A COMPARISON OF THE INTERNAL AND EXTERNAL EGG QUALITY CHARACTERISTICS OF THREE STRAINS OF F1 LOCAL TURKEYS REARED IN THE HUMID TROPICS

[1]Ogbuagu, K.P,[3]Obasi, E.N,[1]Abel-Achimugu, J,[1]Itodo, I.J,[2]Yakubu, A,[4]Atteh,A.P.
[1]Department of Animal Science, Federal University of Lafia, Nigeria
[2]Department of Animal Science, Nasarawa State University Shabu-Lafia, Lafia, Nigeria
[3]Department of Animal Breeding and Physiology, Michael Okpara University of Agriculture, Umudike, Nigeria
[4]Department of Agricultural Economics and Extension, Federal University of Lafia, Nigeria
Corresponding Author: e-mail:neneobrown@gmail.com

ABSTRACT

This study was carried out to determine the effect of strain on internal and external egg quality characteristics of three strains of local turkey. A total of Sixty-six (66) adult breeding local turkeys of three phenotypic classes (Black, White and Lavender) were used as a parent population for the mating. Each strain had 18 hens mated to 3 toms. The three strains Black, White and Lavender were used to generate 113, 104 and 182 eggs, respectively collected over a period of 10 weeks. The study was conducted in the Poultry Unit of Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Abia State.Completely Randomized Design (CRD) was used for the experiment with 3 replicates and a mating ratio of 1 tom: 6 hens for each strain.All data collected were subjected to analysis of variance with the Generalized Linear Model (GLM) of the Statistical Procedure of Social Sciences (2010). Significantly different means were separated using Duncan's New Multiple Range Test (Duncan, 1955).The effect of strain was significant (P < 0.05) for most of the traits, except in egg shape index, shell thickness, shell ratio and some of the yolk traits. The Black and White strain had significantly (P < 0.05) higher egg weight, egg length and egg width compared to the Lavender strains. The mean values for egg weight ranged from 57.44 ± 3.12 to 75.47 ± 0.98 for Black, 59.36 ± 1.44 to 75.65 ± 0.08 for White and 56.38 ± 0.58 to 72.81 ± 2.14 for Lavender. The mean values for egg length, ranged from 61.82 ± 1.32 to 65.50 ± 1.34 for Black, 61.85 ± 0.73 to 65.61 ± 3.20 for White and 59.44 ± 0.93 to 63.04 ± 0.74 for Lavender. Egg width values ranged from 40.61 ± 0.51 to 47.60 ± 0.33 for Black, 40.85 ± 0.73 to 47.82 ± 0.41 for White and 40.0. ± 0.24 to 45.63 ± 0.53 for Lavender. The Black and White strain also had significantly (P < 0.05) higher albumen weight, albumen height, albumen index and Haugh unit when compared to its counterpart strain. These significant effectsobserved in the study suggeststhe existence of genetic variation among the local strains. The result therefore indicates that strains significantly influenceinternal and external egg quality characteristics especially egg weight. It is recommended that adequate management and breeding techniques should be maintained during Turkey breeding to enhance increased growth rate in meat and egg production.

Keywords: Local turkey, Strain, Internal &External, Egg quality, Humid Tropics.

1.0 INTRODUCTION

Poultry eggs are of great importance in a balanced and healthy diet. It is important to determine the quality characteristics of eggs, which have both nutritional properties and reproductive material (Aysondu and Ozyurel, 2021).For this reason, in recent years, importance has begun to be given to the quality of eggs and egg products at all stages of the egg industry, from producers

to consumers (Gul *et al*. 2021). Egg quality is generally evaluated in two parts, internal and external quality (Mollazade*et al*. 2021) and it is one of the factors affecting both incubation efficiency and consumer demands (Hisasaga*et al*. 2020). The quality factor plays a significant role in marketing, consumer satisfaction, and the shelf life of table eggs.

