DRY SEASON JUVENILE GROWTH AND PHYSIOLOGICAL PARAMETERS IN EXOTIC AND NIGERIAN INDIGENOUS CHICKEN

CRECIMIENTO JUVENIL Y PARÁMETROS FISIOLÓGICOS EN POLLOS EXÓTICOS Y NIGERIANOS DURANTE LA ESTACIÓN SECA

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ADDITIONAL KEYWORDS

Chick development. Plasma hormones.

PALABRAS CLAVE ADICIONALES

Desarrollo pollos. Hormonas plasmáticas.

SUMMARY

This study evaluated early growth and plasma hormonal profile in exotic strains of broiler and Nigerian indigenous chicken. A total of 1200 hatching eggs, 300 each from four strains of chicken were used for this study. The strains included the Nigerian indigenous chicken (NIC), the Arbor acre, Hubbard, and Marshall broiler strains. Chicks weights were monitored weekly. Blood samples were collected at hatch (day-old), weeks 1, 2, 3 and 4 post-hatch for triiodothyronine (T_3) and corticosterone level determination. The chicks were randomly distributed into four rearing pens for a 28-d assessment of growth rate. Results showed that the body weights (g) in the broiler strains were higher than that of the NIC throughout the rearing period. There was no significant difference ($p>0.05$) in the levels of T_3 at day-old and at week 1 until later in the growth phase. Corticosterone levels did not differ significantly at day-old but became different from week 1 post-hatch. The levels of T_3 were not statistically different in the first week of growth. In the second week of post-hatch growth, there was a statistical difference in the levels of T_3 among the four strains of chicken. The level in the NIC was comparable ($p<0.05$) to those of Arbor acre and Marshall strains. The level in the Hubbard was significantly lower than that of the NIC, Arbor acre and Marshall. In the third week of growth, the level in the NIC was similar to that of Marshall strain and higher than those of Hubbard and Arbor acre strains. This study showed that at hatching, there was no difference ($p>0.05$) in the metabolic rate and the stress level among the strains of chicken as shown by the levels of T_3 and corticosterone respectively. The day-old chick weight and the weights in subsequent weeks post-hatch were smaller in the NIC than the broiler strains possibly as a result of low hatching weight. The early growth difference could not be explained by physiological parameters such as T_3 and corticosterone. However, the differences in post-hatch physiological and metabolic parameters may be due partly to genetic differences.

RESUMEN

En este estudio se evaluó el crecimiento juvenil y perfil de hormonas plasmáticas en cepas exóticas de broilers y pollos nigerianos, empleando un total de 1200 huevos eclosionados, 300 de cada una de las cuatro líneas estudiadas. Las líneas estudiadas fueron Pollo Indígena Nigeriano (NIC) y las líneas Arbor Acre, Hubbard y Marshall. Semanalmente se controló el peso y se tomaron muestras de sangre a la eclosión (1 día) y semanas 1, 2, 3 y 4 de vida para la determinación de triyodotironina (T3) y corticosterona. Los pollos fueron distribuidos al azar en cuatro jaulas de cría para evaluación del crecimiento en 28 días. Los resultados mostraron que el peso en las líneas de broilers fueron mayores que en los pollos NIC en todo el periodo. No hubo diferencias significativas en los niveles de T3 a 1 día de edad y semana 1 hasta el final de la fase de crecimiento. Los niveles de corticosterona no variaron en el día 1, pero se

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hicieron diferentes desde la semana 1. Los niveles de T3 no fueron diferentes en la primera semana de crecimiento. En la segunda semana de crecimiento hubo diferencias entre las cuatro líneas estudiadas. El nivel en NIC fue conmparable al de las líneas Arbor Acre y Marshall. El nivel en la línea Hubbard fue inferior al de NIC, Arbor Acre y Marshall. En la tercera semana de crecimiento, el nivel en NIC fue similar al de Marshall y superior al de Hubbard y Arbor Acre. El estudio demostró que a la eclosión, no hubo diferencias en la tasa metabólica y nivel de estrés entre las cepas estudiadas como se comprueba por los niveles de T3 y corticosterona respectivamente. El peso de los pollos de un día y el peso en las siguientes semanas fueron más bajos en los pollos NIC. Sin embargo, las diferencias en los parámetros fisiológicos y metabólicos en el crecimiento juvenil, pueden ser parcialmente debidas a las diferencias genéticas.

