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Egg quality parameters and blood biochemical profile of six strains of poultry under extensive management system in Nigerian savanna

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***Target audience**: Smallholder poultry farmers, Poultry Scientists, Egg dealers, retailers and consumers and Extension agents.*

Abstract

Six different poultry strains (Indigenous chicken, Broiler, Turkey, Geese, Duck and Guinea fowl) were studied under extensive system of management to investigate the effect of rearing system on their egg quality and the blood biochemical profile, respectively. Birds used for the study were obtained from four different locations (Zangon Shanu, Bomo, Samaru and Kurmin Bomo) in Sabon Gari Local Government Area. Eighteen (18) birds were randomly selected from the flock with three birds (3) per strain as replicates. Three eggs were collected daily per replicate for the determination of external and internal egg quality parameters. Blood samples (2ml) were collected from the same birds at the end of the laying phase for the determination of blood biochemical profile, haematological parameters and cholesterol levels. Data collected was analyzed using the General Linear Model of the SAS (2002) Software. Significant means were separated using the Duncan Multiple Range Test (DMRT). Results obtained from the study showed that the geese had significant ($P<0.05$) better external and internal egg parameters for most of the parameters, while indigenous chicken and broiler had the least results for external and internal egg parameters, respectively. The results of haematological parameters showed that all the parameters measured were significantly ($P<0.05$) different amongst the strains. However, the monocytes, eosinophiles and bands were not significantly ($P>0.05$) different from each other. Hence, it was concluded that management system had effect on egg quality parameters and blood biochemical profile in poultry strains raised under extensive management system in Nigeria.

Keywords: *Chicken, egg, indigenous, management, Nigeria, strain.*

Description of Problem

The poultry industry is a versatile business in Nigeria (1) and it is one area of animal production with significant contribution to human food production in egg and meat. Poultry products provide protein of high biological value (2). Nigeria is endowed with many poultry species which are indigenous to the country which includes: the domestic fowl, pheasant, quail, guinea fowl, pigeon, turkey, goose and Muscovy ducks (3). These have lived, adapted and reproduced for several years in the Nigeria environment. Food and Agriculture Organization (4) estimated poultry population in Nigeria to be about 33million.

With the ever growing population and improvement in the living standard of Nigerians, the demand for egg and other poultry products will continue to grow. As this increase continues, the quality of food stuff produced by poultry and other

agricultural animals becomes increasingly important with growing consumer awareness for healthy aspect of food which includes not only pathogens or trace of contaminations but also the compositions and nutritional values of the products (5).

The egg is the only complete food material that natures knows because of its nutritive quality for both man and for the transformation of a fertile egg into a living organism making it a perfect biological composition (6). As a complete food, eggs are inexpensive and low calorie source of nutrients such as folate, riboflavin, selenium, choline vitamin-12 and vitamin A, K and D. The lipid matrix of the egg yolk serves to enhance the bio-availability of nutrients such as lutein and zeaxanthin (7).

The physiology and chemistry of blood were used as indicators for various diseases in birds (8, 9) however; these values were affected by different factors such as nutrition, age and sex (10, 11). Caution could be taken, as uric acid is the catabolic end product of proteins in birds not blood urea nitrogen as in case of mammals. Uric acid in mammals represents the metabolic end product of nucleic acids. Therefore, appropriate explanation of these parameters used in avian medicine is of great importance (8). In many species of birds, normal values for biochemical factors were measured and a comprehensive database was established as their blood profiles (12). However, there are no sufficient information's about the egg cholesterol levels and blood biochemical profile of the six poultry species.

In Nigeria, more emphasis is laid on the production and importance of domestic fowl to the neglect of other classes of poultry species like the pheasant, quail, guinea fowl, pigeon, turkey, goose and Muscovy ducks. As a result, domestic fowl constitutes 91% while guinea fowl, duck, turkey and others constitute 4, 3 and 2%, respectively (13). There are no any social or religious stigmas attached to the use of poultry meat in human diet. Hence the demand is high for live birds from local markets either for home consumption or as gifts at the time of festivities such as Christmas, New Year, Easter, Id El-Fitri, etc. Restaurants, hotels and supermarkets in Nigeria are noted for fast food business that involves the sale of products like chicken burger, egg bonze among others. Besides, fowl meat has good potential export driven nature worldwide while exportation of eggs into some West African countries is a lucrative business (14). The aim of this study was to compare the egg morphometric parameters and blood profile of six strains of poultry birds raised under extensive management system in the Nigerian savanna.