Turkey is a carinate (flying bird) of the order (Galiforms)belonging to the family (Meleagrididae), genus (*Meleaagrisgallopavo*) and species (Omole*et al.*, 2006). Olomu (2003) stated that turkeys are raised either for meat or as breeders to produce hatching eggs which in turn are used to produce poults. Turkeys are rarely kept for the production of table eggs, although turkey eggs are edible. Nwachukwu*et al*. (2006) reported that an acceptable level of reproduction is highly desirable in poultry stock. One of such most important economic productive parameters in poultry is egg traits.Haque*et al*. (2001) stated that effective selection and breeding is one of the bases of successful operation in the maintenance of a satisfactory level of production and reproduction. Egg quality refers to those characteristics of an egg which affects its acceptability to consumers (Song *et al*., 2000).

In Nigeria, three varieties of turkey characterized by plumage colour (Black, White and Spotted or Lavender) are predominant (Smith, 1990). These locally-adapted turkeys are good genetic resources for improvement of important economic traits such as production and reproduction performance traits which are the most important traits considered in poultry breeding. Productive and/or reproductive adaptability is a phenomenon where an animal gives acceptable level of production/reproduction in a stressed or local environment (Ibe, 1990). It also indicates the reproductive fitness of the parent stock which has an overall significance for an economic breeding (Metin, 2007; Egahi, *et al*., 2011). Therefore, evaluation of egg quality traits is important for both layer and breeder flocks.Egg quality is an important economic index in commercial egg (Jibir*et al*., 2000). Parmar*et al*., (2006) stated that egg quality is the most important price determinant factor in table eggs. Brain (2005) stated that egg quality traits are of immense importance to the duck breeding industries. Egg quality characteristics are affected by various factors including genetic profile, hen's age, feeding, health, housing, storage, etc (Salahuddin and Howlider, 1991; Hurnik*et al*., 1997). It has been reported that egg quality is a breed characteristic based on significant effect of genotype of layer chickens on egg quality traits (Suto*et al*., 1997). Olawumi and Ogunlade (2009) also reported significant breed effects for egg quality traits in some exotic breeds of chickens.

A significant genotype effect on internal and external egg quality traits of chicken and turkey has been reported (Yasmeen*et al*., 2008 and Isidahomen*et al*., 2014). Metin (2007) also noted that egg composition of the domestic fowl showed high variation due to species, hen's age and breeding environment. Danilov (2000) also noted that the proportion of yolk, albumen and shell that contributed to egg weight increased with hen's age. Roland (1979) observed that both internal and external characteristics of the egg changed significantly with age.Previously, other researchers have evaluated egg quality traits of the chicken (Padhi*et al*., 1998; Yasmeen*et al*., 2008; Olawumi and Ogunlade, 2009). Consequently, there are few reports of studies on assessment of egg quality parameters of other poultry species, including the local turkey strains in Nigeria. Such a study will boost the characterization of the local strains for improvement purposes, since phenotypic variations aid in determining the relative genetic diversity in populations (Adejoro*et al*., 2010).Baykalir and Aslan, (2020) suggested that evaluating the relationships between some external and internal traits for a better understanding of the egg quality parameters. This study was carried out to determine the effect of strain on internal and external egg quality characteristics of F_1local turkey in the humid Tropics.

2.0 MATERIALS AND METHODS

2.1 Location of Study

The study was conducted in the Poultry Unit of Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Abia State. Umudike lies between latitude 05° 29^1 N, longitude 07° 33^1 E and altitude of 122 m above sea level. The town is within the humid rain forest zone of South Eastern Nigeria and has a bimodal rainfall pattern with a total annual rainfall range of 1700mm to 2100mm. The minimum and maximum daily temperatures of the area ranges from 18.6^0 to 23^0C and from 26^0 to 36^0C during the rainy and dry seasons, respectively while the humidity range from 57.0% to 91.0% depending on the season of the year. The climatic data were taken from the meteorological station of the National Root Crops Research Institute, Umudike.

2.2 Experimental Birds and Their Management

A total of Sixty-six(66) adult breeding local turkeys of three phenotypic classes (Black, White and Lavender) were used as a parent population for the mating. Each strain had 18 hens mated to 3 toms. The mating design and total number of eggs used for the study are as shown in Table 1. The three strains – Black, White and Spotted had 113, 104 and 182 eggs, respectively collected over a period of 10 weeks.