INTRODUCTION

Nigerian indigenous chickens like the improved breeds have a sigmoid growth pattern with differences in growth rates and feed efficiency (Nwosu, 1979). Oluyemi (1979) stated that Nigerian indigenous fowl is extremely well adapted to the tropics, and also resistant to poor management and feed restrictions. The assessment of the growth pattern is of importance as a result of its practical implications.

Indigenous chickens constitute 80 % of the 120 million poultry found in Nigeria (Fayeye *et al.,* 2006). The indigenous chickens are assets of poor people living in rural areas in Sub-Saharan Africa, especially Nigeria. Guèye (2003) reported that the indigenous chickens represent about 98 % of the total poultry numbers kept in Africa. Annually the native chicken has however remained largely unimproved (Oluyemi and Roberts, 2000). Adedeji *et al.* (2006) reported that several attempts have been made in the past by the Nigerian government to improve the performance of the indigenous chickens as a result of their potential as a source of meat to reduce animal protein deficiency in the country. However, the attempts did not yield the desired result because there was no proper articulation and involvement of animal breeders. It is imperative that the improvement of the growth of these birds be done to meet the protein needs of the Nigerian populace.

There is however, a paucity of information on the growth trajectory and hormonal profile of the indigenous chicken in Nigeria unlike the exotic strains. The local chickens are also being improved alongside different lines. It is not clear whether the eggs should be incubated using the same protocol as established for either broiler or layer type of chickens. An egg failing to hatch is a considerable energetic loss to the bird that laid it as well as to those that incubated it (Walter 1982). It is also believed that exotic broilers perform better in terms of body weight and growth under Nigerian climate compared to the Nigerian local chicken. There is also a dearth of information on the comparative study of these exotic strains with the local chicken in order to ascertain the underlying genetic or physiological reasons for the difference in performance. The null hypothesis for this study is that the difference may not only be due to genetic reasons but also to other physiological and incubation conditions. Proper understanding can be obtained through the study of their developmental trajectory and the comparative measurement of different physiological parameters with the exotic strains.

MATERIALS AND METHODS

EXPERIMENTAL DESIGN

A total of 1200 eggs (300 eggs from each of Hubbard, Marshall and Arbor acre strains of broiler and one Nigerian indigenous chicken) were used for this study. The hatching eggs for the three exotic strains were purchased from commercial farms in Nigeria. The hatching eggs from the Nigerian indigenous chicken (NIC) were purchased from the Department of Animal Breeding

and Genetics of the University of Agriculture, Abeokuta. Prior to incubation, the eggs were individually numbered and weighed. The age of the layer breeders' was 43 weeks. The hatching eggs were stored for 1 day before setting for incubation.

Determination of egg quality characteristics

Ten eggs from each of the strains of the chicken were randomly selected for external egg quality study. The following parameters were determined:

The egg weight was measured with an electronic balance to the nearest 0.01 g.

Shell thickness was measured after removing the internal membranes of the eggshell. A precision micrometer was used to the nearest 0.01mm. Measurements were taken at the three regions of the shell and the means were calculated.

Shell weight was measured after remotion of content and air-drying using an electronic balance.

Albumen height was measured using P6085 spherometer (tripod micrometer) with 0.01 mm accuracy in a flat dish.

Yolk weight was measured, after carefully removed, on an electronic balance

Haugh Unit (HU): The HU was calculated using the values obtained for egg weight and albumen height as expressed by Haugh (1937) in the formular shown below:

$$HU = 100 \log (H + 7.5 - 1.7W^{0.37})$$

where:
H= albumen height in mm;
W= egg weight in gram.

