FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 4 No. 1, March, 2020, pp 567 – 572

EFFECT OF FEEDING WHOLE OR GROUND PEARL MILLET (*Pennisetum glaucum*) WITH OR WITHOUT ENZYME SUPPLEMENTATION ON THE EGG QUALITY OF LAYING JAPANESE QUAILS (*Coturnix coturnix japonica*)

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ABSTRACT
The effects of dietary inclusion level (50% or 100%), form (whole or ground), and enzyme supplementation (with or without) of pearl millet at the expense of maize on the egg quality of laying Japanese quails was evaluated in this experiment. One hundred and sixty two female Japanese quails of seven weeks of age were used in a 2 x 2 x 2 factorial arrangement in a completely randomized design with eight treatments and a control all replicated thrice with 6 quails per replicate. Three fresh eggs were randomly picked from each replicate fortnightly starting from the 8th week for the measurement and determination of the following egg quality parameters; egg weight, shell weight, albumen weight, yolk weight, shell thickness and Haugh unit. Results of the study showed that completely replacing maize with whole or ground pearl millet wit-h or without enzyme supplementation increased the egg weight and reduced the Haugh unit of laying Japanese quails. Albumen and yolk percentages increased when 50% pearl millet was fed and decreased with the feeding 100% pearl millet. Feeding ground pearl millet and feeding pearl millet without enzyme supplementation decreased yolk percentage. The feeding of whole pearl millet with or without enzyme supplementation increased shell thickness, while shell weight, shell percentage, albumen weight and yolk weight were not affected by those factors.

Keywords: Egg, Millet, Enzyme, Carcass, Whole

INTRODUCTION

The reduction of feed particle size is the largest user of energy in layer industry where feeds are fed as mash. Hence, any reduction in energy consumption from grinding could significantly lower feed cost (Amerah, 2008). Energy required for grinding comprises between 25 and 30% of feed manufacturing (Umar Faruk *et al.,* 2010a). Blair (2008) pointed out that the poultry digestive system is capable of processing whole grain and it therefore seems unnecessary to feed it a ground diet. Therefore, it is logical to think that the cost incurred in grinding and handling of cereals will be significantly reduced if birds are fed whole grains (Umar Faruk *et al.,* 2010a). In addition, it allows the use of locally grown cereals in the farm (Umar Faruk *et al.*, 2010a).

Maize is the major source of energy in poultry production accounting for 45 – 65% of poultry feeds (Ijaiya *et al*., 2012). However, with the current trend of global warming, erratic fertilizer supply and increased transport costs, the availability and affordability of maize especially in the semiarid regions is likely to become difficult. Hence, the search for viable alternatives and way of improving their utilization becomes imperative. Millet is one of such alternatives, as it is draught tolerant, with acceptable grain yields even on acidic soils with low fertility (Dozier *et al*., 2005).

The high fibre levels of pearl millet could be a limiting factor to its use in poultry diets. The utilization of this fibre could be improved with the use of exogenous enzymes (Singh and Perez-Maldonado, 1999). Svihus (2010) hypothesized that a more developed gizzard as a consequence of structural components may improve efficacy of exogenous enzymes. This could be due to increased retention time in the gizzard and the favourable pH there. Particle size influences retention time in the digestive tract. The larger the particle size, the longer feed is retained, the greater its exposure to endogenous and exogenous enzymes and subsequently the greater the nutrients utilization (Patrick, 2004).

This study was conducted to evaluate the effect of pearl millet inclusion level, pearl millet form and enzyme supplementation of pearl millet diets as replacement for maize on egg quality of Japanese quails.

MATERIALS AND METHODS

Experimental Site

The study was conducted at the Poultry Unit of the Research and Training Farm of the Department of Animal Science, Ahmadu Bello University Zaria, located within latitude 11˚ 09' 06″N longitude 7˚ 3' 8″E and having a tropical continental climate with rainfall ranging from 1102 mm to 1904 mm. The mean temperature fluctuates from 31ºC maximum to 18ºC minimum (as reported by Hassan *et al.,* 2013).