Table 1: Mating Scheme and Number of Eggs Produced Per Local Turkey Strain

Mating Type	Number of Hens	Number of Toms	Number of eggs
Black x Black	18	3	113
White x White	18	3	104
Lavender x Lavender	18	3	182
Total	**54**	**12**	**399**

Eighteen (18) freshly laid eggs were collected randomly from each strain and used to evaluate the internal and external quality traits. All the birds were subjected to the same management practices throughout the experimental period. The birds werereared on a deep litter pens andfed ad libitum with a commercial layers diet containing 14% CP and 2850 Kcal/kgME. Water was given regularly.A completely randomized design (CRD) was used for the experiment with 3 replicates and a mating ratio of 1 tom: 6 hens for each strain.
The statistical model for the data is as specified below:

$Y_{ij} = \mu + S_i + e_{ij}$
where,
Y_{ij} = Single observation
μ = Overall mean
S_i = Effect of i_{th} strain
eij = Random error, independently, identically, normally distributed with zero mean and constantvariance {(iind) $0,\sigma^2$}.

2.3 Data Collection and Statistical Analysis

Data were collected on both the external and internal egg characteristics.Measurements of Egg weight was taken with a 0.01g electronic sensitive scale, egg length (longitudinal distance between the narrow and the broad ends), egg width (diameter of the widest cross-sectioned region), egg shape index (%), shell thickness (mm) and shell ratio (%). The internal egg quality traits measured were: yolk height (distance between the ends), yolk width, yolk index (%), albumen length (mm), albumen width (mm), albumen index (%) and Haugh unit. Egg length and width, yolk height and width and albumen height and width were measured with a veniercaliper

sensitive to 0.01 mm. Shell thickness was determined as the average of 3 measurements taken at the pointed end, the equator and the broader end of each egg.

$$\text{Shell thickness (mm)} = \frac{\text{pointed + equator + broad}}{3}$$

Egg shape index, albumen index, yolk index and shell ratio were calculated as percentages.

$$\text{Egg shape index (\%)} = \frac{\text{Egg width}}{\text{Egg length}} \times 100$$

$$\text{Albumen index (\%)} = \frac{\text{Albumen height}}{\text{Albumen width}} \times 100$$

$$\text{Yolk index (\%)} = \frac{\text{Yolk height}}{\text{Yolk weight}} \times 100$$

$$\text{Shell ratio (\%)} = \frac{\text{Shell weight}}{\text{Egg weight}} \times 100$$

Haugh unit was computed as indicated below (Haugh, 1937)

$$\text{Haugh unit} = 100 \log (H + 7.57 - 1.7 W^{-37})$$

Where,
H = observed height of the albumen (mm)
W = weight of the egg (g)
All data collected were subjected to analysis of variance with the Generalized Linear Model (GLM) of the Statistical Procedure of Social Sciences (2006). Significantly different means were separated using Duncan's New Multiple Range Test (Duncan, 1955).

3.0 RESULTS AND DISCUSSION

3.1 Effect of Strain on External Egg Quality Traits

The least square means ± standard errors of mean of egg weight, egg length and egg width of the three local turkey strains from weeks 1 – 10 are presented in Tables 2, 3 and 4, respectively.

Table 2: Means (±SE) of egg weight (g) of the Three Local Turkey Strains (1 – 10 weeks)