Incubation protocol

Single Stage Western® Incubator was used for setting of the eggs at a temperature of 37.8 °C and 60 % relative humidity (R.H) with oxygen concentration of 20 %. At day 19 R.H. was increased to 70 %. Towards day 21 when chicks were likely to hatch, R.H. was reduced to 60 %.This was to allow chicks to dry off before being taken out of the hatcher. Turning of eggs was automatically done by the incubator at an angle of 90° hourly until day 18. Turning ensures even distribution of nutrients and prevents adherent of embryo to egg shell.

Post hatch management

Prior to the last day of incubation period, the brooding pen was washed, disinfected and covered with polythene nylon to prevent heat loss. The feeders and drinkers were washed and disinfected. The brooding pen floor was littered to an even depth of 8 cm with wood shavings. Feeders, drinkers and heat source (electric bulb and kerosene stoves) were provided. Chicks were brooded at a temperature of 35 °C at one day of age. The temperature was reduced gradually until the birds developed enough feathers. The temperature was reduced gradually by reducing heat supply and opening up the side covers.

Blood sampling and hormone levels determination

At day 0, 7, 14, 21, and 28 of post-hatch growth, 10 chicks per strain were selected and blood samples were aspirated from wing vein or jugular vein using 2 ml syringe. The blood samples were put in to heparinized tubes to avoid blood clotting. The blood samples were centrifuged at 3000 revolution per minute (r.p.m.) for 10 minutes to separate blood plasma. The plasma samples were labeled for identification and later frozen at the temperature of –20 °C until ready for analysis to determine the levels of corticosterone and tri-iodothyronine (T_3) using radio immunoassay (RIA) technique as described by Darras *et al*. (1992). The analysis was carried out in K.U. Laboratory of Livestock Genetics, Immunology and Physiology, Leuven, Belgium.

Ration formulation

A single ration was formulated for the chicks to meet the nutritional requirements

of broiler chicks at starter phase. The composition is shown in **table I**. Water and feed were provided *ad libtum*.

CHICKS WEIGHT MEASUREMENT (G)

The chicks were tagged for identification purpose. The initial body weights were taken while subsequent body weights were recorded on weekly basis.

EXPERIMENTAL DESIGN

The experiment was a Completely Randomized Design (CRD). The model is shown below:

Model

$$Y_{ij} = \mu + T_i + \Sigma_{ij}$$

Y_{ij}= Observed value of dependent variable;
μ= population mean;
T_i= effect of i_{th} strains of chicken;
Σ_{ij}= residual error.

Table I. *Composition of the starter diet.* (Composición de la dieta de iniciación).

	Incorporation rate (%)
Ingredients	
Maize	52.00
Soya meal	19.25
Groundnut cake	12.70
Fish meal (72%)	5.00
Wheat offal	5.00
Bone meal	3.00
Oyster shell	2.00
*Premix	0.25
Salt	0.25
Methionine	0.25
Lysine	0.30
Total	100
Calculated analysis	
Metabolizable energy (MJ/kg)	12
Crude protein(%)	22.80
Crude fibre	3.10
Calcium	1.69
Lysine	1.52
Phosphorus	0.6
Methionine	0.77
Ether extract	4.01

1 kg of premix contains: vitamin A: 10 000 000 IU; vitamin D3: 2 000000 IU; vitamin E: 20 000 IU; vitamin K: 2250 mg; thiamine B1: 1750 mg; riboflavin B2: 5000 mg; pyridoxine B6: 2750 mg; niacin: 27 500 mg; vitamin B12: 15 mg; pantothenic acid: 7500 mg; folic acid: 7500 mg; biotin: 50 mg; choline chloride: 400 g; antioxidant: 125 g; magnesium: 80 g; zinc: 50 g; iron: 20 g; copper: 5 g; iodine: 1.2 g; selenium: 200 mg; cobalt: 200 mg.

