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EGG QUALITY PARAMETERS OF THREE STRAINS OF LAYER HEN FED FOUR DIETARY ENERGY LEVELS

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Abstract

This study was conducted to assess the egg quality in three strains of layer hen (Isa White, Isa Brown and Black Nera). A total of four hundred and eighty (480) layer birds consisting of 160 of each strain aged 42 weeks were used for this study. The experimental birds were randomly allocated into four diets containing different energy levels (2500, 2600, 2700 and 2800 Kcal/kg ME). Data collection lasted for a period of 8 weeks (42 – 50 weeks of age). Egg quality assessment was conducted at the end of the feeding trial. Three fresh eggs were randomly selected from each replicate for external and internal quality assessment. The parameters assessed include; Haugh unit, shell thickness (mm), shell weight (g), yolk weight (g), yolk width (cm), yolk height (cm), albumen weight (g), albumen width (cm), albumen height (cm), egg length (cm) and egg width (cm). Results obtained showed that Isa White and Isa Brown strains recorded best haugh unit, the freshness of egg, at 2,800 kcal/kg ME while Black Nera strain recorded the best haugh unit at 2,700 kcal/kg ME. Results on average shell thickness ranges from 0.41–0.47 mm. Isa Brown produced thicker shell at energy levels of 2,700 and 2,800 kcal/kg as against Black Nera that produced thicker shell at 2,500 kcal/kg energy level. Thus, it can be concluded that egg quality was better at higher dietary energy levels in Isa White and Isa Brown strains.

Keywords: Albumen, Laying Hens, Yolk, Quality, Shell, Strains

INTRODUCTION

Eggs are commonly used in many dishes, both sweet and savory, including many baked foods. Egg consumption has the capacity for meeting the daily animal protein requirement. Egg quality is one of the most important traits for the egg producing industry. Egg quality is composed of those characteristics that affect its acceptability to the consumers (Stadelman, 1995). Eggs quality affect the demand by consumers and determine their market values (Uluolak *et al*., 1995). Egg quality is a factor which contributes for better economy of egg production industry.

External qualities of the eggs are directly related with the amount of broken eggs, leading to serious economic problems for both the breeders and the dealers (Hamilton, 1982) and on hatchability and development of the chicks (Khurshid *et al*., 2004). External and internal egg qualities are influenced by a number of factors such as diet (DeGroote, 1972; Koelkebeck, 2007).

Variations in external and internal egg quality characteristics between species, breeds and strains had been widely reported (Wu *et al*., 2005) and established that egg quality have genetic basis. However, there is dearth report on the influence of different dietary energy levels on egg quality. Therefore, the objective of this study was to determine the dietary levels effects on some internal and external quality parameters of eggs in Isa White, Isa Brown and Black Nera strains of laying hen.

MATERIALS AND METHODS

Experimental Location

This study was conducted at Sovet Farm, Kano, Kano State, located at Danbare village opposite the new site of Bayero University, Kano. Kano State is located between longitude 9^0 30' and 12^0 30' North and latitude 9^0 30' and 8^0 42' East (KNARDA, 2006).

Experimental Birds and Management

Three strains of laying hen (Isa White, Isa Brown and Black Nera) were used for this study. A total of four hundred and eighty (480) layers of 42 weeks of age consisting of one hundred and sixty (160) birds each of Isa White, Isa Brown and Black Nera strains were used in the experiment. The birds were housed in battery cages 40 X 35 X 40 cm length, width and height respectively. Birds of each strain were randomly allocated into 4

groups of four dietary energy levels (2,500, 2,600, 2,700 and 2,800 Kcal/kg ME) and each group had four replicates of 10 birds each.

The birds were given commercial layer mash prior to the commencement of the experiment. Birds were dewormed with piperazine, treated for coccidiosis with *amprolium*, vaccinated against common poultry diseases and deloused in case of lice infestation. Feed and water were provided *ad libitum*. Table 1 shows the composition of the experimental diets.

