Evaluation of growth performance traits of F_1 progenies derived from crossbred of an exotic chicken with Nigerian Indigenous chicken

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Abstract

Data were obtained for growth traits from fifty (50) progenies from straight crossing produced from crosses involving Arbor Acre (broiler) cocks and Nigerian Indigenous (Normal feather and naked neck) hens. Significant differences ($p < 0.05$) were observed in breed and sex across all bodyweight and body linear measurements at 4-12 weeks of age. The result indicated that Arbor acre naked neck (AANN) birds had the highest body weight (120.95 g), keel length (5.11 g), and shank length (7.34 g). Also, AANN had the highest feed intake (148.40 g) with AANN having a good FCR of 3.98 and WG of 37.33. There were also similar body weights of AANN (456.20 g) and AANF (302.73 g) at 8 weeks of age, while the feed conversion rate was also observed to be better in AANN (1.61) than Arbor acre normal feather (1.70). The interaction effects of growth traits revealed slightly similar values for both sexes in AANF while male AANN outperformed across all parameters measured except for keel length It was concluded that Arbor Acre x Naked neck (AANN) had higher morphometric characteristics and also exhibited higher values for growth performance than Arbor Acre x Normal feather (AANF), hence can be utilized for meat purposes if further study can be conducted on it.

Keywords: growth performance, growth traits, normal feather, naked neck, arbor acre

Avaliação de características de desempenho de crescimento de progênies F_1 derivadas de cruzamento de galinha exótica com galinha Indígena Nigeriana

Resumo

Os dados foram obtidos para características de crescimento de cinquenta (50) progênies de cruzamentos diretos produzidos a partir de cruzamentos envolvendo galos Arbor Acre (frangos de corte) e galinhas indígenas nigerianas (penas normais e pescoço nu). Diferenças significativas ($p < 0,05$) foram observadas em raça e sexo em todos os pesos corporais e medidas lineares corporais às 4-12 semanas de idade. O resultado indicou que as aves AANN apresentaram maior peso corporal (120,95 g), comprimento de quilha (5,11 g) e comprimento de perna (7,34 g). Além disso, a AANN teve o maior consumo de ração (148,40 g), com a AANN tendo uma boa conversão alimentar de 3,98 e GP de 37,33. Houve também pesos corporais semelhantes de AANN (456,20 g) e AANF (302,73 g) às 8 semanas de idade, enquanto a taxa de conversão alimentar também foi observada melhor em AANN (1,61) do que em AANF (1,70). Os efeitos de interação das características de crescimento revelaram valores ligeiramente semelhantes para ambos os sexos na AANF, enquanto a AANN masculina superou todos os parâmetros medidos, exceto para KL. Concluiu-se que Arbor Acre x Naked neck (AANN) apresentou características morfométricas mais altas e também exibiu maiores valores de desempenho de crescimento do que Arbor Acre x Normal Feather (AANF), portanto pode ser utilizado para fins de carne se estudos adicionais puderem ser realizados sobre isto.

Palavras-chave: desempenho de crescimento, características de crescimento, penas normais, pescoço nu, arbor acre

1. Introduction

Chicken breeds make up the majority of all avian breeds in the world (63%) (González et al., 2021). Halfway through February 2021, out of the 875 chicken breeds officially recognized in Europe, 10.64% were extinct and 41.16% were considered to be at risk and included in the " vulnerable" and " critical" classifications according to DAD-IS (Domestic Animal Diversity Information System) FAO database (FAO, 2021). Chickens are recognized as a valuable component of global genetic resources (Ogbu, 2021), and the most widely distributed avian species in the Nigerian poultry production industry with a total population size of 180 million birds (FAOSTAT, 2019).

Indigenous Nigeria naked neck chickens possess robust adaptability and can thrive efficiently in the tropics and hot humid zones. They are distributed in rural areas and reared by the majority of the rural poor (Ogbu, 2021). Keeping naked neck birds in warm and hot humid areas supports the attainment of birds' growth potential, body weight, and egg production (Galal; Fathi, 2001; Goli et al., 2024).

Adedeji et al. (2004) reported that Naked neck and Frizzled-feathered chickens performed better than Normal feathered types in body weight and linear body measurement traits. Findings by Peters et al. (2005) showed that the indigenous chicken genotypes had a higher maturing rate than their exotic counterpart. Furthermore, Olori (2009) pointed out that there was a need to identify, develop, and conserve those unique features of indigenous chickens that could be of potential value in the future. These indigenous chicken genotypes exhibit lower egg production and growth performance despite better adapting to low input or semi-scavenging systems (Wondmeneh, 2015; Oyeyinka et al., 2019; Negash et al., 2023). Conversely, improved exotic chickens produce more eggs and meat than indigenous varieties, but they face significant challenges in tropical environments (Islam; Nishibori, 2009).

