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Comparative Analysis of Fertile Egg Quality Traits in Exotic, two Nigerian Ecotype Chickens and their Crosses.

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Target Audience: *Academics, Researchers and Farmers*

Abstract

The study evaluated the effect of Strains on External and Internal quality traits of egg produced by Exotic breed (Sussex), two Nigerian chicken breeds (naked neck (NK) and Normal feathered (NM)) and their crosses (Sussex x naked neck (SNK) and Sussex x normal feathered (SNM) in a battery cage system and designed in a Completely Randomized Design. Total population of 100 matured birds (36 hens per Nigerian ecotype and 25 hens of exotic breed with one cock per ecotype and breed).Thirty freshly laid egg per day per strain were cracked for External and internal parameters: - egg weight (EW), egg length (EL), egg width (ED), shell weight (SW), egg shell index (ESI), shell ratio (SR), yolk height (YH), yolk index (YI), albumen weight (AW), albumen ratio (AR), albumen height (AH) yolk ratio (YR) and Haugh unit (HU) for the 10 weeks study. Data collected were subjected to one-way Analysis of Variance. Results obtained indicated a significant ($P<0.05$) effect of strains on most internal and external egg parameters in this study. The crossbred and pure indigenous chickens had means statistically ($P < 0.05$) lower for all the traits than that of pure Sussex except for SI, YH, YI, AR, YW and AR. The ranges for the traits are EW (42.30-55.55), SR (9.98-12.4), ED (34.40-42.29), EL (47.73-56.60), ESI (72.07-78.79), SW (4.34-6.90), AW (23.30-30.65) and AH (3.62-6.50). Eggs of Crossbreds had higher values than eggs of pure indigenous strains in all the external egg parameters exception of EW. Hence, crossbreeding should be adopted for the improvement of egg quality traits.

Key words: Exotic chicken breed; Indigenous chickens; Crossbred chickens; Egg traits.

Description of Problem

The rapid increase in population in Nigeria has led to a relatively high demand for protein in our daily diets. The avian egg is excellent sources of proteins which is widely needed and are acceptable by human for consumption. Meats and eggs gotten from local hens are available in smaller sizes and quantities which could not meet the demand of the populace. Chickens are good source of animal protein and income yielding through Meats and eggs production (1). Despite these attributes, the productivity of indigenous chicken is low when compared to the exotic chickens. Therefore, there is pressing need to improve our indigenous birds and this starts from the improvement of the eggs through cross breeding with Exotic breeds of chicken. The knowledge of the structure of egg and its various parameters are essential for the understanding of egg quality, fertility, embryo development, chicks' production and disease of poultry. The egg quality is influenced by both genetic and environmental factors; hens laying substandard eggs should be culled besides the management of the hens can help in improving the quality of eggs (2). Eggs of unnatural shape and of poor shell quality too are not desired, as such eggs usually have poor hatchability and even if the chicks hatch out they rarely survive or grow well (3). Egg length varies across genotypes and also influenced by non- genetic factors (4). One of the main factor that affect subsequent productivity of layer and broiler chicken is egg weight (5). Economically, important egg quality traits such as egg weight, size, yolk and albumen content are quantitative traits with continuous variability. It is obvious that beneficial egg quality traits which according to (6) referred to the characteristics of egg affect its acceptability to breeding industries (7). In addition, embryonic development of hen’s egg is dependent on traits like egg weight, yolk and albumen weights, genetic line and age of the hen (8).

The general performance of the local breed compared with the exotic is generally low. This situation could however be changed if the local chickens are suitable for the development of layer strain for the tropical environment (9). This is because they possess some inherent advantages which include good fertility and hatchability, better flavour of meat and egg, high degree of adaptability to prevailing conditions, high genetic variance in their performance, hardiness, diseases tolerance, ease of rearing and ability to breed naturally (10). Moreover, the low genetic potential of local chickens could be improved substantially through crossbreeding programmes with exotic chicken breeds (11). Due to its great potentials for genetic breeding programme such as selection and crossbreeding (10) and provisions of better nutrition, housing and disease control. Crossbreeding of the local stock with an exotic commercial stock could take advantage of artificial selection for hardiness in the indigenous chicken (12). Moreover, chickens with better production performance can result from the combining ability of best performing exotic lines and the indigenous chicken.