Table 1: Ingredients and nutrient composition of experimental diets with different levels of energy

Ingredients (%)	Different Levels of Energy (kcal/kg)			
	A	B	C	D
Maize	44.50	50.00	57.00	64.00
Wheat offal	17.00	10.00	3.00	3.00
Rice milling waste	6.00	7.00	7.00	5.10
Soybean	9.00	10.00	11.50	3.00
Groundnut cake	7.30	7.30	4.30	4.00
Fish Meal	4.20	4.20	5.20	9.70
Bone Meal	5.00	5.00	5.00	4.50
Salt	0.50	0.50	0.50	0.50
Limestone	6.00	6.00	6.00	6.00
Vitamins/Mineral Premix	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10
Total	**100.00**	**100.00**	**100.00**	**100.00**
Crude protein (%)	17.00	17.00	16.60	16.50
Lysine (%)	0.90	0.90	0.90	0.90
Methionine (%)	0.40	0.40	0.40	0.40
Calcium (%)	3.50	3.50	3.60	3.60
Available Phosphorus (%)	0.90	0.90	0.90	0.90
Fibre (%)	6.00	6.00	5.10	4.00

A = 2,500 kcal/kg, B = 2,600 kcal/kg, C = 2,700 kcal/kg and D = 2,800 kcal/kg

Data Collection

Data collection lasted for a period of 8 weeks (42 – 50 weeks of age). Three fresh eggs were randomly selected from each replicate for external and internal quality assessment. The parameters measured include; haugh unit, shell thickness (mm), shell weight (g), yolk weight (g), yolk width (cm), yolk height (cm), albumen weight (g), albumen width (cm), albumen height (cm), egg

length (cm) and egg width (cm) following the procedures described by Kul and Seker (2004) and Amao *et al*. (2013).

Other parameters evaluated were:

Yolk colour: The colour of the yolk was scored visually with the aid of the Roche colour fan.

Albumen index: Estimated as the ratio between the height and diameter of the albumen (Ihekoronye and Ngoddy, 1985).

Egg shape index (ESI): Estimated as the ratio of maximum width to maximum length of the egg (Anderson *et al*., 2004).

Yolk index: Calculated as the ratio of yolk height to yolk width.

Egg shape index: Calculated as egg diameter divided by the length.

Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA) according to SAS (1999) statistical package. Means separation was carried out using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS

Table 2 shows the results on the quality of eggs produced by three strains of layer chickens fed 2,500 kcal/kg ME diet. The results indicated non-significant ($P>0.05$) differences between the three strains in haugh unit, shell weight, yolk index, yolk colour, yolk width, yolk height, albumen width, egg length, egg width, egg shape index and albumen index. However, shell thickness was significantly ($P<0.05$) higher in Black Nera (0.47 mm) compared to Isa White (0.43 mm) while Isa Brown (0.45 mm) stand in between the two. Yolk weight was significantly ($P<0.05$) higher in Isa White (22.95 g) followed by Isa Brown (19.90 g) while the least value was obtained in Black Nera (16.11 g).

Albumen weight was significantly ($P<0.05$) higher in Black Nera (41.82 g) compared to Isa Brown and Isa White (35.11 g and 32.93 g respectively) whose values did not differ significantly ($P>0.05$) between each other. Albumen height was significantly ($P<0.05$) higher in Isa Brown (0.75 cm) compared to Isa White (0.30 cm) while Black Nera (0.50 cm) stand in between the two.

Table 2: Quality of eggs produced by three strains of layer chickens fed 2,500 kcal/kg

Parameters	Strains of Layer Chickens			SEM
	Isa White	Isa Brown	Black Nera	
Haugh (%)	68.12	67.67	67.76	1.34
Shell thickness (mm)	0.43[b]	0.45[ab]	0.47[a]	0.03
Shell weight (g)	7.64	6.59	6.23	1.87
Yolk Index	0.31	0.30	0.31	0.06
Yolk Colour	1.00	1.00	1.00	0.00
Yolk weight (g)	22.95[a]	19.90[b]	16.11[c]	2.03
Yolk width (cm)	5.05	4.50	4.43	0.85
Yolk height (cm)	1.53	1.35	1.35	0.20
Albumen weight (g)	32.93[b]	35.11[b]	41.82[a]	5.25
Albumen width (cm)	6.43	6.78	6.68	1.62
Albumen height (cm)	0.30[b]	0.75[a]	0.50[ab]	0.37
Egg length (cm)	4.35	4.43	4.38	0.29
Egg width (cm)	2.93	2.90	2.95	0.33
Egg Shape Index	0.67	0.66	0.67	0.08
Albumen Index	0.05	0.12	0.15	0.12

[a,b,c]means with different superscripts within the same row are significantly different (P<0.05)