STATISTICAL ANALYSIS

All the data collected were subjected to Analysis of Variance (ANOVA) and the mean differences were separated using Duncan Multiple Range test using SPSS (1992).

RESULTS

Table II shows the quality characteristics of the eggs of the exotic chickens and those of the NIC. The mean egg weight of the NIC was comparable to Marshall broiler strain ($p>0.05$). The initial weights of eggs at setting were higher for the Arbor acre strain than that of the other strains. The shell weights were not significantly different ($p>0.05$) among the strains but the NIC had the least value. Albumen weight varied significantly ($p<0.05$) among the strains of chicken. Arbor acre had the highest value (38.40 g) while the NIC had the lowest value (29.92). Albumen height was significantly higher in the NIC ($p<0.05$) while Arbor acre, Marshall and Hubbard strains had similar albumen height. Yolk weight varied with strains. The NIC was comparable to Marshall and Hubbard broiler strains while the Arbor acre had significantly higher yolk weight ($p<0.05$). Shell thickness was not significantly different among the strains of chicken considered. Haugh Unit was significantly higher in the NIC ($p<0.05$) while all the broiler strains had similar values.

GROWTH RATE

Table III shows the day-old chick weight (g) and the body weight of the growing chicks among three strains of exotic broilers

Table II. *Egg quality characteristics of different strains of chicken.* (Características de calidad de los huevos de cuatro líneas de pollos).

Strain	Egg quality Characteristics					
	EW	AH	AW	YW	ST	HU
Arbor acre	62.14±5.58[a]	3.35±0.19[b]	38.40± 4.18[a]	17.88±2.05[a]	0.38±0.47	47.65±0.59[b]
Marshall	54.62±3.03[bc]	2.99±0.43[b]	33.92±1.92[b]	15.22±0.99[b]	0.39±0.06	47.76±6.43[b]
Hubbard	55.92±2.08[b]	3.46±0.82[b]	35.38±1.26[ab]	14.64±2.39[b]	0.39±0.49	51.86±14.14[b]
NIC	49.36±4.47[c]	4.49±0.41[a]	29.92±3.14[c]	14.50±1.35[b]	0.35±0.55	71.98±3.06[a]

EW= egg weight (g); AH= albumen height (mm); AW= albumen weight (g); YW= yolk weight (g); ST= shell thickness (mm); HU= haugh unit (%).
[abc]means with different superscripts differ significantly along the same column ($p<0.05$).

and Nigerian indigenous chicken in successive weeks after hatching. The NIC was significantly smaller ($p<0.05$) than the broiler strains in body weight throughout the weeks of measurements. The weight at 1-day-old was significantly different among the strains considered. Hubbard had the highest value while the local chicken had the lowest. In the first week of growth, Arbor acre, Marshall and Hubbard strains had similar values in the weights of the chicks but significantly higher ($p<0.05$) than that of the NIC. Likewise, in the second week of growth, there was a significant difference in the growth rate of the four strains of chicken. Arbor acre, Hubbard and Marshall had similar values higher than the NIC. There was a slight change in the trend in the third week of growth. The body weight in the NIC was still smaller than those of the Arbor acre, Hubbard and Marshall strains. The broiler strains however differed significantly in their body weight. Arbor acre strain was comparable with Marshall but higher than that of the body weight of the Hubbard strain. Marshall and Hubbard strains were however comparable. In the fourth week of growth, the body weight of Arbor acre was higher than those of Hubbard, Marshall and the NIC. Marshall and Hubbard were comparable but higher that of the NIC. Overall body weight increased significantly at every successive week in all strains ($p<0.05$).

PLASMA HORMONES

Triiodothyronine (T_3)

The triiodothyronine (T_3) levels in the four strains of chicken in successive weeks

Table III. *Body weight (g) in four strains of chicken in successive weeks after hatching.* (Peso corporal en cuatro líneas de pollos durante las semanas siguientes a la eclosión).