Experimental design, birds and their management

162 seven weeks old female Japanese quails were used in 2 x 2 x 2 factorial arrangement in a completely randomized design with two levels of millet inclusion (50 and 100) as replacement for maize, two forms of millet (whole or mash) and enzyme supplementation (with or without). The birds were allocated to 9 dietary treatments with each treatment having three replicates of 6 birds. The birds were reared in constructed cages and all routine management practices were strictly adhered to.

Experimental diets

A maize based layer diet was formulated according to the National Research Council (1994) recommendation (20% CP and 2900MEkcal/kg) as the control. Pearl millet replaced

maize on a weight to weight basis for the different inclusion levels and forms and each with or without enzyme supplementation as shown in table 1. The exogenous enzyme used in this study was Maxigrain®.

Measurements

Three fresh eggs were randomly picked from each replicate fortnightly starting from the 8th week to determine the egg quality parameters. The parameters determined were:

Egg weight, Shell weight, albumen weight and yolk weight

Egg weight, Shell weight, albumen weight and yolk weight were measured for individual egg to the nearest 0.01g using a sensitive electronic scale.

Shell thickness

Shell thickness was measured for individual dry egg shells to the nearest 0.01mm using a micrometer screw gauge.

Egg Haugh Unit

Each egg was broken around equator; care was taken to keep the yolk intact. The albumen height was measured with the aid of Vernier calipers and values obtained were used to calculate the haugh unit values for each replicate.

Statistical Analysis

Data were subjected to analysis of variance using the general linear models (GLM) procedure of SAS software (SAS, 1994). Where the analysis of variance was significant, Duncan's multiple range test was used to separate treatment means other than control (0%PM) (Steel and Torrie, 1980). The control was contrasted from each of the treatments using Dunnett test at 5%.

Table 1: Composition (%) of Experimental Diets

Ingredients	0%Pearl Millet	50% Pearl Millet	100% Pearl Millet
Maize	46.0	23.0	-
Pearl millet	-	23.0	46.0
Soyabean meal	20	20	20
Groundnut cake	25	25	25
Maize offal	3.25	3.25	3.25
Palm oil	2.0	2.0	2.0
Limestone	1.0	1.0	1.0
Bone meal	2.0	2.0	2.0
Salt	0.25	0.25	0.25
Vitamin Premix	0.25	0.25	0.25
Lysine	0.10	0.10	0.10
Methionine	0.15	0.15	0.15
Maxigrain	-	-	-
Total	100	100	100
Calculated analysis			
Crude protein (%)	24.8	25.4	25.9
ME (kcal/kg)	2896	2696	2495
Ether extract (%)	2.1	2.1	2.1
Crude fibre (%)	3.14	4.4	5.6
Calcium (%)	1.2	1.2	1.4
Phosphorus (%)	0.7	0.7	0.6
Lysine (%)	1.3	1.3	1.4
Methionine (%)	0.5	0.5	0.5
Feed cost(₦/kg)	95.82	97.53	101.44

RESULTS AND DISCUSSION

Proximate Composition of the Experimental Diets

Tables 2 shows the proximate composition of the starter diet and proximate composition of the layer diet respectively. With increase in the inclusion of pearl millet there was gradual increase in protein, fibre and ash but decrease in ether extract and nitrogen free extract. These agree with previous observations that millet has lower metabolizable energy, higher crude protein, crude fibre and ash than maize (Abubakar *et al.,* 2006; Dale, 2006).

Table 2: Proximate composition (%) of feed samples

Parameter	0% Pearl Millet	50% Pearl Millet	100% Pearl Millet
Dry Matter	92.21	92.56	92.80
Crude Protein	25.04	26.25	27.45
Crude Fibre	8.65	8.94	9.75
Ether extract	5.32	5.22	5.01
Ash	9.44	11.1	11.15
Nitrogen free extract	51.55	48.49	46.64

Effect of pearl millet inclusion level on the external and internal egg quality characteristics of laying Japanese quails

The effect of pearl millet inclusion level on external and internal egg quality characteristics of laying Japanese quails is shown in Table 3. Laying Japanese quails fed 50 and 100% pearl millet had similar (P>0.05) shell weight, shell

percentage, albumen weight and yolk weight when compared to the control (0% pearl millet).