Materials and methods

Sources of the experimental birds, design and management

The birds were randomly selected from four villages (Zangon Shanu, Bomo, Samaru and Kurmin Bomo) in Sabon Gari Local Government Area, based on the number and productivity of poultry birds raised under extensive management system. A total of eighteen (18) birds consisting of three (3) birds per strain as replicates were used for the study. The birds were obtained at laying stage. They were kept under the free range system in their owner's homes. They received whole grains (sorghum and millet) in the morning as supplement before going out to feed on other household wastes and insects. Clean water was provided *ad libitum.* All birds

had free access to laying nests and boxes in their cages. Eggs laid per day from the birds were carefully collected, weighed and kept for further analysis and determination of quality parameters.

Determination of egg quality parameters

Eggs were collected once daily, counted, weighed and recorded per replicate. Three (3) eggs representing the average weight of the eggs from each replicate were used forthnightly to determine the egg quality parameters throughout the 13 weeks experimental period. Each egg was assessed separately for its internal and external egg quality traits. External quality traits were egg weight, egg length, egg breadth, egg shape index and shell thickness (was measured with micrometer screw gauge). Individual egg weights were measured using a sensitive electronic balance (FEJ-1500 a series) citizen scale to the nearest 0.01g. After weighing, measurement of various internal egg quality parameters such as albumen height, albumen diameter and yolk height, yolk diameter was done using a vernier calliper. The egg length was measured as the distance between the two extremes while the egg breadth was measured as the diameter of the egg at its widest circumference to the nearest 0.01mm. The egg shape index was calculated using the formula described by Sauveur (15).

$$ESI = EB/EL$$

Where;

ESI- egg shape index

EB- egg breadth (mm)

EL- egg length (mm)

The eggs were broken around the equator and were emptied out unto a clean Petri dish (care being taken to keep the yolk intact). The albumen and yolk heights were measured, the albumen height was taken at three different points and the average was obtained. The yolk width was taken as the widest circumference of the yolk while the yolk height was measured as the distance between the base of the Petri dish and the highest point of the yolk. The yolk was then separated from the albumen and the yolk was weighed. The weight of albumen was calculated by subtracting the weight of yolk and shell from the weight of the whole egg. Haugh unit was calculated from the measured height of albumen and weight of the egg using the formula outlined by Haugh (16).

$$HU = 100\log 10 (h-1.7w^{0.37} + 7.6)$$

Where;

HU = Haugh Unit

h = Observed height of the albumen in millimeters

W = Weight of the eggs in grammes

The shell weight was taken after removal of remaining albumen and subsequent air dried for 12 hours. This was used to calculate the egg shell index using the formula described by (17).

$$I = 100SW/S$$

Where;

I – Egg shell index

SW – Shell weight

S – Surface area (cm)

S was calculated from egg weight using the equation

$$S = k.EW\ 2/3$$

Where k has a value of 4.67 for egg weight less than 60g.

EW – Egg weight

The thickness of the egg shell were obtained by average measurement of three areas (the blunt end, the pointed end and the middle part of the egg) using a micrometer screw gauge. Egg yolk, height and width were measured using Vernier calliper and the values obtained were used

to calculate the yolk index.

YI = YW/YH

Where;

YI – yolk index
YW – yolk width
YH – yolk height

Percentage shell was determined by using the formula:

Shell percentage = (shell weight/egg weight) x 100

Percentage yolk was determined using the formula

Percentage yolk = (yolk weight/egg weight) x 100

Egg specific gravity (ESG) was estimated based on weight of egg and shell.

ESG = EW/ {(0.9680 (EW – SW) + (0.4921)}

Where:

ESG – egg specific gravity
EW - egg weight
SW – shell weight

The external and internal egg quality parameters were expressed as percentages relative to the weight of the eggs per strain of birds.