Strains	Week				
	0	1	2	3	4
Arbor acre	40.23±2.10[b]	84.99±12.07[a]	180.25±27.26[a]	315.67±51.33[a]	487.32±85.70[a]
Marshall	35.07±2.21[c]	83.40±8.80[a]	179.64±22.27[a]	293.02±34.62[ab]	435.54±56.41[b]
Hubbard	48.59±4.09[a]	89.68±10.73[a]	165.19±24.10[a]	279.15±41.07[b]	427.25±7.50[b]
NIC	31.89±3.70[d]	51.21±8.31[b]	94.36±17.15[b]	142.25±28.55[c]	202.23±43.66[c]

[ab]Means on the same column with different superscripts, differ ($p<0.05$).
NIC= Nigerian indigenous chicken.

Table IV. *Plasma triiodothyronine (T_3) levels (ng/mL) in four strains of chicken in successive weeks after hatching.* (Triyodotironina plasmática en cuatro líneas de pollos en las semanas siguientes a la eclosión).

Strains	Week 0	1	2	3	4
Arbor acre	0.28±0.21	1.44±0.33	1.55±0.62^{a}	1.05±0.21^{bc}	0.67±0.25^{b}
Marshall	0.18±0.17	1.58±0.23	2.09±0.66 ^{a}	1.48±0.58^{ab}	0.81±0.30^{b}
Hubbard	0.20±0.15	1.60±0.20	0.83±0.20^{b}	0.71±0.19^{c}	1.04±0.15^{ab}
NIC	0.25±0.17	1.59±0.42	1.62±071^{a}	1.95±0.82^{a}	1.340±0.65^{a}

^{ab}Means on the same column with different superscripts, differ (p<0.05).
NIC= Nigerian indigenous chicken.

after hatching are presented in **table IV**. At day-old, there was no significant difference in the levels of T_3 among the four strains of chicken compared. The levels of T_3 was not statistically different in the first week of growth. In the second week of post-hatch growth, there was a statistical difference in the levels of T_3 among the four strains of chicken. The level in the NIC was comparable (p<0.05) to those of Arbor acre and Marshall strains. The level in the Hubbard was significantly lower than that of the NIC, Arbor acre and Marshall. In the third week of growth, the level in the NIC was similar to that of Marshall strain and higher than those of Hubbard and Arbor acre strains. In the fourth week of post-hatch growth, the level of T_3 in the NIC was similar (p<0.05) to that of Hubbard strain but higher than those of Marshall and Arbor acre strains. The levels in Arbor acre and Marshall strains were comparable.

PLASMA CORTICOSTERONE

Table V shows the corticosterone levels at day-old and subsequent weeks after hatching. At hatch, corticosterone levels were not different among the strains of chicken. On the seventh day however, the levels were statistically different (p<0.05). The concentration in the NIC was higher than those of Arbor acre, Hubbard and Marshall strains. On the second week of growth, the level in the NIC remained high

Table V. *Plasma corticosterone levels (ng/mL) in four strains of chicken in successive weeks after hatching.* (Corticosterona plasmática en cuatro líneas de pollos en las semanas siguientes a la eclosión).

Strains	Week 0	1	2	3	4
Arbor acre	18.25±5.54	8.87±3.97^{b}	13.18±6.30^{b}	5.09±2.22^{b}	4.50±2.55^{b}
Marshall	36.04±21.52	12.06±6.91^{b}	9.35±5.12^{b}	4.71±2.30^{b}	1.76±0.60^{b}
Hubbard	18.45±7.27	9.07±2.88^{b}	32.61±13.52^{a}	18.64±11.24^{a}	11.03±6.58^{a}
NIC	28.32±8.69	45.49±19.12^{a}	31.71±18.06^{a}	5.30±2.97^{b}	6.29±4.63^{ab}

^{ab}Means on the same column with different superscripts, differ (p<0.05).
NIC= Nigerian indigenous chicken.

but comparable with that of Hubbard strain and higher than those of Arbor acre and Marshall strains. On the third week of growth, there was a shift in the trend. The corticosterone level in the NIC was comparable with Arbor acre and Marshall strains. The level in the Hubbard strain remained higher ($p<0.05$). On the fourth week the levels in the NIC and Hubbard strain were similar ($p<0.05$) and higher than those of Arbor acre and Marshall.