Egg weight of laying quails fed 100% pearl millet was significantly (P<0.05) higher than that of the control group (0% pearl millet) but similar to the 50% pearl millet fed group. Quails fed the control diet (0% pearl millet) and 50% pearl millet produced eggs with similar (P>0.05) weights. Albumen percentage was higher (P<0.05) for quails fed 50% pearl millet compared with the 100% pearl millet group. Quails fed either 50% or 100% pearl millet had similar (P>0.05) albumen percentage with the control. Yolk percentage was also affected (P<0.05) by the varying pearl millet inclusion levels. The control (0% pearl millet) diet has higher yolk percentage than the 100% pearl millet diet. Quails fed 50% pearl millet had similar (P>0.05) yolk percentage with either the 100% pearl millet diet or the control. Shell thickness was lower (P<0.05) for the control diet than either of the two pearl millet inclusion levels (50% or 100%).

The two pearl millet inclusion levels (50% or 100%) have similar (P>0.05) shell thickness. Haugh unit was higher (P<0.05) for the control diet than either of the two pearl millet inclusion levels (50% or 100%). The two pearl millet inclusion levels (50% or 100%) have similar (P>0.05) Haugh unit. Earlier works on the replacement of maize with pearl millet reported a variety of effects on egg quality parameters. Similar to these results, increase in egg weight of laying hens was observed by Faruk (2010) when maize was replaced completely with pearl millet. On the contrary, Faruk (2010) observed no statistical difference between the egg yolk, egg albumen and eggshell of pearl millet and maize based diets. Also replacing 50% or more of maize with pearl millet in the diet of laying hens increased their eggshell percentage, decreased their egg weight and did not alter their shell thickness and Haugh unit as observed by Filardi *et al.* (2005). Egg weight, yolk weight, and percentage yolk of laying hens were unaffected by diet when maize was replaced with pearl millet (Collins *et al.*, 1997). Egg weight showed a tendency to improve with diets providing pearl millet compared to maize (Kumar *et al.*, 1991). Umar Faruk *et al.* (2010b) observed increased egg weight and egg mass when maize was replaced with pearl millet in the diet of laying hens. Diets containing up to 60% pearl millet had no effect on egg weight and egg mass (Singh and Perez-Maldonado, 1999). Similar egg weights with increased shell thickness and reduced albumen height was observed in eggs laid by hens fed pearl millet as replacement for maize by Abd-ElRazig (1997). Lower egg weight was observed when maize was completely (Amini and Ruiz-Feria, 2008) or partially (Mehran *et al.*, 2010) replaced with pearl millet. However in this study, it might be assumed that higher egg weight might be related to the additional supply of protein in the pearl millet-based diet. Leeson and Summers (2005) explained an obvious linear relationship between increased egg size and increased protein intake. The Haugh unit of Japanese quails obtained in this study has met the minimum requirement of Haugh unit for eggs reaching the consumer which is 60 (Roberts, 2010). The decrease in Haugh unit with pearl millet inclusion might be as a result of the increase in protein content in the pearl millet based diets. This agrees with the report of Roberts (2010) who reported that albumen quality decreases with increasing dietary protein and amino acid content.

Table 3: Main effect of Pearl Millet inclusion level on the External and Internal egg quality characteristics of laying Japanese quails

PARAMETER	Control	50% Pearl Millet	100% Pearl Millet	SEM
Egg weight (g)	9.16^{b}	9.50^{ab}	9.67^{a}	0.08
Shell weight (g)	1.20	1.35	1.23	0.60
Shell percentage	13.08	14.18	12.78	0.50
Albumen weight (g)	4.35	4.62	4.30	0.20
Albumen percentage	47.49^{ab}	48.63^{a}	44.45^{b}	1.14
Yolk weight (g)	2.91	2.78	2.75	0.07
Yolk percentage	31.81^{a}	29.31^{ab}	28.46^{b}	0.70
Shell thickness (mm)	0.103^{b}	0.126^{a}	0.130^{a}	0.004
Haugh unit	61.99^{a}	61.01^{b}	60.84^{b}	0.17