The external and internal quality traits of eggs in hen have significant effect on hatchability of incubated and fertile eggs (13) as well as the weight and development of the embryo. Exploring the potential of the indigenous naked neck and normal feather fowl through crossbreeding will not only lead to improvement of these local strains of chicken but reduce the cost of importation of day old chicks and breeder stock which are costly to manage, especially in Nigeria. Genetic improvement can take many forms but it must follow an ordered hierarchy of events which starts from understanding of production and marketing system, choice of appropriate breed or stains that sometimes lead to replacements of existing breeds. It can also lead to establishment of an effective pure breeding and cross breeding systems and further improvement through selection of superior genotypes within populations that best suits the production and marketing conditions (14). This study therefore is to evaluate the external and internal egg quality traits of exotic and their crosses with Nigerian indigenous strains of chickens as well as the pure line of the Nigerian indigenous chicken.

Materials and Methods

The experiment was conducted in the poultry unit of the Teaching and Research farm of the Department of Animal Science, Faculty of Agriculture, University of Uyo, Uyo of Akwa Ibom. It is located in the coastal southern part of the country, lying between latitude 4^0 32'N and 5^0 33'N, and longitudes $7^0$25'E and $8^0$25E. An annual rainfall which ranges from 800 mm to 3200 mm, begins in March and continue till October. Dry season in Uyo is from November and lasts till February while annual temperature varies between 26 °C – 28 °C. Its topography is gentle slope with a sandy loam soil and a soil pH of 4.5 - 6.5 (15).

Chickens used for the egg production were Purebred of Exotic breed (Sussex cock x

Sussex hen (SS) as a Control), pure Nigerian indigenous chicken strains (naked neck x naked neck (NK) and Normal feathered x Normal feathered (NM)) and Crossbreds were Sussex cock x normal feathered hen (SNM) and Sussex cock x naked neck hen (SNK)) through Artificial Insemination technique. 25 Exotic breed hens and one cock was purchased from Songhai farms in Port Harcourt and the two Nigerian indigenous chicken strains (matured Cocks (2) and hens (36 per strain)) were purchased from Itam market in Uyo at matured age of 16 weeks. The experimental birds were reared for a period of 2 weeks for acclimatization while semen collection started from the 3rd week. Fertile eggs were evaluated by candling through fluorescence tube.

Table 1: Effect of strain on external parameter of the eggs

Parameters	N	SS	NM	NK	SNK	SNM
Egg weight (g)	30	55.55±0.92^{a}	42.30±1.12^{b}	44.36±0.88^{b}	44.90±1.34^{b}	45.35±0.98^{b}
Egg width (mm)	30	42.29±0.03^{a}	36.67±0.08^{c}	34.40±0.04^{b}	39.98±0.04^{b}	39.91±0.49^{b}
Egg length(mm)	30	56.60±0.04^{a}	47.73±0.08^{d}	50.08±0.05^{c}	52.28±0.09^{b}	53.39±0.06^{b}
Shell weight (g)	30	6.90±0.16^{a}	4.34±0.12^{b}	4.47±0.11^{b}	4.45±0.15^{b}	4.50±0.14^{b}
Shape index (%)	40	76.50±0.60^{ab}	76.97±1.57^{ab}	78.79±0.78^{a}	72.07±3.83^{b}	72.61±1.10^{b}
Shell ratio (%)	40	12.43±0.22^{a}	9.98±0.32^{b}	10.10±0.20^{b}	10.67±0.46^{b}	10.64±0.23^{b}

$^{a, b =}$ means with different letters in the superscript within the row shows significant difference. N=Number of eggs, SS=Sussex x Sussex, NM=Normal x Normal feathered, NK=Naked x Naked neck, SNK=Sussex x Naked neck, SNM=Sussex x Normal feathered.

Table 2: Effect of Strain on the Internal Parameter of the Eggs

Parameters	N	SS	NM	NK	SNK	SNM
Yolk height (mm)	20	16.67±0.03^{a}	13.36±0.11^{c}	14.40±0.02^{bc}	14.48±0.03^{a}	15.25±0.03^{ab}
Yolk width (mm)	20	42.22±0.04^{b}	42.21±0.11^{b}	39.07±0.07^{c}	45.15±0.06^{a}	39.77±0.07^{c}
Albumen height (mm)	20	6.50±0.03^{a}	5.50±0.03^{b}	4.19±0.01^{c}	3.62±0.01^{c}	4.39±0.02^{b}
Albumen width (mm)	20	20.84±0.68^{a}	17.04±0.66^{c}	18.51±0.41^{bc}	19.36±0.60^{ab}	18.26±0.52^{bc}
Yolk weight (g)	20	17.75±0.39^{a}	17.15±0.30^{a}	14.95±0.32^{b}	15.50±0.52^{b}	13.81±0.42^{c}
Yolk index (%)	20	39.56±0.80^{a}	32.94±2.94^{b}	40.67±1.30^{a}	31.04±0.50^{b}	39.29±1.09^{a}
Albumen weight (g)	20	30.65±0.69^{a}	23.70±1.04^{b}	24.95±0.58^{b}	23.30±1.37^{b}	23.83±0.67^{b}
Albumen ratio (%)	20	55.16±0.75^{a}	51.81±1.21^{b}	56.14±0.50^{a}	52.11±2.42^{b}	56.73±0.43^{a}
Yolk ratio (%)	20	32.03±0.60^{c}	38.21±1.13^{a}	33.67±0.49^{bc}	35.56±0.97^{b}	32.78±0.37^{c}
Haugh unit (%)	20	80.73±2.00^{a}	79.79±1.18^{a}	74.07±1.02^{b}	63.32±1.17^{c}	74.12±1.18^{b}

