daily feed intake (g) | $29.30^{b}$ | $32.34^{a}$ | $23.95^{c}$ | $29.97^{b}$ | 0.37 |
| Hen day production (%) | $79.72^{a}$ | $62.22^{b}$ | $68.61^{b}$ | $53.88^{c}$ | 1.63 |
| Egg mass (g) | $8.51^{a}$ | $6.90^{b}$ | $7.48^{b}$ | $5.48^{c}$ | 0.04 |

[a-c]Means along the same row with different superscripts are significantly different ($p < 0.05$)
*SEM= Standard error of means.

The egg quality characteristics of the laying quails are presented in Table 4. The birds fed sorghum based diet had highest egg weight. Studies by several workers showed that sorghum may totally replace corn in birds' diet without affecting quality of eggs (Streeter *et al.,* 1991; Louis *et al.,* 1997*)*. In a study conducted by Usman and Garba (2012) Isa Brown chicken were fed with a maize and sorghum based diet formulations and concluded that there were no significant differences in the egg weight, yolk weight, albumen weight, Haugh percentage and shell thickness. Costa *et al.* (1974) found no difference in mean egg weight when laying hens were fed diets containing sorghum as maize substitutes at levels of 50% and 100%. However Malik and Quisenberry (1963) observed a decrease in egg weight when 75% of the corn in the diets was substituted.

In this study therefore millet based diet had egg width, egg shape index and yolk height values not significantly different ($p>0.05$) from sorghum based diets. This buttressed the study of Savage (1995) who observed that pearl millet rather than maize promoted a greater growth rate in Bobwhite quail, and so it is excellent for game birds (Iler and Hanna, 1995).

Birds on cassava flour based diets had least values for egg weight, egg width and egg length. . This is in agreement with the result of (Anaeto and Adighibe, 2011) who observed that cassava root meal inclusion above 50% reduced egg production and egg weight. Similar findings were by Aderemi *et al*. (2006). This report also buttressed the ~~studies of~~ several reports that cassava alone cannot replace maize in layers diets without adversely affecting the performance of layers (Willie and Kinabo, 1980; Eruvbetine *et al.,* 1994; Longe and Oluyemi, 1997). However this report was contrary to ~~with~~ the report of Smith (2003) that replacing cassava up to 50% did not affect the performance of layers or egg quality.

In this study average values that are determined are similar to the results reported by (Dudusola, 2010, 2009; Odunsi *et al.,* 2007; Ipek *et al.,* 2007).

**Table 4: Egg quality characteristics of Japanese quail fed maize, sorghum, millet and cassava flour-based diets**

| Treatments | T1 | T2 | T3 | T4 | |
|---|---|---|---|---|---|
| Major energy source | Maize | Sorghum | Millet | Cassava flour | SEM |
| *Parameters:* | | | | | |
| Shell weight (g) | 1.00 | 1.00 | 1.30 | 1.10 | 1.68 |
| Shell thickness (mm) | 0.192$^{b}$ | 0.203$^{a}$ | 0.199$^{ab}$ | 0.199$^{ab}$ | 0.001 |
| Egg weight (g) | 10.77$^{b}$ | 11.40$^{a}$ | 10.84$^{b}$ | 10.28$^{c}$ | 0.06 |
| Egg length (cm) | 3.14$^{a}$ | 3.12$^{ab}$ | 3.08$^{bc}$ | 3.04$^{c}$ | 0.01 |
| Egg width (cm) | 2.41$^{b}$ | 2.48$^{a}$ | 2.45$^{a}$ | 2.73$^{c}$ | 0.01 |
| Egg shape index | 76.70$^{b}$ | 79.58$^{a}$ | 79.75$^{a}$ | 78.10$^{b}$ | 0.28 |
| Albumen weight (g) | 5.24$^{a}$ | 4.90$^{ab}$ | 5.11$^{ab}$ | 4.79$^{b}$ | 0.06 |
| Yolk weight (g) | 3.34$^{b}$ | 4.15$^{a}$ | 3.58$^{b}$ | 3.29$^{b}$ | 0.06 |
| Yolk height (cm) | 0.780$^{b}$ | 0.841$^{a}$ | 0.827$^{a}$ | 0.747$^{b}$ | 0.01 |
| Yolk Index | 0.306$^{c}$ | 0.330$^{b}$ | 0.348$^{a}$ | 0.315$^{bc}$ | 0.01 |
| Albumen height (cm) | 0.24 | 0.31 | 0.59 | 0.22 | 0.09 |
| Haugh Unit (%) | 84.33 | 88.52 | 87.70 | 83.34 | 1.31 |

$^{a-c}$Means along the same row with different superscripts are significantly different ($p < 0.05$)
*SEM= Standard error of means.