Results of the egg quality from the three strains of layer chickens fed 2,600 kcal/kg ME diet were presented on Table 3. There was no significant (P>0.05) difference between the three strains in haugh unit, shell thickness, yolk index, yolk colour, yolk weight, yolk width, albumen height and albumen index. However, shell weight was significantly (P<0.05) higher in Isa Brown (6.69 g) than Black Nera (5.59 g). Yolk height was significantly (P<0.05) higher in Black Nera (1.83 cm) compared to Isa Brown (1.55 cm). Albumen weight was significantly (P<0.05) higher in Isa Brown (43.72 g) compared to Isa White (33.68 g). Albumen width was significantly (P<0.05) higher in Isa Brown compared to Black Nera and Isa White (6.50 cm, 5.80 cm and 5.53 cm respectively). Egg length was significantly (P<0.05) higher in Isa Brown than in Isa White and Black Nera (6.23 cm, 5.69 cm and 4.43 cm respectively) while the egg width was significantly (P<0.05) higher in Isa Brown and Isa White than in Black Nera (4.43 cm, 4.23 cm and 2.88 cm respectively).

Table 3: Quality of eggs produced by three strains of layer chickens fed 2,600 kcal/kg

Parameters	Strains of Layer Chickens			SEM
	Isa White	Isa Brown	Black Nera	
Haugh (%)	67.21	68.88	68.14	1.95
Shell thickness (mm)	0.46	0.45	0.44	0.05
Shell weight (g)	6.05[ab]	6.69[a]	5.59[b]	1.09
Yolk Index	0.39	0.39	0.44	0.08
Yolk Colour	1.00	1.00	1.00	0.00
Yolk weight (g)	18.87	16.45	19.15	2.87
Yolk width (cm)	4.35	4.08	4.23	0.28
Yolk height (cm)	1.68[ab]	1.55[b]	1.83[a]	0.24
Albumen weight (g)	33.68[b]	43.72[a]	39.35[ab]	7.63
Albumen width (cm)	5.53[b]	6.50[a]	5.80[b]	0.42
Albumen height (cm)	0.86	0.95	0.80	0.22
Egg length (cm)	5.69[b]	6.23[a]	4.43[c]	0.37
Egg width (cm)	4.23[a]	4.43[a]	2.88[b]	0.23
Egg Shape Index	0.75[a]	0.71[ab]	0.65[b]	0.07
Albumen Index	0.16	0.15	0.14	0.04

[a,b,c]Means with different superscripts within the same row are significantly different (P<0.05)

Results of the quality of eggs produced by the three strains of laying chickens fed 2,700 kcal/kg ME diet were presented on Table 4. Black Nera and Isa White had significantly (P<0.05) higher values in Yolk width (cm) and egg length (cm) than Isa Brown while haugh unit was significantly (P<0.05) higher in Black Nera (69.12) compared to Isa Brown (68.00) whereas there was no significant difference between Isa White (68.05) and Isa Brown (68.00).

Table 4: Quality of eggs produced by three strains of layer chickens fed 2,700 kcal/kg

Parameters	Strains of Layer Chickens			SEM
	Isa White	Isa Brown	Black Nera	
Haugh (%)	68.05[ab]	68.00[b]	69.12[a]	1.10
Shell thickness (mm)	0.44	0.46	0.42	0.07
Shell weight (g)	6.20	6.59	6.69	0.57
Yolk Index	0.39	0.47	0.41	0.12
Yolk Colour	1.00	1.00	1.00	0.00
Yolk weight (g)	20.33	18.21	21.30	3.26
Yolk width (cm)	4.73[a]	4.05[b]	4.43[a]	0.35
Yolk height (cm)	1.83	1.86	1.82	0.38
Albumen weight (g)	35.98	37.62	39.10	5.91
Albumen width (cm)	7.05	6.80	7.58	0.96
Albumen height (cm)	0.80	0.86	0.88	0.24
Egg length (cm)	6.30[a]	5.61[b]	6.33[a]	0.09
Egg width (cm)	4.45	4.30	4.43	0.56
Egg Shape Index	0.71	0.77	0.70	0.10
Albumen Index	0.12	0.13	0.12	0.05

[a,b,c]Means with different superscripts within the same row are significantly different (P<0.05)

Results of the quality of eggs produced by the three strains of layer chickens fed 2,800 kcal/kg ME diet were shown in Table 5. The results indicated non-significant (P>0.05) variations between strains in terms of haugh unit, shell thickness, yolk colour, yolk weight, yolk width, albumen weight and albumen index. However, shell weight was significantly (P<0.05) higher in Isa Brown (6.99 g) than Isa White (6.23 g) and Black Nera (5.69 g). Yolk index was significantly (P>0.05) higher in Isa White (0.43) and Isa Brown (0.43) than Black Nera (0.37). Albumen width and height as well as egg shape index was significantly (P<0.05) higher in Isa Brown compared to Isa White. Egg length was significantly (P<0.05) higher in Isa White (6.12 cm) compared to Isa Brown (5.60 cm) and Black Nera (5.75 cm).