Discussion

Data from this study showed that day-old chicks weights were significantly different among the four strains considered. This contrasts with the findings of Tona *et al*. (2004) despite the difference in initial egg weight used. The smaller body weights of the NIC observed at different weeks of this experiment may be due partly to the genetic make-up of the birds. There was no consistency in the day-old chick weight and early performance up to seven days in the two strains of the broilers. This is comparable with the report of Tona *et al*. (2003) who observed variation in the juvenile growth of chicks. NIC however showed a consistency up to seven day. There is a paucity of information on the comparison of juvenile growth of chicks from different strains of chicken. The difference in growth is probably due to the difference in physiological processes in the different strains. Wilson (1991) reported that every 1 g increase in hatch weight resulted in an 8 to 13 g advantage in broiler market weight in the 1980s. This emphasizes the importance of matching incubation conditions to allow for optimal broiler growth during incubation. Scheuermann *et al*. (2003) compared chick growth and muscle development in 8 strain crosses and suggested that different growth curves exist among commercially available strain crosses.

The differences in the growths recorded in this study is consistent with the findings of Tona *et al*. (2004). Powel and Bowman (1964) reported a positive correlation between a day-old chick weight and post-hatch growth. From the second week onward, the growth rate was highest in the Arbor acre strain.

Because the end of 7 day of rearing is often considered as the true starting point for production and that the chick body weight between 7 to 10 day has been shown to linearly related to the body weight at slaughter age (Decuypere *et al*., 1979; Tona *et al*., 2003), performance up to four week s of age was considered to be a good indicator of the the difference in the NIC and the broiler strains in this study. This is comparable with the findings of Tona *et al*. (2004) who reported that only seven to ten-day old chicks onwards are are correlated with slaughter age weight.

The plasma T_3 levels observed in this study is in line with the reports of Tona *et al*. (2003), Decuypere *et al*. (1979) and Careghi *et al*. (2005). These authors reported that thyroid hormones increased from day-old until day 7 post-hatch. The differences in the thyroid hormone levels suggest differential metabolic rate among strains at different stages of development. The NIC had significantly higher levels than the Hubbard and Arbor acre strains at week 3 and week 4 and hence a higher metabolic rate. The higher metabolic rate recorded in the NIC in this study points to the fact these birds could cope better than the exotic broilers. This may be because the indigenous chickens are more adapted to the tropics.

Corticosterone is the main hormone associated with stress in chickens (Curtis *et al*., 1980). Its concentration in plasma rises under stressful conditions. The similarity in the levels of plasma corticosterone observed at day old in all the strains of the birds used in this study indicates that they were not yet stressed and the environmental influence had not been imposed on them. An increase in plasma corticosterone levels with increasing age of chicks up to 7-day-post-hatch has been reported (Tona *et al*.,

2003; Wise and Fry, 1973; Tona *et al*., 2005). In agreement with these previous studies, our results show increasing concentrations of corticosterone up to 7-day-post-hatch in the NIC. Suprisingly, the broiler strains deviated from this. The inconsistent pattern of the levels of plasma hormone observed in the broiler strains in this study may be due to the fact that their adaptation to stress was poorer than that of the NIC.

CONCLUSION

This study showed that the day-old chick weights and the weights in subsequent weeks post-hatch were smaller in the NIC than the broiler strains possibly as a result of low hatching weight. The early growth difference could not be explained by physiological parameters such as T_3 and corticosterone. However, the differences in post-hatch physiological and metabolic parameters may be due partly to genetic differences which is in agreement with the report of Adegbola and Olatoke (1988).

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