Determination of Haematological Parameters

At the end of the laying phase of the birds, 2mls of blood samples for serum biochemical tests were collected from the brachial vein of each of the birds. A total of eighteen birds were used. Also, 2mls of blood samples were separately collected into small plastic bottles (vials) containing 1mg/ml of EDTA for hematological parameters analysis. Differential white blood cell count (WBC counts) were made on monolayer blood films, fixed and stained with Geimser-Wright's stain. Total WBC count was determined by a manual method using haemacytometer. Packed cell volume was measured by a standard manual technique using microhaematocrit capillary tubes and centrifuged at 2500rpm for 5 minutes. The haematological study was carried out in the Parasitological Laboratory of the Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria. The samples were analyzed for packed cell volume (PCV), Hemoglobin (Hb) count, red blood cell count (RBC) and white blood cell count (WBC), together with absolute count of heterophils, lymphocytes, monocytes, eosinophils, and basophils as well as band were determined by routine methods as previously described (11).

Data analysis

Data obtained from this study was subjected to analysis of variance, using the General Linear Model of SAS (18). Means were declared significant when $P<0.05$. Significantly different means were separated using the Duncan's Multiple Range Test (DMRT) in SAS package.

Results and Discussion

Table 1 shows the external egg parameters of the six different poultry strains reared extensively. There was significant ($P<0.05$) difference in all the external egg parameters in the six poultry strains. Egg weight was significantly ($P<0.05$) highest in Geese (142.40g) followed by Turkey (72.63g) in which it did not differ significantly ($P<0.05$) from Duck (67.60g), but did differ from Broiler (57.30g). In another vein, Indigenous Chicken (35.80g) and Guinea fowl (37.83g) did not differ significantly ($P>0.05$) from each other in terms of their egg weight.

Table 1: The external egg parameters of six different strains of poultry birds

	Strains of Poultry Birds						
	I/chicken	**Broiler**	**Turkey**	**Geese**	**Duck**	**G/fowl**	
Egg wt (g)	35.800^{d}	57.300^{c}	72.633^{b}	142.400^{a}	67.600^{b}	37.833^{d}	2.21
Egg ht (mm)	49.700^{d}	56.433^{c}	65.400^{b}	87.367^{a}	59.433^{c}	50.067^{d}	1.12
Egg width (mm)	37.067^{d}	42.900^{c}	45.667^{b}	54.667^{a}	45.833^{b}	37.100^{d}	0.68
Egg shape index	1.340^{c}	1.313^{c}	1.430^{b}	1.596^{a}	1.303^{c}	1.350^{c}	0.02
Egg specific gravity	1.137^{c}	1.140^{c}	1.130^{c}	1.173^{b}	1.150^{bc}	1.233^{a}	0.01
Shell wt (g)	3.733^{d}	5.833^{c}	6.767^{bc}	17.433^{a}	7.367^{b}	6.700^{bc}	0.43
Shell th (mm)	0.280^{d}	0.370^{c}	0.430^{b}	0.613^{a}	0.350^{c}	0.590^{a}	0.02
Shell %	10.540^{bc}	10.190^{bc}	9.317^{c}	12.247^{b}	10.873^{bc}	17.640^{a}	0.63
Shell index	3.387^{bc}	3.273^{bc}	2.990^{c}	3.933^{b}	3.493^{bc}	5.663^{a}	0.20

^{abcd} = Means with different superscript within the same row for a trait differ significantly (P<0.05), I = Indigenous, G= guinea, wt = weight, th = thickness, SEM = Standard error of mean.

Comparison of the production of bigger and heavier egg and quality traits of eggs from different poultry strains shows that geese had higher values than the other species in terms of egg weight (142.40g), egg height (87.37g), diameter (54.67), shape index (1.60), shell weight (17.43g) and shell thickness (0.61). This could be due to the good genes responsible for egg production in geese as well as their size and genetic make-up compare to the various poultry strains studied. The result of this study is in consonance with the report of Lin *et al*. (19); Bawa *et al*. (20) and Tuleun *et al*. (21) that egg mass or weight can be used as criterion in assessment of nutritional stress due to the management practice especially if they are obtained from birds of the same age, strain and health status. The egg weight from this study is within the normal range of the various strains (19, 22). The height of egg in Geese (87.37mm) was significantly (P<0.05) higher than the other poultry strains followed by Turkey (65.40mm). Broiler (56.43mm) and Duck (59.43mm) did not differ significantly (P>0.05) from each other; similarly, indigenous Chicken (49.70mm) and Guinea fowl (50.07mm) were significantly (P>0.05) similar. Geese (54.67mm) egg width was better than all the poultry strains followed by Duck (45.83mm) and Turkey (45.67mm), which did not vary significantly (P>0.05) from each other. In the same way, Guinea fowl egg width (37.10mm) and indigenous Chicken (37.07mm) did not differ significantly (P>0.05) from each other but was significantly (P<0.05) lower than the Broiler egg width (42.90mm). Geese (1.60) produced the best egg shape index, followed by Turkey (1.43) and the lowest was observed in other strains in which they did not differ significantly (P>0.05) among themselves. The results obtained in this study agree with the findings of (19, 22).