The growth rate is an important tool in assessing the growth performance and potential productivity of animal livestock (Okafor et al., 2022). Growth involves a structured sequence of maturation changes, including the natural accretion of protein and increases in length and size, not merely an increase in body weight (Adedeji et al., 2015a). Animal growth encompasses the increase in size and enhancement of functional capabilities of various tissues and organs from conception to maturity (Adeleke et al., 2010). Several studies have x-rayed growth and compared the growth performance of different indigenous and exotic farm animal species including chickens (Malpotra et al., 2017; Mueller et al., 2020), rabbits (Gasco et al., 2019), sheep and goats (Yashim et al., 2016; Worku et al., 2019) and Cattle, (Denis et al., 2019).

Many reports in the literature indicated that the local chickens are slow-growing and lay fewer eggs relative to the exotic types (Pym et al., 2006; Peters et al., 2008; Besbes, 2009; Miyumo et al., 2024) and that genetic variation existed for growth and reproductive traits in these local chickens. The genetic profile of these local chickens can be changed through different breeding strategies due to the existence of genetic variation. Crossbreeding has been a pivotal strategy in developing modern commercial chicken breeds (Devankar et al., 2018) and also holds potential for improving rural chickens. Crossbred chickens generally demonstrate higher feed efficiency and lower mortality rates than purebreds, which are crucial for enhancing profitability in poultry production (Arora et al., 2011).

This study therefore aimed at evaluating the growth performance traits of f_1 progenies derived from crossbred Arbor acre sires with Normal feather and Naked neck dams.

2. Materials and Methods

2.1 Experimental location

The experiment was carried out at the Poultry Unit of Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso Oyo State, Nigeria. Ogbomoso is situated in the derived savanna zone of Nigeria on longitude 4o10' East of Greenwich meridian and latitude 8o10' North of the equator. The altitude is between 300 and 600 m above sea level. The mean annual rainfall and temperature are 1,247 mm and 27 ºC respectively (Google Earth Map, 2022).

2.2 Experimental birds and management

The experimental chickens that were used for this study were the local chicken and exotic broiler breeds. The local strains were the normal feather and naked neck chicken at maturity. The local birds were selected from the available chicken population. Arbor acre hens were acquired from a reputable farm at 7-8 months of age. A total

of 60 birds were sourced and used as parents for the experiment. The experimental birds were strictly under intensive management. The birds were housed in 3-tiers galvanized battery cages, one bird per cell.

2.3 Experimental feed and feeding

The sires and dams were fed ad-libitum with commercial breeder feed containing 17.5% crude protein and 2700 kcal/kg^{-1} metabolizable energy. Medications and vaccinations were done as required.

2.4 Experimental mating

Straight crossing was done with Arbor acre cocks and Nigerian local hens to get the F_1 crossbred progenies. Artificial Insemination (AI) was adopted in mating the hens. The massage technique was used to collect semen from the Arbor Acre cocks and Nigerian local chicken cocks. The semen collected was inseminated immediately into a doughnut shape in the left vent of the hens. This was done 3 times every week late in the evening. For each hen, 0.2 mL of undiluted semen was used for insemination each time, while the depth of the inseminator to the hens' reproductive tract was less than 5 cm. The mating procedure is as follows:

Arbor Acre (male) x Normal feather (female): AA_m x NF_f

Arbor Acre (male) x Naked neck (female): AA_m x NN_f

2.5 Housing and management of chicks

Fifty (50) chicks resulting from straight crossings were properly identified by wing tagged with industrial galvanized aluminum tags at the wing web at day old. The day-old chicks were transferred to a separate and disinfected brooder pen. All the chicks were raised separately according to genotypes under the same intensive management system. They were brooded for 4 weeks period before sexing. The chicks were fed with a commercial chick feed that supplied 22% crude protein and 3000 kcal/kg^{-1} metabolizable energy up to 4 weeks of age. Thereafter, they were fed with commercial grower and finisher ration that supplied 18% crude protein and 3100 kcal/kg^{-1} metabolizable energy from 4 to 12 weeks of age, clean and cool water was supplied ad-libitum while medication and vaccination were done as at when due.