In table 5 it was revealed that the diet containing millet was the cheapest in total feed cost followed by maize. However the highest value for total revenue and economic efficiency were obtained from quails fed maize diets. Conclusively, the results indicated that millet, sorghum and cassava in laying quails diets affected economic parameters, where quails fed millet had lowered the economic efficiency by 3.17% compared to 53. 05% in cassava flour. Result of economic efficiency from the presented data favoured feeding quail diets containing millet. Ojewola and Oyim (2006) observed no significant effect on gross margin and revenue when cockerels were fed maize and millet based diet. However this finding contradicts the results of Rostago *et al.* (2000) that increasing pearl millet levels did not result in lower production cost. The cassava flour based diet which had the poorest economic efficiency was in agreement with results of Uchegbu *et al.* (2011) who observed the performance of starter broilers fed cassava root meal fortified with palm oil as replacement for maize. In their study least cost per kg meat produced was recorded with birds or maize diet while cassava root meal (100% maize replacement) incurred highest cost per kg meat produced. However this contradicted the studies of Anaeto and Adighibe, 2011; Ukachukwu, 2005; Salami and Odunsi, 2003) who observed that cassava as an alternative unconventional energy feedstuff could help reduced feed cost. However, reduced feed cost may not necessary lead to improved performance of the birds. The high cost of balancing for protein in cassava-based diet is due to the high cost of soybean meal (protein source) and also most likely that on balancing for crude protein, the protein provided by cassava flour fortified with palm oil was of rather inferior quality compared with those of other feedstuffs in study. These two factors might have contributed to poorer economic efficiency in cassava flour based diets.

**Table 5: Economic efficiency of Japanese quail layers as affected by maize, sorghum, millet and cassava flour-based diets**

| Treatments<br>Major energy source | T1<br>Maize | T2<br>Sorghum | T3<br>Millet | T4<br>Cassava flour |
|---|---|---|---|---|
| *Parameters:* | | | | |
| Feed intake (g/bird/day)(*a)* | 29.30 | 32.34 | 23.95 | 29.97 |
| Cost feed/g (₦)(*b)* | 0.100 | 0.103 | 0.108 | 0.116 |
| Cost of feed intake/day (₦) *a x b=c* | 2.93 | 3.33 | 2.58 | 3.47 |
| Price/ egg (₦) *d* | 20.0 | 20.0 | 20.0 | 20.0 |
| Cost of feed/egg produced (₦)$^{c/e}$ | 3.68 | 5.37 | 3.78 | 6.47 |
| Egg number/bird/day) *e* | 0.70 | 0.62 | 0.68 | 0.54 |
| Total revenue (₦) *d x e =f* | 15.92 | 12.4 | 13.66 | 10.72 |
| Net revenue (₦) *f-c =g* | 12.99 | 9.07 | 11.08 | 7.25 |
| Economic efficiency *g/c* | 4.43 | 2.72 | 4.29 | 2.08 |
| * Relative efficiency | 100.00 | 61.39 | 96.83 | 46.95 |

* Relative efficiency: Assuming economic efficiency of maize diet equals 100

## CONCLUSIONS AND RECOMMENDATION

- Laying performance of birds was significantly better in maize-based diet compared with sorghum, millet or cassava flour.
- Quail hens fed Cassava flour-based diet had reduced egg weight, egg mass and hen-day production. Cassava should therefore be least considered as energy source for laying quails.
- The overall economic efficiency showed that maize and millet are both economically efficient as energy sources for laying quails.

## REFERENCES


Aderemi, F.A., Lawal, T.E., Alabi, O.M., Ladokun, O.A. and Adeyemo, G.O. 2006. Effect of enzyme supplemented cassava root sieviate on egg quality gut morphology and performance of egg type chickens. *Int. J. Poult. Sci.,* 5 (6): 526-529.

Anaeto, M. and Adighibe, L.C. 2011. Cassava root meal as substitute for maize in layers ration. *Brazilian Journal of Poultry Science.* 13:153-156.

Aina, A.B.J. and Fanimo, A.O. 1997. Substitution of maize with cassava and sweet potato meal as the energy source in the rations of layer birds. *Journal of Tropical Agricultural Science, 20(2/3): 163-167.*

Ajaja, K., Agbede J.O. and Aletor, V.A. 2002. Replacement value of sorghum dust for maize in diets for broiler chickens. Proc. 27th Annual Conf. Nig. Soc. for Anim. Prod. March 17-21, Federal Univ. Techn. Akure, pp: 109-112.

Akinola, L.A.F. and Oruwari, B.M. 2007. Response of laying hens to total Dietary Replacement of Maize with cassava. *Nig. J. Anim. Prod*. 34 (2): 196-202

AOAC. 2002. Official methods of analyses, 17th edition, Association of official analytical Chemists, Gaithersburg, MD, USA.