Table 5: Quality of eggs produced by three strains of layer chickens fed 2,800 kcal/kg

Parameters	Strains of Layer Chickens			SEM
	Isa White	Isa Brown	Black Nera	
Haugh (%)	69.16	68.99	68.22	1.32
Shell thickness (mm)	0.43	0.46	0.41	0.06
Shell weight (g)	6.23^{b}	6.99^{a}	5.69^{c}	0.51
Yolk Index	0.43^{a}	0.43^{a}	0.37^{b}	0.04
Yolk Colour	1.00	1.00	1.00	0.00
Yolk weight (g)	18.79	19.90	18.17	2.42
Yolk width (cm)	4.33	4.40	4.58	0.40
Yolk height (cm)	1.83^{ab}	1.91^{a}	1.70^{b}	0.15
Albumen weight (g)	42.24	40.23	39.78	4.45
Albumen width (cm)	6.63^{b}	7.38^{a}	6.75^{ab}	0.75
Albumen height (cm)	0.88^{b}	1.06^{a}	0.92^{ab}	0.17
Egg length (cm)	6.12^{a}	5.60^{b}	5.75^{b}	0.34
Egg width (cm)	4.49^{ab}	4.65^{a}	4.39^{b}	0.24
Egg Shape Index	0.74^{b}	0.83^{a}	0.77^{ab}	0.65
Albumen Index	0.14	0.14	0.14	0.02

^{a,b,c}Means with different superscripts within the same row are significantly different (P<0.05)

DISCUSSION

Haugh unit (HU) showed better results at high energy level (2,800 kcal/kg ME) in Isa White and Isa Brown strains of birds while for Black Nera the HU was better at 2,700 kcal/kg ME diet. The results of HU obtained from the present study were closer to 66 – 70% obtained by Dongmo and Fomunyam (2005). Brandt *et al.* (1991) reported that eggs of inferior quality have HU values of less than 40% therefore the HU obtained from the present study is of good quality since none of the HU values obtained in this study was less than 67%.

Haugh unit and the albumen height were important indices concerning internal egg quality (Roberts, 2004). Haugh unit is usually a factor of the albumen height of the egg, however, Haugh units were also influenced by the age, strain of bird or storage (Naber, 1979). Results on average shell thickness obtained from the present study ranges from 0.41 – 0.47 mm. These values are higher than the recommended minimum by Oluyemi and Roberts, (2000) who reported that the average shell thickness of a fowl egg is about 0.34 mm and it tends to be thinner in the tropics than in the temperate. Isa White did not show any specific pattern as energy level increased in the diet but Isa Brown produced thicker shell at energy levels of 2,700 and 2,800 kcal/kg ME diet as against Black Nera which produced thicker shell at low (2,500 kcal/kg ME) energy level. The results show that Black Nera layer chickens are better utilizers of calcium at low energy diet compared to Isa White which requires high energy for effective mobilization of calcium. These results contradicted the reports of Grobes *et al*. (1999) and Garba (2012) who reported that egg shell quality was not affected by dietary energy levels. Egg shell thickness is an important

indicator for reflecting egg shell quality as low shelled-eggs were more prone to have cracks and breakages followed by subsequent microbial contamination.

Yolk index value obtained for Isa White ranges from 0.31–0.43 with the highest values at 2,800 kcal/kg ME diet, Isa Brown ranges from 0.30–0.47 with the highest value in diet with energy level of 2,700 kcal/kg ME diet while that of Black Nera ranges from 0.31–0.44 with the highest value in the diet with energy level of 2,600 kcal/kg ME diet. Yolk colour did not differ at all levels of dietary energy and strains of birds. This is due to the fact that white maize was used as the main ingredient for energy source and the birds were exposed to the same light intensity. Haugh unit (HU) presented better results (69.16%) at high energy level (2,800 kcal/kg ME diet) in Isa White.

Conclusion

According to the results in this study, diet containing 2,800 kcal/kg ME produced better haugh unit in Isa White and Isa Brown whereas diet containing 2,700 kcal/kg ME produced better haugh unit in Black Nera.

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