	Strain		
Week	Black	White	Lavender
1	57.44 ± 3.12^{b}	59.36 ± 1.44^{a}	56.38 ± 0.58^{b}
2	59.02 ± 7.03^{a}	59.67 ± 4.65^{a}	58.17 ± 2.13^{b}
3	65.44 ± 0.33^{b}	66.51 ± 2.25^{a}	65.60 ± 0.15^{b}
4	68.72 ± 0.51^{a}	68.98 ± 3.60^{a}	66.14 ± 1.24^{b}
5	70.88 ± 0.28^{a}	71.96 ± 1.51^{a}	68.48 ± 3.11^{a}
6	71.90 ± 1.35^{a}	72.20 ± 2.20^{a}	69.16 ± 0.42^{b}
7	72.41 ± 0.21^{a}	73.10 ± 2.33^{a}	69.88 ± 0.87^{b}
8	73.10 ± 0.32^{a}	73.89 ± 1.54^{a}	70.21 ± 0.82^{b}
974.21 ± 1.33^{a}	74.63 ± 0.88^{a}	71.56 ± 1.35^{b}	
1075.47 ± 0.98^{a}	75.65 ± 0.18^{a}	72.81 ± 2.14^{b}	

[a-b] Means with different superscripts in the same row are significantly different (P =.05).
SE = standard error of mean.

Significant ($P < 0.05$) strain effect was observed for these traits in the various weeks. The Black and White strain had significantly highest values for egg weight in all the weeks compared to itsLavenderstrain counterpart. Significant differences ($P < 0.05$) were seen in from weeks 1 to 10 with the Black and White strains having significantly higher values than its Lavender strain

counterpart for egg length. Consequently, egg width showed significant differences in all the weeks with the White and Black strains having slight higher values compared to its Lavender straincounterpart.

The result of this study as seen in (Table 2) indicates significant difference ($P < 0.05$) of egg weight among the three strains in all the weeks. Egg weight variations in different genetic groups were reported by other authors (Yamak, 2020, Sun *et al*., 2019, Padhi*et al*., 1998; Chatterjee*et al*., 2007; Isidahomen*et al*., 2014).

Pandey*et al*. (1986) reported that egg weight is a direct proportion of the albumen, yolk and shell and that it varies significantly between strains of hen. In general, the egg of the Black and White strains weighed highest compared to the Lavender strains. The values recorded in this study is comparable with values reported for local (65.85 ± 0.87) and crossbred (70.98 ± 0.92) turkeys (Isidahomen*et al*., 2014). However, the values were below 76.10 ± 1.71 and 85g documented for Indian and exotic turkeys (Majood*et al*., 2004; Isidahomen*et al*., 2014), respectively. The effect of strain on egg length (Table 3) and egg width (Table 4) were also significantly ($P< 0.05$) from each other also in all the weeks.

Genotypic differences with regards to egg length and egg width have been reported for chicken (Anderson *et al*., 2004) and turkey (Yamak, 2020, Isidahomen*et al*., 2014). Egg length and width are important traits with respect to mechanical handling of eggs. The values of both traits noted in this study are slightly higher compared to reports of Anderson *et al*. (2004) for chicken (49.00 – 69.98 mm and 38.49 – 48.99 mm) and turkey (5. 85 – 6.27 cm and 4.04 – 4.32 cm) eggs, respectively.

Within the strains, the values of egg weight, length and width increased with increase in age (weeks). This is in agreement with the findings of Yamak, 2020, Sun *et al*., 2019, Yannakopoulos and Tserveni (1986), Hurnik*et al*. (1997) and Fikret*et al*. (2010) who observed that egg weight increased significantly with quail, chicken and pheasant age.

Table 3: Means (±SE) of Egg Length (mm) of the Three Local Turkey Strains (1–10weeks)

	Strain		
Week	Black	White	Lavender
1	61.82 ± 1.32^{a}	61.85 ± 0.73^{a}	59.44 ± 0.93^{b}
2	61.91 ± 0.30^{a}	61.95 ± 1.56^{a}	60.80 ± 1.30^{b}
3	62.35 ± 0.51^{a}	62.38 ± 0.64^{a}	60.95 ± 0.18^{b}
4	62.86 ± 0.51^{a}	62.88 ± 0.81^{a}	61.63 ± 0.71^{b}
5	62.93 ± 0.41^{a}	62.95 ± 0.38^{a}	61.35 ± 0.91^{b}
6	63.32 ± 0.85^{a}	63.55 ± 0.80^{a}	62.03 ± 0.94^{a}
7	63.78 ± 0.72^{a}	63.98 ± 0.33^{a}	62.48 ± 0.71^{b}
8	64.28 ± 0.44^{a}	64.43 ± 0.52^{a}	62.71 ± 0.56^{b}
9	64.73 ± 0.35^{a}	64.85 ± 0.43^{a}	62.94 ± 0.73^{b}
10	65.52 ± 1.34^{a}	65.61 ± 3.20^{a}	63.04 ± 0.74^{b}

[a-c] Means with different superscripts in the same row are significantly different (P =.05).
SE = standard error of mean.