The egg specific gravity was significantly (P<0.05) highest in Guinea fowl (1.23), followed by Geese (1.17 which was comparable to Duck (1.15) and the later was comparable to Turkey (1.13), Broiler (1.14) and indigenous Chicken (1.14). The shell weight was found to be significantly (P<0.05) higher in Geese (17.43g). This was followed by Duck (7.37g) in comparable to Turkey (6.77g) and Guinea fowl (6.70g) and later was comparable to Turkey (5.83g) while the lowest was recorded in indigenous Chicken (3.73g). There was significant

(p<0.05) egg shell thickness in Geese (0.61) and Guinea fowl (0.59) followed by Turkey (0.43) and Duck (0.35) which was significantly (P<0.05) higher than the one in indigenous Chicken (0.28). The highest and lowest shell percentage was found in Guinea fowl (17.64) and Turkey (9.32); similar result was observed for shell index.

Table 2: Internal Egg Parameters for the Six Different Poultry Strains

	Strains of Poultry Birds						
Parameters	**I/chicken**	**Broiler**	**Turkey**	**Geese**	**Duck**	**G/fowl**	**SEM**
Yolk wt (g)	9.667^{d}	18.760^{c}	26.167^{b}	43.533^{a}	26.833^{b}	11.600^{d}	1.34
Yolk ht (mm)	14.267^{c}	15.300^{c}	17.600^{b}	21.733^{a}	19.933^{a}	15.267^{c}	0.62
Yolk width (mm)	41.40^{c}	47.567^{b}	49.700^{b}	67.433^{a}	50.667^{b}	40.900^{c}	1.83
Yolk %	26.747^{c}	32.800^{b}	36.020^{ab}	30.593^{bc}	39.713^{a}	30.713^{bc}	1.70
Yolk index	0.347^{ab}	0.323^{b}	0.357^{ab}	0.323^{b}	0.393^{a}	0.377^{ab}	0.02
Albumen wt (g)	27.167^{c}	32.173^{bc}	38.967^{b}	76.000^{a}	31.500^{c}	17.033^{d}	2.28
Albumen width (mm)	48.333^{c}	71.533^{a}	66.833^{ab}	74.100^{a}	61.950^{abc}	54.667^{bc}	4.81
Albumen ht (mm)	8.900^{bc}	5.767^{bc}	9.633^{bc}	13.667^{a}	9.933^{b}	7.700^{c}	0.59
Albumen %	75.373^{a}	56.050^{b}	53.687^{bc}	53.340^{bc}	46.593^{c}	45.360c	2.67
Albumen index	0.183^{a}	0.127^{b}	0.147^{ab}	0.187^{a}	0.163^{ab}	0.143^{ab}	0.02
Haugh unit	100.533^{ab}	94.000^{c}	94.833^{bc}	102.567^{a}	97.133^{abc}	94.233^{c}	2.91

^{abcd} = Means with different superscript within the same row for a trait differ significantly (P<0.05), wt= weight, I= Indigenous, G= guinea, ht=height, SEM= Standard error of mean.

The variation in internal egg parameters for the poultry strains is shown in Table 2. There were significant variations in all the parameters measured across the birds' strains. The amount of yolk weight (g) was significantly (P<0.05) highest in Geese (43.53) but Duck (26.83) and Turkey (26.17) did not differ significantly (P>0.05). Similarly, Guinea fowl (11.60) and indigenous Chicken (0.67) did not show significant (P>0.05) different but were significantly (P<0.05) lower than the yolk weight in Broiler. This result could be attributed to the weight of the eggs which is in turn related to the size of the egg. Previous studies also found similar result (17, 23). The yolk height (mm) did not vary significantly (P>0.05) between Geese (21.73) and Duck (19.93) compared to other strains. Turkey yolk height (17.60) was significantly (P<0.05) second highest. There was no significant difference (P>0.05) of yolk height among indigenous Chicken (14.27), Broiler (15.30) and Guinea fowl (15.27). The yolk width (mm) was significantly (67.43) higher in Geese (67.43) compared to other poultry strains. This scenario can be attributed to the mass of the yolk which was higher in Geese egg than others. This result is in agreement with the reports (13, 24, 25). There was no significant (P>0.05) difference in the yolk width of Broiler (47.57), Turkey (49.70) and Duck (50.67) but differed from Guinea fowl (40.90) and indigenous Chicken (41.40). The albumin index was relatively higher in indigenous Chicken (0.18) and Geese (0.19) comparable to Turkey (0.15), Duck (0.16) and Guinea fowl (0.14) while Broiler (0.13) recorded the least. Haugh unit was significant (p<0.05) in Geese (102.57) comparable to Indigenous Chicken (100.53) and Duck (97.13) while Broiler (94.00) and Guinea fowl (94.23) were significantly (P<0.05) the least. Previous findings reported that the internal egg quality parameters could be influenced by diet, management system imposed;