2.6 Data collection

2.6.1 Growth performance

Body weights, feed intake, and feed-to-gain ratio were monitored from birds of pure and crossbred progenies from day-old to 12 weeks of age. There was obtained through the below procedures:

Body weight Gain (g): This is measured with the use of the electronic weighing balance of 3,000 g capacity

Feed Intake (g): The feed left over is subtracted from the feed given and the value is divided by the total number of birds daily.

Feed intake (g) = Feed given to the birds-feed leftover/Total number of birds

Daily Weight Gain (g): This is the difference in body weight values between two consecutive measurements divided by the number of days to obtain the daily body weight gain.

Daily weight gain (g) = Recent body weight-Previous body weight/Number of days

Feed Conversion Ratio: This is calculated as the ratio of daily weight gain to daily feed intake within each measurement period.

FCR = feed intake/weight gain

2.6.2 Growth traits

Data were obtained for growth traits from fifty (50) progenies from straight crossing produced from different crosses involving various sires and different dams of Nigerian indigenous chickens and Arbor acre chickens on the body weight (g), body length (cm), keel length (cm) and shank length (cm) from day-old and this was carried out every week for 12 weeks.

Body Weight (g): The body weight was measured with a sensitive scale from day-old to 12 weeks.

Body Length (cm): The body length was measured with the tailoring tape rule. The body length was from the wing joint to the vent region.

Chest Girth (cm): This was measured as the region of breast expansion when positioned vertically with the aid of the tailoring tape rule. The chest girth is in between the crop and the keel.

Shank Length (cm): It is taken as the length of the tarsometatarsus from the hock joint to the metatarsal pad. It is measured using a tailoring tape.

Thigh length (cm): Distance between the hock joint and the pelvic joint with the aid of tailoring tape rule.

Keel length (cm): This is taken as the length of the keel bone from the V- joint to the end of the sternum with tailoring tape.

Wing length (cm): This is measured as the distance between the tip of the phalanges and coracoid humerus joint with the use of tape rule.

2.7 Data analysis

Data obtained were subjected to analysis of variance in a Completely Randomized Design using the procedure of General Linear Model and comparing means of SAS, (2009) while significant mean were separated with the same procedure of SAS (2009) at $p < 0.05$.

2.7.1 Model for growth parameters

Using the procedure of the General Linear Model of SAS (2009)

$Y_{ijkl} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + e_{ijkl}$

Were,

Y_{ijk} = Individual observation with each genotype

μ = Overall Mean

α_i = Mean effect of ith genotype (1,2) on BDW, BL, CG, KL, SL, TL, WL, FI, WG and FCR

β_j = Mean effect of jth sex (1,2) BDW, BL, CG, KL, SL, TL, WL, FI, WG, and FCR

$(\alpha\beta)_{ij}$ = Mean interaction effect of ith genotype (1,2) and jth sex (1,2) on BDW, BL, CG, KL, SL, TL, WL, FI, WG and FCR

e_{ijk} = Experimental random error common to measurement in each bird and assumed to be normally and independently distributed with a mean of zero and variance δ^2.

3. Results

The Pooled mean effect of growth performance traits of crossbred chickens as affected by breeds of chicken at 4 and 8 weeks of age showed a significant impact ($p < 0.05$) across all body weight and body linear measurements at 4 weeks old. AANN birds had the highest body weight (120.95g), keel length (5.11 g), and shank length (7.34 g), Also AANN had the highest feed intake (148.40) with AANN having a good FCR of 3.98 and WG of 37.33. The table also revealed a similar body weight of AANN (456.20 g) and AANF (302.73 g) at 8 weeks of age, while the feed conversion rate was also observed to be better in AANN (1.61) than AANF (1.70).

Table 1. The pooled mean value of growth performance traits of crossbred chickens as affected by breeds of chicken at 4 and 8 weeks of age.

	WEEK 4		WEEK 8	
Par/Breed	**AANF**	**AANN**	**AANF**	**AANN**
N	28	22	28	22
BW (g)	81.58±4.13^{b}	120.95±15.37^{a}	302.73±17.82^{b}	456.20±40.78^{a}
BL (cm)	10.74±0.25	10.25±0.50	16.33±0.25^{b}	17.15±0.86^{a}
CG (cm)	5.38±0.14	5.05±0.18	6.25±0.13^{b}	7.00±0.18^{a}
KL (cm)	4.76±0.20^{b}	5.11±0.15^{a}	6.80±0.18^{b}	10.05±0.19^{a}
SL (cm)	6.33±0.13^{b}	7.34±0.31^{a}	9.57±0.29^{b}	10.72±0.47^{a}
TL (cm)	6.49±0.11^{a}	6.54±0.19^{a}	8.35±0.25^{b}	9.08±0.41^{a}
WL (cm)	8.18±0.35^{b}	8.40±0.40^{a}	11.88±0.33^{b}	13.00±0.50^{a}
FI (g)	131.23±14.84^{b}	148.40±12.83^{a}	320.39±30.41^{a}	272.45±34.87^{b}
WG (g)	32.80±2.98^{b}	37.33±2.48^{a}	188.18±16.78^{a}	169.30±8.94^{b}
FCR	4.00±0.12	3.98±0.0.02	1.70±0.13	1.61±0.12