Table 4: Means (±SE) of Egg Width (mm) of the Three Local Turkey Strains (1–10 Weeks)

	Strain		
Week	Black	White	Lavender
1	40.61 ± 0.51[a]	40.85 ± 0.73[a]	40.03 ± 0.24[a]
2	42.54 ± 0.37[a]	42.61 ± 0.44[a]	41.50 ± 0.60[b]
3	42.77± 0.17[a]	42.90 ± 0.51[a]	41.52 ± 0.72[b]
4	42.61 ± 0.92[a]	42.74 ± 0.63[a]	41.83 ± 0.33[b]
5	43.55 ± 0.72[a]	43.79 ± 0.15[a]	42.06 ± 0.81[b]
6	43.91± 0.39[a]	43.95 ± 0.22[a]	42.50 ± 0.54[b]
7	44.54 ± 0.83[a]	44.81 ± 0.66[a]	43.03 ± 0.29[b]
8	45.95 ± 0.44[a]	45.98 ± 0.18[a]	43.48 ± 0.55[b]
9 46.54 ± 1.68[a]		46.74 ±0.33[a] 44.61 ± 0.73[b]	
1047.60 ± 0.33[a]47.82 ±0.03[a]		45.63 ± 0.58[b]	

[a-b] Means with different superscripts in the same row are significantly different (P =.05).
SE = standard error of mean.

3.2 Effect of Strain on Shape Index, Shell and Internal Egg Quality Characteristics

Least square means and standard errors of means for average egg shape index, egg shell and internal egg quality traits of the three local turkey strains are shown in Table 5. Significant ($P < 0.05$) strain effect was observed only for albumen width, albumen height, albumen index and Haugh unit.

The Black and Whitestrain also recorded significantly ($P < 0.05$) highest values for these traits. Although no significant strain effect was observed except forHaugh unit where the Black strain showed significantly ($P < 0.05$) highest value compared to the White and Lavender strain counterpart.Summarily, the Black and White strainrecorded numerically higher values than the Lavender strain for egg shape index, shell ratio, shell thickness, yolk width, yolk height and yolk index, albumen width, albumen height, albumen index and Haugh unit compared to the Lavender strains. It has been reported that a Haugh unit of 90 and above is considered excellent depending on the breed type (USDA, 2012).

Table 5: Means (±SE) of Internal and Egg Shellquality traits of the three local turkey strains (1–10 weeks)

	Strains		
Trait	Black	White	Lavender
YW (mm)	44.30 ± 0.22[a]	44.53 ± 0.80[a]	42.97 ± 0.25[a]
YH (mm)	18.23 ± 0.91[a]	17.66 ± 0.48[a]	17.12 ± 1.36[a]
YI (%)	40.12 ± 0.32[a]	40.05 ± 1.51[a]	39.55 ± 0.81[a]
AW (mm)	89.62 ± 1.08[a]	88.96 ± 0.54[a]	85.33 ± 1.30[a]
AH (mm)	8.30 ± 0.47[a]	8.45 ± 0.35[a]	6.88 ± 0.30[a]
AI (%)	8.55 ± 0.23[a]	8.41 ± 1.05[a]	7.41 ± 0.83[a]
HU	97.54 ± 0.41[a]	96.61 ± 0.83[b]	95.88 ± 0.54[c]
ST (mm)	0.82 ± 0.05[a]	0.83 ± 0.06[a]	0.82 ± 0.02[a]
SR (%)	11.05 ± 0.41[a]	11.08 ± 0.42[a]	10.74 ± 0.24[a]
ESI (%)	71.65 ± 0.83[a]	71.73 ± 0.31[a]	70.55 ± 0.92[a]

[a-c] Means with different superscripts in the same row are significantly different (P =.05).
SE = standard error of mean. YW = yolk width, YH = yolk height, YI = yolk index, AW = albumen weight, AH = albumen height, AI = albumen index, HU = haugh unit, ST = shell thickness, SR = shell ratio, ESI = egg shape index.