N=Number of eggs, SS=Sussex x Sussex, NM=Normal x Normal feathered, NK=Naked x Naked neck, SNK=Sussex x Naked neck, SNM=Sussex x Normal feathered

Management of Experimental Chickens

The experimental birds were subjected to the same management practices in an intensive management system with each bird in a separate cell in the battery cage pen. The experimental birds were given both feed and water *ad libitum.* The layer mash contained 16% crude protein, 2800 Cal/Kg Metabolizeable Energy. During the egg production period, 30 eggs per strain per day were collected and the freshly collected eggs were cracked to measure for both external and internal egg parameters throughout the study period of 10 weeks of the research.

Data Collection

During the egg production period, 30 eggs per strain per day were collected which were labeled according to their Sire strain and the freshly collected eggs were cracked and analyzed for external and internal egg parameters throughout the study period of 10 weeks of the research in the Animal Science Laboratory.

Measurement of External Egg Parameter

External egg parameters measured were: - Egg weight (EW), Egg length (EL) (along the longitudinal axis), egg width (ED) along the equatorial axis), eggshell weight (SW), shell ratio (SR) and Eggshape index (SI) which was calculated as the ratio of egg width to length (%) by the method of (17).

Measurement of the Internal Egg Parameter

Internal egg parameters measured were: - albumen weight (AW), albumen width (AD), albumen height (AH), yolk weight (YW), yolk height (YH), yolk width (YD), yolk index (YI) and Haugh unit (Hu).

Internal components were obtained by carefully breaking open around the posterior end of the egg, large enough to allow free passage of both the albumen and the yolk through it without mixing their content. The content (yolk and albumen) were poured on a transparent flat glass plate of dimension 45cm x 40cm. Yolk weight was gotten by carefully separating the yolk into a cup and then weighed on an electronic scale and recorded in grams. Yolk and albumen width, yolk and albumen height were measured using a venire caliper and micrometer. Yolk weight with 0.01 g accuracy was determined using the laboratory electronic scale and its percentage proportion was calculated. Yolk index (%) was measured on the basis of the ratio of the yolk height (mm) to the yolk width (mm) by (18) and (19) using micrometer with 0.01mm accuracy.

After the eggs were broken and emptied the internal contents. Each egg shell was then washed with water and oven dried in order to clean off any remaining albumen. Following this procedure, shell weight with membrane was measured using Sensitive electronic scale and recorded in grams and the percentage proportion of the shell in the egg was determined by using the equation according to (20).

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

Albumen weight was calculated as the difference between the egg weight, the yolk and shell weight. The percentage proportion of albumen in the (egg Albumen ratio (%)) was computed with this formula:

$$\frac{\text{Albumen weight}}{\text{Egg weight}} \times 100$$

Albumen index (%) was determined by the method of (21) on the basis of the ratio of the thick albumen height (mm) measurement taken with a micrometer to the average of width (mm) and length (mm) of this albumen with 0.01mm accuracy. Yolk weight with 0.01 g accuracy was determined using the laboratory sensitive scale and its percentage proportion was calculated. Yolk index (%) was measured on the basis of the ratio of the yolk height (mm) to the yolk width (mm) using venire caliper/ micrometer with 0.01mm accuracy (18, 19). The following measurement of egg quality traits were calculated as:-

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

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

Haugh unit was determined according to the formula of (22).

$Hu = 100 \log (h + 7.5 - 1.7w^{0.37})$ where,

H=height of the thick albumen in mm

W=weight of the eggs in grams

Statistical Analysis

The evaluated variables were subjected to Analysis of variance (ANOVA) using SAS Statistical Software package (23). Means were separated using Duncan's Multiple Range Test at the Probability level of 0.05%.