Note: ^{ab}mean along the same row with different superscripts are significantly ($p < 0.05$) different. N = Number of Observation, BW = Body weight, BL = Body length, CG = Chest girth, KL = Keel length, SL = Shank length, TL = Thigh length, WL = Wing length, FI = Feed Intake, WG = Weight gain, FCR = Feed conversion rate, AANF = Arbor Acre × Normal feather crossbred, AANN = Arbor Acre × Naked neck crossbred. Source: Authors, 2024.

Table 2 revealed that sex had significant effects ($p < 0.05$) on body weight and body linear measurements. At 12 weeks, both sexes of AANN and AAFE recorded a similarly significant increase in body weight and linear measurements. Male AANF showed a significant increase in BW than the female, while no significant effects were recorded in the BW of both sexes in AANN. Consistently, values of body weight and other body conformations measured increased with the age of the birds among the two breeds.

Table 2. Least square mean values of growth performance traits of crossbred chickens as affected by breeds and sex of chicken at 12 weeks of age.

Par/Breed	**AANF**		**AANN**	
SEX	**Male**	**Female**	**Male**	**Female**
N	16	12	10	12
BW (g)	658.96±22.15^{b}	748.17±38.79^{a}	1230.17±91.62	1210.25±86.11
BL (cm)	22.51±0.64	22.42±0.99	27.00±1.26	24.75±2.26
CG (cm)	16.68±0.38	15.38±0.56	19.08±1.25	18.94±0.42
KL(cm)	9.02±0.27	9.13±0.48	11.50±0.57	10.69±0.74
SL (cm)	12.56±0.28	13.17±0.70	12.00±0.71	10.25±0.40
TL (cm)	13.04±0.35	12.63±0.66	14.50±0.67	13.69±0.62
WL(cm)	16.10±0.42	15.67±0.84	18.04±0.94	15.88±0.72
FI (g)	763.08±177.86	774.08±21.51	1424.83±34.01	1453.75±34.26
WG (g)	402.08±21.42	412.50±22.21	716.33±91.72	687.13±115.37
FCR	1.89±0.30	1.87±0.02	1.98±0.04	2.12±0.07

Note: ^{ab} mean along the same row with different superscripts are significantly ($p < 0.05$) different. N = Number of Observation, BW = Body weight, BL = Body length, CG = Chest girth, KL = Keel length, SL = Shank length,

TL = Thigh length, WL = Wing length, FI = Feed Intake, WG = Weight gain, FCR = Feed conversion rate, AANF = Arbor Acre x Normal feather crossbred, AANN = Arbor Acre x Naked neck crossbred. Source: Authors, 2024.

Table 3 revealed the interaction effects of growth traits of crossbred chickens as affected by Breed × Sex at Weeks 8-12. The result showed an increase in the body weight and other body linear measurements among the two breeds. Slightly similar values were recorded for both sexes in AANF while male AANN outperformed across all parameters measured except for KL.

Breed	Sex	B/W	B/L	C/G	K/L	S/L	T/L	W/L
AANF	1	828.72±48.11	22.94±0.54	9.98±0.35	9.55±0.25	12.92±0.27	13.11±0.33	16.48±0.41
	2	865.71±78.76	22.75±1.05	9.64±0.57	9.04±0.40	13.25±0.66	12.39±0.61	15.71±0.82
AANN	1	919.75±52.63	25.72±0.98	10.96±0.69	11.02±0.36	14.67±0.52	13.32±0.53	18.46±0.49
	2	1239.50±197.37	26.75±1.55	12.00±0.72	10.42±0.62	15.42±0.91	15.08±0.47	19.58±0.90

Table 3. Interaction effects of growth traits of crossbred chickens as affected by breed × sex at week 8-12.