climatic condition and breed of the birds (24, 25).

The haematological parameters (Table 3) showed that Duck proved to be better in PCV (50.00MG/DL), Hb (16.33) and RBC (6.17) while indigenous chicken was better in lymphocytes (95.33mg/dl). In avian medicine, interpretation and sensible utilization of blood profiles are often limited by lack of values for physiological parameters relevant to the individual avian strains and each strain to breeding lines, production type. This is in consonance with the report of Kral and Suchy (26). The results of this study is in comparison with the value reported for biochemical parameters among different strains of birds including Ostrich (27), captive birds (28), Sea-birds (29), and broiler strains (30), which indicates that biochemical parameters values of birds are strains-dependent and differences between plasma and serum values. This agrees with the report of (31).

Table 3: Effect of management system on some haematological parameters in six strains of poultry birds

Parameters (mg/dl)	Strains of Poultry Birds						SEM
	I/chicken	Broiler	Turkey	Geese	Duck	G/fowl	
PCV	33.667^{b}	25.333^{c}	45.000^{a}	43.667^{a}	50.000^{a}	44.000^{a}	2.52
Hb	11.200^{b}	8.400^{c}	14.967^{a}	14.533^{a}	16.333^{a}	15.000^{a}	0.87
WBC	3.500^{b}	24.400^{a}	8.333^{b}	6.267^{b}	6.300^{b}	5.767^{b}	3.34
RBC	4.933^{ab}	5.933^{a}	5.600^{a}	3.167^{b}	6.167^{a}	4.500^{ab}	0.69
Hematocrit	6.667^{b}	11.000^{b}	21.000^{a}	7.000^{b}	5.667^{b}	26.333^{a}	3.22
Lymp.	95.333^{a}	82.333^{abc}	77.667^{bc}	88.333^{ab}	86.667^{ab}	69.000^{c}	4.66
Mono.	0.667^{a}	3.333^{a}	1.333^{a}	0.667^{a}	1.667^{a}	2.667^{a}	0.91
Eosi.	3.000^{a}	2.333^{a}	0.000^{a}	2.333^{a}	1.000^{a}	0.000^{a}	1.49
Bands	0.000^{a}	1.000^{a}	0.000^{a}	1.333^{a}	5.000^{a}	2.000^{a}	2.27

^{abcd}= Means with different superscript within the same row for a trait differ significantly (P<0.05), PCV= Packed cell volume, HB=Haemoglobin, WBC=White blood cell, RBC=Red blood cell, Hemato=Hematocrit, Lymp=Lympocytes, Mono=Monophil, Eosi=Eosinophil

The full blood count examines mostly the cellular components of blood whereas biochemical testing focuses on its chemical constituents (31). It has been shown that data from blood profiles could be exploited in the improvement of chicken stocks (32). In addition, blood parameters help in the diagnosis of specific poultry hen pathologies and might serve as basic knowledge for studies in immunology and comparative avian pathology. Whereas (33) reported that significant reduction in red and white blood corpuscles indicates haemolytic anaemia and exposes the birds to high risk of infection irrespective of the bird strains.

Conclusion and Application

1. Extensive system of management of poultry birds has effect on internal and external egg quality parameters and blood profile of six strains of birds in Northern Guinea Savanna of Nigeria.
2. Eggs of the strains of poultry studied are safe for storage for certain period of time before spoilage due to their quality

attributes. Hence, smallholder farmers in Nigeria should be encouraged to rear more of these chicken strains.

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