Bramel-Cox, P.J., Anand-Kumar, K., Hancock, J.H., Andrews, D.J. 1992. Sorghum and millets for forage and feed. In: D.A.V. Dendy (Eds.). Sorghum and the millets, chemistry and technology. Amer. Assoc. Cereal Chem.

Chen, K.H., Huber, J.T., Theurer, C.B., Swingle, R.S., Simas, J., Chan, S.C., Wu, Z. and Sullivan, J.L. 1994**.** Effect of steam flaking of corn and sorghum grains on performance of lactating cows. *Journal of Dairy Science* 77:1038-1043.

Costa, P.T.C., Peishel, A., Stiles, D. 1974. Avaliação de milho x sorgo com e semfarinha de peixeem dietas de poedeiras industriais. 1974. In**:** 11a Reunião da SociedadeBrasileira de Zootecnia, 1974, anais. *Sociedade Brasileira de Zootecnia*, p. 205-206.

Doki, T. 2007. Benue gives land to NNPC. In: Saturday Independent January 27, (2007), Tunde Abatan (Ed).Vol. 1, No. 86, p. A4

Duncan, D.B. 1955.Multiple range and Multiple F. tests. *Biometrical* 11: 1-42

Dudusola, I.O. 2009**.** Effects of storage method and length of storage on some quality parameters of Japanese quail eggs. *Tropicultura*, 27(1) 45-48

Dudusola, I.O. 2010**.** Comparative evaluation of internal and external qualities of egg from quail and guinea fowl. *International Research Journal of plant science*. 1(5) 112-115

Eruvbetine, D. and Oguntona, E.B. 1997**.**Unpeeled cassava root meal in diets for laying hens. *Trop. Agric.,* 774: 299-302.

Etuk, E.B. 2008. Nutrient composition and feeding value of sorghum for turkeys. PhD Thesis, Fed. Univ. Tech., Owerri, Nigeria.

Etuk, E.B., Ifeduba, A.V., Okata, U.E., Chiaka, I., Okoli, I.C., Okeudo, N.J., Esonu, B.O., Udedibie, A.B. I. and Moreki, J.C. 2012**.** Nutrient composition and feeding value of sorghum for livestock and poultry: A Review. *J. Anim. Sci. Adv.* 2(6): 510-524.

Haruna, E.S.U., Musa, E.S., Okewole, P.A., Shemaki, D., Lombin, L.H., Molokwu, J.U., Edache, J.A. and Karsin, P.D. 1997. Protein requirement of quail chicks in Plateau state, Nigeria. *Nig. Vet. J., 18: 108-133.*

Haugh, R.R. 1937. A new method for determining the quality of an egg. *US Poult. Magazine* 39:27-29.

Ibrahim, S.C., Fisher, E.H., Soliman,H. and Anwar, A. 1988. Improvement of the nutritional quality of Egyptian and Sudanese sorghum grains by the additions of Phosphates *Brit. Poultry .Sci*. 29 (4):721-728

Iler, A. and Hanna, W.W. 1995**.** Pearl millet in wildlife plantings. In *Proceedings of the 1st National Grain Pearl Millet Symposium*, (editor: I.D. Teare), University of. Georgia, Tifton. pp.125.

Ipek, A., Canbolat, O., Karabulut, A. 2007**.** The Effect of Vitamin E and Vitamin C on the performance of Japanese quail (*Coturnix coturnix japonica*) Reared under heat stress during Growth and Egg Production Period. *Asian-Aust. J. Anim*. 20(2)252-256

Issa, S. 2009. Nutritional Value of Sorghum for Poultry Feed In West Africa. Ph.D. thesis submitted to the Department of Animal Sciences and Industry. College of Agriculture, Kansas State University, Manhattan, Kansas.

Kana, J.R., Kreman, K., Mube, K.H., Teguia, A. and Manjeli, Y. 2013. Effect of substituting maize with cassava root meal on laying performances of local barred-chicken under improved management conditions in Cameroon

Kul, S. and Seker, I. 2004. Phenotypic correlations between external and internal egg quality traits in Japanese quail (*Coturnix coturnix japonica*). *Int. J. of Poult. Sci*.3:400-405

Kumari, P.B.R., Gupta, B. G., Prakash, M.R,. Reddy, A. 2008. A study of egg quality traits in Japanese quails. *Journal Veterinary & Animal Sciences* 4(6)227-231.

Longe, O.G. 1987.Replacement value of biscuit waste for maize in broiler diets. *Nig. J. Anim Prod.* 13:70-78.

Longe, O.G. and Oluyemi, J.A. 1977**.**Comparative use of cassava, maize and guinea corn as the major dietary source of carbohydrate for chicks. *J. Assoc. Adv. Agric. Sci. Afr*., 4: 47-52.