$^{a, b, c}$ means in a row with no common superscript(s) differ significantly (P<0.05)
SEM – standard error of mean

Effect of millet form on the external and internal egg quality characteristics of laying Japanese quails

The effect of pearl millet form on external and internal egg quality characteristics of laying Japanese quails is shown in Table 3. Laying Japanese quails fed either whole, ground pearl millet or the control had similar (P>0.05) shell weight, shell percentage, albumen weight, albumen percentage and yolk weight. Egg weight of quails fed either whole or ground pearl millet was significantly (P<0.05) higher than that of the control. The egg weights of quails fed whole or ground pearl millet were similar (P>0.05). Laying Japanese quails fed the control had higher yolk percentage (P<0.05) than those fed ground pearl millet. The yolk percentage of the quails fed whole pearl millet was similar (P>0.05) to that of control and ground pearl millet group. Feeding of whole pearl millet resulted in higher (P<0.05) shell thickness compared to feeding ground pearl millet or the control. Quails fed ground pearl millet or the control have similar (P>0.05) shell thickness. Haugh unit was higher (P<0.05) for the control diet than either of the two pearl millet forms (whole or ground). The two pearl millet forms (whole or ground) have similar (P>0.05) Haugh unit. From the above results it can be seen that there were no significant differences in egg quality parameters considered in this study between quails fed whole pearl millet and the quails fed ground pearl millet, except for shell thickness.

When comparing whole or ground pearl millet as fed to laying hens, Faruk (2010) observed similar egg and albumen weights, but heavier yolk and eggshell for whole millet fed hens compared to ground pearl millet. Similarly, the average egg mass, egg weight, eggshell weight (g and %), albumen weight (both in g and %) and yolk weight of loose-mix and control were not statistically different (Umar Faruk *et al.*, 2010a). With reference to feeding whole grains, Bennett and Classen (2003) found that feeding 60% whole barley increased egg weight. Increased shell thickness in whole pearl millet compared to feeding ground pearl millet or the control obtained in this study might be due to prolonged retention

time in the whole pearl millet fed groups. It has been ascertained that larger particles are retained in gizzard for a prolonged period of time. This retention allows calcium to dissolve slowly and enter the intestine at a slow rate and make calcium available during the period of shell formation (Pavlovski *et al*., 2000).

Table 3: Main effect of Millet Form on the External and Internal egg quality characteristics of laying Japanese quails

PARAMETER	Control	Whole Pearl Millet	Ground Pearl Millet	SEM
Egg weight (g)	9.16[b]	9.62[a]	9.55[a]	0.08
Shell weight (g)	1.20	1.30	1.28	0.60
Shell percentage	13.08	13.52	13.44	0.50
Albumen weight (g)	4.35	4.62	4.29	0.20
Albumen percentage	47.49	48.11	44.97	1.14
Yolk weight (g)	2.91	2.79	2.74	0.07
Yolk percentage	31.81[a]	29.07[ab]	28.69[b]	0.70
Shell thickness (mm)	0.103[b]	0.143[a]	0.113[b]	0.004
Haugh unit	61.99[a]	61.01[b]	60.83[b]	0.17

[a, b, c] means in a row with no common superscript(s) differ significantly (P<0.05)
SEM – standard error of mean

Effect of enzyme supplementation of pearl millet based diets on the external and internal egg quality characteristics of laying Japanese quails