Note: BW = Body weight, BL = Body length, CG = Chest girth, KL = Keel length, SL = Shank length, TL = Thigh length, WL = Wing length, FI = Feed Intake, WG = Weight gain, FCR = Feed conversion rate, AA = Arbor Acre crossbred, AANF = Arbor Acre x Normal feather crossbred, AANN = Arbor Acre x Naked neck crossbred. 1 = Male, 2 = Female. Source: Authors, 2024.

4. Discussion

Crossbreeding programs with specialized meat-type or egg-type chickens have been demonstrated by various researchers to significantly enhance productivity. Growth traits such as body weight and morphometric measurements are critical for both poultry breeders and meat processors (Adedeji et al., 2015a).

A recent study on the growth performance traits of crossbred chickens, produced from Arbor Acre sires and Nigerian indigenous chicken dams, confirmed that the AANN progenies exhibited the highest body weight and superior body conformations compared to other crossbred chickens. This finding aligns with earlier studies by Assefa & Mellese (2018), Amao (2018a, 2018b), and Ojedapo et al. (2018). The notable effect of sex on body weight and linear measurements at 8-12 weeks aligns with the findings of Ajayi & Ejiofor (2009). The sexual dimorphism favoring males observed in both genotypes in this study is consistent with the reports by Adeleke (2005) and Isidahomen et al., 2012, who also noted differential growth patterns in chickens. The variation in growth rates among Normal feather birds, naked necks, and Arbor Acre crossbreeds indicates differences in their growth patterns, likely due to strain differences and genetic factors.

The significant breed and sex interaction observed in Normal feather birds, naked neck, and Arbor Acre crossbreeds is in corroboration with Ajayi & Ejiofor (2009) and Razuki et al. (2011), who also reported significant breed and sex interactions affecting body weight in Ross and Anak Broiler strains. However, this contrasts with the findings of Ojedapo et al. (2008), who found no significant genotype and sex interaction on chicken body weight.

Assefa & Mellese (2018) observed variations in morphological and morphometric characteristics within the chicken population in Ethiopia. Arbor Acre x Naked Neck birds among the crossbreds weighed 120.95 g and 456.20 g at 4 and 8 weeks of age, respectively, with males showing a slight improvement in body weight over females at 12 weeks of age. This result mirrors an earlier study by Amao (2020), which also recorded the highest body weight for Arbor Acre x Naked Neck (AANN) birds among various crossbreds. This study confirmed that the naked neck gene enhances body conformation more effectively compared to the normal feather gene. This finding aligns with Amao (2017c), who reported that naked neck genotypes exhibited superior growth traits when crossed with exotic chickens compared to normal feather, frizzled feather, and Fulani ecotype chickens. Additionally, the AANN crossbreeds demonstrated lower feed intake, higher weight, and improved feed conversion ratios, corroborating Mahmoud & El-Full's (2014) research. They observed that crossing Rhode Island Red with Gimmizah chickens in Egypt resulted in progenies with better growth performance traits than purebred Rhode Island Red and Gimmizah chickens.

Moreover, individuals from each strain that produce the best cross progeny can be mated to propagate their respective strains, leading to improved cross performance whether due to overdominance, epistasis, or additive effects. Adeleke et al. (2012) also reported higher body weights for crossbred progeny from Anak Titan x Naked Neck compared to other contemporary crossbreds. The greater weight and improved feed conversion ratio displayed by AANN crossbreds over AANF align with Amao's (2020) findings.

5. Conclusions

The study revealed the facts that crossbred chickens from Exotic meat type of chickens crossed with Nigerian indigenous chickens were better in respect to growth performance traits than purebred local chickens. It was concluded that Arbor Acre x Naked neck (AANN) had higher morphometric characteristics and they also exhibited higher values for growth performance than Arbor acre x Normal feather (AANF), hence can be utilized for meat purposes if further study can be conducted on it.

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7. Authors' Contributions

Ifanegan Oluwadamilare David: conceptualize the study and write the article. *Ojedapo Lamidi Oladejo*: designed the study. *Adedibu Tolulope Margaret*, *Fasasi Abdulhakeem Olabayonle*, *Popoola Abimbola Deborah*, *Abdulrauf Bilqees Olajumoke*: proofread the writing. *Ifanegan Oluwadamilare David*, *Oyetoro Blessing Abiola* and *Popoola Abimbola Deborah*: carried out the experiment.

8. Conflicts of Interest

No conflicts of interest.

9. Ethics Approval

Yes, applicable. All procedures were certified by the University's Animal Use and Ethics Committee under reference ANB/AB/2000366.

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