Statistical Model :

$\gamma_{ij} = \mu + G_i + \varepsilon_{ij}$

γ_{ij} = observation of the i^{th} Strain in j^{th} chicken

μ = population mean

G_i = effect of the i^{th} treatment

ε_{ij} =Random residual error

Results and Discussion

Effect of Strain on External Egg Parameters

The results of the analysis of variance in Table 1 revealed that strain significantly ($p<0.05$) affected all the external egg parameters measured in this study. Egg weight of Sussex (SS) was the highest with mean of 55.55 ± 0.92 g followed by eggs of crossbreds of Sussex x Normal feathered (SNM) (45.35±0.98 g) next by Sussex naked neck (SNK) (44.90 ± 1.34g) while purebred of NK had the mean of 44.36 ± 0.88g and Normal Feathered eggs had mean of 42.30±1.12 g. The eggs of crosses showed values higher than eggs of indigenous pure bred strains of chicken which agrees with (4) that crossing exotic with indigenous improves the indigenous traits. In this study exotic had the highest mean egg weight and this agrees with the findings of (24). Generally, exotic breed eggs are heavier than indigenous breed eggs (25). However, the variation might be attributed to some factors as stated by (26) that the egg size is influenced by hen's breed, genetic factors, and age of laying hen, season, climatic conditions, nutrition, egg account in series and individuality of laying hens. Eggs width of Sussex was the widest with (42.29 ± 0.03 mm) followed by SNK cross, SNM and NM chickens strain with the mean of 39.98 ± 0.04 mm, 39.91± 0.49 mm, 36.67± 0.08 mm, respectively while NK strain was 34.40 ± 0.04 mm. However, SS egg width was statistically ($P<0.05$) different from all other strains measured in this study. However, the variations observed in the egg width might be attributed to some factors as stated by (26) that the egg size is influenced by hen's breed, genetic factors, age of laying hen, season, climatic conditions, nutrition, egg account in series and individuality of laying hens. The mean egg length observed in this study are Sussex (56.60±0.04 mm), SNM (53.39 ± 0.06 mm), SNK (52.28 ± 0.09 mm), NK (50.08±0.05 mm) and NM (44.73 ± 0.08 mm). The trend observed showed that eggs of crosses had mean egg length values closer to that of SS while the two Nigerian indigenous strains were the least. These agree with the observation of (2,27) who reported on different agro-ecology of Amhara, from lowland area of Western zone of Tigray, on egg length values to be 51.30 and 53.80 mm, respectively. The results are in line with the result of (29, 28, 30, 11, 31). Sussex (SS) had the heaviest mean egg shell weight of 6.90 ± 0.16 g followed by eggs of Sussex x Normal feathered (4.50±0.14g), pure naked neck (4.47±0.11g), Sussex x naked neck (4.45±0.15g) and pure normal feathered cross (4.34 ± 0.12g). Sussex had the heaviest egg shell weight and was statistically ($P<0.05$) highest among all other strains. The results are in agreement with the observation of (26).

The result obtained for egg shape index showed that Naked neck pure strain had the highest mean (78.79 ± 0.78 %), followed by the Normal feathered pure strain (76.97 ± 1.57 %) and Sussex (76.50 ± 1.57 %) while SNK and SNM were the least with 72.07±3.83 % and 72.61±1.10 %, respectively. The results obtained in this study are higher than the values obtained by (26) who recorded lower values of 75.71 ± 0.90% and 74.96 ± 0.36% for Oravka and RIR breeds, respectively. The variations in the egg shape index could be attributed to the genetic constitution of the chicken (31). The shell ratio among the strains varied significantly ($p<0.05$). Sussex had the highest mean value of 12.43 ± 0.22%, followed by the crossbreds of SNK (10.67 ± 0.46 %), SNM (10.64 ± 0.23 %) and Nigerian indigenous purebred strains, NK (10.10 ± 0.20 %) and NM (9.98±0.32 %). The results are in agreement with the observations of (26) who observed 9.98 ± 0.10% and 10.83 ± 0.16% values for egg shape index in Oravka and RIR breeds. The highest mean value of egg shell index in this study is in accordance with (20) who observed significant breed effect for egg quality traits in exotic breeds of the chickens.