Louis, G.F., Lewis, A.J. and Peo, E.R. 1997**.** Feeding value of grain sorghum for the lactating sow. *Journal of Animal Science*; 69(1):223-229.

Malik, D.P. and Quisenberry, J.H. 1963. Effects of feeding various milo, corn and protein levels on laying house performance of egg production stock. *Poultry Science 1963*; 42(3):625-633.

McNab, J.M. and Shannon, D.W.F. 1974. The nutritive value of barley, maize, oats and

wheat for poultry. *Brit. Poult. Sci.* 15: (6) 516-567.

Mtimuni, J. 1995. Ration formulation and feed guides. 57pp ISBN 99908 9060 9

Nyachoti, C.M. and Atkinson, J.L. 1995. The effect of feeding high-tannin sorghum on digestive organ response and overall performance of broiler chicks. *Poultry. Sci*., 74: 125.

Nyachoti, C.M., Atkinson, J.L. and Leeson, S. 1997**.** Sorghum tannins: a review *World's Poultry Sci J*., 53:5-12.

Odunsi, A.A., Rotimi, A.A. and Amao, E.A. 2007. Effect of Different Vegetable Protein Sources on Growth and Laying Performance of Japanese Quails (*Coturnix coturnix japonica*) in a Derived Savannah Zone of Nigeria. *World Applied Sciences Journal* 3 (5): 567-571

Ojewola, G.S. and Oyim, S. 2006**.** Comparative evaluation of maize, sorghum and millet in growing cockerel's ration. *Agricultural Journal,* 1: 176-179

Persson, T.A. Garcia, J., Paz, J.J. and Hoogenboom, G. 2009. Maize ethanol feedstock production and net energy value as affected by climate variability and crop management practices. *Agricultural Systems* 100: 11–21

Rostago, H.S., Albino, L.T.F., Donzele, J.L., Gomes, P.C., Ferreira, A.S., Olivera, R.F. and Lopes, C.D. 2000. TabelasBrasileirasparaaves e suinos (composicao de alimentos e exigencies nutricisionalis de aves e suinos). Vicosa (MG): UFV, ImprensaUniversitaria. Pp: 141–142.

Salami, R.I. and Odunsi, A.A. 2003. Evaluation of processed cassava peel meals as substitutes for maize in the diets of layers. *International Journal of Poultry Science,* 2: 112-116.

Savage, S. 1995. Quail performance on pearl millet grain. In *Proceedings of the 1stNational Grain Pearl Millet Symposium*, (editor: I.D. Teare) University of. Georgia, Tifton. Pp. 121-123 Sci., 74: 125.

Serna-Saldivar, S.O., McDonough, C.M., Rooney, L.W. 1990**.** The millets, p. 271-300. In: K.J. Lorenz and K. Kulp (Eds.). Handbook of cereal science technology. Markel Dekker, New York.

Smith, H. 2003. Cassava as substitute for cereals in livestock rations. RADA; 2003. [Cited2010 Jan 5].

Streeter, M. N., Wagner, D.G, Hibberd, C.A. 1991. Comparison of corn with four sorghum grain hybrids: site and extent of digestion in steers. *Journal of Animal Science;* 68(10):3429-3440

Sullivan, T.W, Douglas, J.H, Andrews, D.J, Bowland, P.L, Hancock, J.D, Bramel-Cox P.J, Stegmeier W.D, Brethour J.R. 1990. Nutritional value of pearl millet for food and feed. Pages 83–94 in: Proc. Int. Conf. Sorghum Nutr. Qual. Purdue University, West Lafayette, IN.

Ukachukwu, S.N. 2005**.** Studies on the nutritive value of composite cassava pellets for poultry: chemical composition and metabolizable energy. *Livestock Research for Rural Development;* 17(11).

Uchegbu, M.C., Omede A.A., Etuk E.B., Okpala C.P., Okoli I.C. and Opara, M.N. 2011. Effect of replacing maize with cassava root meal and maize/sorghum brewers' dried grains on the performance of starter broilers. *Trop. Subtrop. Agroecosyst.*, 14: 363-367.

Usman, H.B and Garba, S. 2012**.** Egg quality Parameters of Isa Brown Layers Fed Sorghum Energy Source Using Different Feeding Systems. In the Proceedings of the 46th Annual Conference of the Agricultural Society; 5th – 9th November, 2012. (Jibrin, J.M., M.A. Hussaini, B.M. Auwalu, E.U. Essiet, I.R. Muhammad, S.G. Mohammed, M.I. Daneji, Y. Garba and S.A. Pantami (eds.)). Pp. 503-507

Willie, D. and Kinabo, A. 1980**.** Cassava or maize meal for broilers and the effect of supplementation with methionine and sulphate in cassava based diets. *Trop. Anim. Prod.*, 5: 182-190.