The result of the effect of enzyme supplementation on the external and internal egg quality characteristics of laying Japanese quails is shown in Table 4. Laying Japanese quails fed pearl millet with or without enzyme supplementation had similar (P>0.05) shell weight, shell percentage, albumen weight, albumen percentage and yolk weight with those fed the control. Quails fed pearl millet with enzyme had heavier (P<0.05) eggs than quails fed the control. While quails fed pearl millet without have egg weight similar (P>0.05) to those fed either pearl millet with enzyme or the control. Laying Japanese quails fed the control had higher yolk percentage (P<0.05) than those fed pearl millet without enzyme. The yolk percentage of the quails fed pearl millet with enzyme was similar (P>0.05) to that of quails fed control and quails fed pearl millet without enzyme. The shell thickness of laying Japanese quails fed pearl millet with or without enzyme supplementation was higher (P<0.05) than that quails fed the control. Quails fed pearl millet with enzyme and those fed pearl millet without enzyme have similar (P>0.05) shell thickness. Haugh unit of quails fed the control was higher (P<0.05) than that of quails fed either pearl millet with enzyme or without enzyme supplementation. Quails fed pearl millet with or without enzyme supplementation had similar (P>0.05) Haugh unit.

From the above results, laying Japanese quails fed pearl millet with enzyme or without enzyme supplementation had similar egg quality parameters. Hence the addition of enzymes in pearl millet diet as replacement for maize might not be necessary. The improvements obtained by adding enzymes to the diet of poultry depends on many factors, including the type and amount of cereal in the diet and the level of anti-nutritive factor in the cereal, which can vary within a given cereal (Geraert and Dalibard, 2003; Munir and Maqsood, 2013). Barley and wheat based diets show more improvement than wheat and maize based diets (Geraert and Dalibard, 2003). Improvement expected and usually achieved via the use of currently available enzymes for wheat- or barley-based diets is higher, or at least more consistent, than may be anticipated via the use of same enzymes for diets based on maize (Cowieson *et al*., 2006). Contrary to the findings of this study, no significant effect of enzyme supplementation was observed on egg characteristics by Geraert and Dalibard (2003). Similar to the results of this study, Shehab *et al.* (2012) reported increased egg weight, yolk weight and shell thickness of laying Japanese quails with enzyme supplementation. Albumen weight and shell weight were not affected by enzyme supplementation (Shehab *et al*., 2012). Attia *et al.* (2008) reported that yolk percentage, albumen percentage, Haugh unit score and other shell quality criteria were not significantly affected by enzyme supplementation. However, they observed that enzyme supplementation improved shell thickness.

Table 5: Main effect of Enzyme supplementation of pearl millet diets on the External and Internal egg quality characteristics of laying Japanese quails

PARAMETER	Control	Pearl millet without enzyme	Pearl millet with enzyme	SEM
Egg weight (g)	9.16[b]	9.47[ab]	9.70[a]	0.08
Shell weight (g)	1.20	1.27	1.31	0.60
Shell percentage	13.08	13.40	13.55	0.50
Albumen weight (g)	4.35	4.35	4.57	0.20
Albumen percentage	47.49	45.90	47.19	1.14
Yolk weight (g)	2.91	2.67	2.86	0.07
Yolk percentage	31.81[a]	28.22[b]	29.54[ab]	0.70
Shell thickness (mm)	0.103[b]	0.129[a]	0.126[a]	0.004
Haugh unit	61.99[a]	61.07[b]	60.78[b]	0.17

[a, b, c] means in a row with no common superscript(s) differ significantly (P<0.05) SEM – standard error of mean

The improvement in shell thickness of enzyme supplemented diet could be due to the improvement in the utilization of mineral complexes in the cell wall (Attia *et al.*, 2008). In this study, addition of enzymes to pearl millet based diets did not improve

shell thickness. This was contrary to the effect of enzyme on shell thickness in wheat and barley based diets. Addition of enzymes improved shell quality for wheat and barley based diets (Roberts, 2010). Also a reduction in Haugh unit was not observed with the addition of enzyme as quails fed pearl millet with or without enzyme supplementation had similar Haugh unit. However, there were reports of reduction in Haugh unit with enzymes supplementation of wheat and barley based diets (Roberts, 2010).

CONCLUSION AND RECOMMENDATIONS

Completely replacing maize with whole or ground pearl millet with or without enzyme supplementation increased the egg weight and reduced the Haugh unit of laying Japanese quails. The feeding whole pearl millet increased shell thickness. It is therefore recommended that whole pearl millet can be used to completely replace maize in the diet of laying Japanese quails.

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