Effect of Strain on Internal Egg Parameters

Strains significantly ($p <0.05$) affected all the internal parameters as showed in Table 2. Yolk height was highest in Sussex (16.67±0.03 mm) and least in NM chickens strain (13.36 ± 0.11 mm.) while the crossbred values fell in-between. This is in agreement with the findings of (4, 27) who recorded higher yolk heights in exotic breeds, followed by the crosses and lastly the local breeds in his studies on egg quality. However, this is not in agreement with the observation of (26). Sussex albumin weight (30.65±0.69 g) was statistically ($P<0.05$) difference from every other strain in this study. The mean values obtained for both crossbreds and pure indigenous were statistically ($p>0.05$) similar. The weight of albumen obtained in this study is lower than that observed in Oravka breed (34.96 ± 0.58 g) and Rhode Island Red breed (32.78 ± 0.73 g) (26).

Sussex had the highest albumen height (6.50±0.03mm), which was significantly ($P<0.05$) higher than every other strains in this study. Albumen heights of NM (5.50±0.03mm) and SNM (4.39±0.02 mm) were next and were statistically ($P < 0.05$) higher than the NK and SNK. The existing difference between strains is in accordance with the findings of (32) which observed significant differences for albumen height and yolk width in the Nigerian indigenous naked neck and Normal feathered. The observations also agree with the findings of (27, 30, 33, 34, 2). Albumen width of SS breed (20.84±0.68 mm) and SNK strain (19.36±0.60 mm) were statistically ($P > 0.05$) similar but significantly ($P < 0.05$) different from albumens of NK, SNM and NM strains measured. The higher values seen in NK and SNK could be due to the naked neck gene present in the eggs combined with the exotic gene. The albumen ratios of SNK, NK strains and Sussex breed were statistically ($p>0.05$) similar but significantly ($P<0.05$) different from the SNM and NM strains. This is in agreement with (26) who observed the mean albumen ratio of exotic (RIR) to be 56.74 ± 0.59 % which is statistically similar to that observed in Sussex breed (55.16±0.75 %) of this study.

The yolk heights Sussex breed and NM strains were statistically ($p>0.05$) similar but significantly ($p>0.05$) different from SNK, NK and SNM strains of this study. This result agrees with the observation of (32) who reported significant differences for the yolk weight and other egg quality traits. Yolk weight in this study ranged between 13.81 g and 11.75±0.39 g corresponds with the findings of (38) whose result revealed 14.72g as yolk weight for NK and 14.20g for (NF) which were within the range of this result. Yolk width of SS and NM were statistically ($P > 0.05$) similar but significantly different from SNM and NK strains. The yolk width values observed is not in line with the report of (2) who reported the value of yolk width of 36.80±0.175 mm. The values in this study are higher than those reported in a study of (30) (37.1 mm and 37.5 mm) in Fayoumi-crosses and Rhode Island Red chicken reared at Gurage zone breeds, respectively. Report by (37) for yolk width of the White Leghorn chickens (44.72±0.11 mm) were within the range of the yolk width obtained in this study.

The yolk index of NK (40.67±1.30%), SS (39.56±0.80%) and SNM (39.29±1.09%)

were statistically higher than that of NM and SNK strains. The value of yolk index for NK obtained in this result is higher than those reported by (39) but lower than the value reported by (40). The yolk ratio of NM strain was significantly ($p<0.05$) higher than all other strains measured in this study. Yolk ratio of SNK and NK were statistically ($p<0.05$) higher than those recorded in SNM and exotic SS which came least. The values obtained in this study for yolk ratio agree with the report of (29) who observed strain differences among egg yolk ratios. The values obtained for yolk ratio in this study is in consonance with the reports of (26). The Haught units of Sussex breed (80.73±2.00 %) and NM (79.79±1.18 %) train were significantly ($p<0.05$) higher than other strains measured. SNM (74.12±1.18 %) and NK strains (74.07±1.02 %) were statistically higher than SNK strain (63.32±1.17 %.) which was the least. The lower value of the SNK could be attributed to the lower value in albumen height of the strain as it was observed in this study. The Haugh units observed in this study for SS, NM, SNM, and NK strains of Chickens were within the range of 74 % to 80 % which is in consonance with the work of (37) who observed that from 70 percent above, Haugh unit shows higher quality of that egg.

Conclusions and Applications

In this study, it could be concluded that:

1. The Haugh unit, a very important albumen indicator for internal egg quality showed that Normal X Normal feather, Naked X Naked neck and Sussex X Normal feather performed better compared to the Sussex strain.
2. Albumen ratio was highest in Sussex cross compared to pure Sussex and the indigenous chickens.
3. The egg weight of the crosses was better than that of pure indigenous chickens.
4. Sussex breed can be used to improved Nigerian indigenous chicken for egg weight which will in turn improves the quality of progeny from the egg.

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