The Haugh unit obtained in this study ranged between 95.88 ± 0.54 and 97.54 ± 0.38. The result of this study is in line with the report of Wang *et al*. (2009) who noted mean value range of 99.15 – 102.64 for chicken eggs. Fikret*et al*. (2010) gave values of 95.27 and 90.38 for one and two year old pheasant eggs. North (1984) reported that the higher value is an indication of eggs with better albumen quality.

Egg shape index (%), shell ratio (%) and shell thickness (mm) did not vary significantly (P > 0.05) among the three strains. This result is in contrast with the work of Fikret*et al*. (2010) and Isidahomen*et al*. (2014) who reported significant differences for shape index and shell thickness in pheasants and turkeys, respectively. However, it agreed with the report of Obike*et al*. (2011) who observed no significant difference for egg shape index and shell thickness between the Black and Pearl strains of guinea fowl. Although not significantly (P > 0.05) different, the high values obtained for these traits may indicate high shell strength of eggs of the strains which could aid good hatchability and resistance to fracture. Hunto (1995) reported that the ability of eggs to resist fracture damage depends on shell structure and shape.

Shape index was reported to have a significant effect on the variation of crushing strength (Richards and Staley, 1967). Eggs of normal shape have been reported to hatch better than those that are abnormally shaped (Narushin and Romanov, 2002). Shell ratio values ranged from 10.74 ± 0.24 to 11.05 ± 0.41, which indicates high shell stiffness. These values are in line with the report (10.81 %) of Egahi*et al*. (2011). Abdallah*et al*. (1993) reported that shell ratio is a more sensitive estimate of shell quality traits. It was reported that percentage of shell is related to total egg weight, with larger eggs frequently having proportionately less shell (Metin, 2007).

Yolk parameters (height, width and index) did not also differ significantly (P > 0.05) among the strains. This is similar to the observations of Sun *et al*2019, Yamak, 2020, Hisasaga*et al*., 2020,Obike*et al*. (2011) and Hayirhi*et al*. (2005) but disagrees with that of Isidahomen*et al*. (2014). The yolk index values obtained in this study fell within the standard range of 33.0 – 50.0 mm reported for fresh eggs (Gul*et al*., 2021 Sun *et al*2019, Yamak, 2020, Hisasaga*et al*., 2020,Obike*et al*. (2011) and Hayirhi*et al*. (2005) and Ihekoronye and Ngoddy, 1985). It then implies that the eggs of these strains could have appreciable hatchability since yolk index determines an egg's freshness and large index makes for good hatchability.

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The significant strain effect recorded for egg weight, egg length, egg width, albumen weight, albumen height, albumen index and Haugh unit is indicative of the existence of genetic variations among the local turkey breeds. Due to these significant traits observed, the Black and White strain had significantly highest values from all the weeks studied for egg weight, egg length and egg width compared to its Lavender strain counterpart. The White and Black strain also had higher numerical values for the non-significant traits – egg shape index, shell ratio, shell thickness, yolk weight, yolk height and yolk index, when compared to Lavender strains. This implies that the Black and White strain may be best suited for improvement of internal and external egg quality traits of local turkeys in the study zone.

4.2 Recommendations

Adequate management and breeding techniques should be maintained during Turkey breeding to enhance increased growth rate in meat and egg productivity. More awareness and extension programmes should be organized by Animal Breeder/Geneticists and Extension Officers to educate theFarmers especially on advantages of advanced crossbreeding and mechanized hatching in Turkey in other to reduce many losses in egg handling, improve hatchability and generally improve protein food supply in the country.

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