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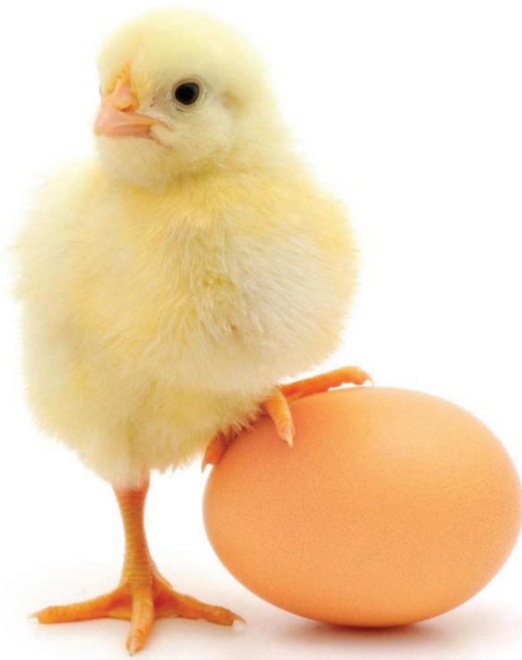

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Research Article
Growth Performance and Profitability Analysis of Five-Chicken Strains in South Western Nigeria

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Abstract
Objective: This experiment was conducted to investigate the growth performance, carcass and organ traits and profitability of five-chicken strains in South-western Nigeria. **Materials and Methods:** A total of 300 birds comprising five strains, 60 birds per strain, were used for the experiment. Each strain was made of ratio 30:30 males to females. The experiment spanned through eight weeks and the birds were distributed based on their strains and sexes into ten treatments of 30 birds with three replicates of 10 birds each. At the end of 8th week, 12 birds (6 males and6 females) were randomly selected for analyses. **Results:** Analytical results showed that genotype significantly influenced ($p<0.05$) the initial weight (IWT), final weight (FWT), total weight gain (TWG), total feed intake (TFI) and feed conversion ratio (FCR). Hubbard birds (HB) consumed the highest quantity of feed (3,084.61 g), utilized the feed more efficiently with FCR of 1.60, gained more body weight (1930.30 g) and showed more final weight (1966.80 g) than the Nigerian indigenous genotypes. However, among the Nigerian chicken genotypes, Fulani ecotype (FE) consumed more feed (3012.40 g), utilized the feed more efficiently, gained more body weight (1812 g) and weighed heaviest (1840.99 g). As expected, the effect of genotype on carcass characteristics showed that Hubbard meat type chicken strain had the highest and significant ($p<0.05$) yields among all the carcass traits. Nevertheless, Fulani ecotype (FE) took the lead among the parameters for the indigenous chickens, followed by naked neck (NN) and least with normal feather (NF). The results also showed a significant difference ($p<0.05$) in organ characteristics of the chicken genotypes. Profitability analysis indicated that the total revenue (₦135,000) accrued from sale of Hubbard broiler chickens was slightly higher than the Fulani ecotype (₦127,500) which is an indigenous chicken. The four profitability indicators used to measure the extent of returns from the production of the 5-chicken strains were gross margin, net farm income, rate of return on investment (RROI) and benefit cost ratio. For Fulani ecotype, the gross margin, net farm income, rate of return on investment (RROI) and benefit cost ratio were estimated to be ₦95,000, ₦90,726.68, 246.72% and 3.47 respectively. The corresponding values for the Hubbard broiler chicken were ₦102, 500, ₦98, 226.68, 267.11% and 3.67. These results were comparable and do not show any considerable difference in profitability between Fulani ecotype and Hubbard broiler chickens. The higher values of profitability indicators suggested that raising of Fulani ecotype as meat type chicken is more profitable for poultry farmers compare to other Nigerian indigenous chickens. **Conclusion:** The study suggested that Fulani ecotype strains could be regarded as heavy breed chicken and be incorporated into a meat producing indigenous chicken with desired improvement.

Key word: Indigenous genotypes, profitability, chicken strains, carcass characteristics, growth performance

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Livestock play a very important role in Nigerian agriculture, contributing about 12.7% of the agricultural Gross Domestic Product[1]. The livestock population comprised about 180 million poultry[2], 20 million cattle[3], 34.5 million goats and 22.1 million sheep[4]. It has also been estimated that since domestication, over 6,379 documented breeds of livestock populations from 30 species have been globally developed in the past years[5]. In Nigeria, the livestock sub-sector is dominated by traditional systems of production and marketing[6]. The gap between demand and supply for poultry products is still very wide due to increase in human population, urbanization, high cost of chicken meat and low production of indigenous chickens which in most cases were complemented with importation[7]. Most of these Nigerian indigenous birds are normally used for dual purposes because they have potential for both meat and egg production.

Several studies have been conducted on the growth performance and carcass characteristics of Nigerian indigenous chickens and exotic strains of broiler chickens but there is dearth of information on the comparative analysis of the growth performance, carcass and organ characteristics, cost structures and returns of Nigerian indigenous chickens and exotic strains of broiler chickens. Studies have shown that the Nigerian indigenous chickens possessed small body size, grew slowly and reached point of inflection earlier than the exotic breeds of chickens[8]. Body size of an individual was also determined by its rate of growth[9]. Olawunmi *et al.*[10] found that the Fulani ecotype chicken was bigger in size than the Yoruba ecotype chicken (1.76 kg versus 0.76 kg) at 6weeks. Indigenous male chickens were also bigger in size than their female counterparts (1.5 kg versus 1.29 kg, respectively) at 6weeks[11]. Crossbreeding of indigenous chicken with exotic breeds also improved body weight greatly at 12 weeks[12]. However, the effect of day-old chick weight on growth rate of indigenous chickens varied among different studies[13]. Comparison on the basis of sex showed that male broilers had greater breast and back but smaller legs than their females. Studies on growth performance of broiler chicken showed that body weight, body weight gain, feed intake and feed conversion ratio were influenced by genotype of the birds[14-16]. On the contrary, Thutwa *et al.*[17] and Hristakieva *et al.*[18] stated that body weight, body weight gain and feed conversion ratio of chicken were not affected by genotype of the birds. In terms of carcass and organ quality of broiler chickens, studies have documented that carcass fatness, meat quality, carcass weight, breast and leg muscle weights, fat and edible giblet weights and back and drumstick weight were significantly affected by the genotype of the birds[19,20]. However, Udeh *et al.*[15] reported that carcass yield among Ross, Arbor Acres and Marshall Breeds were almost similar. In addition to genotype of the birds, studies also revealed the effect of sex on growth performance of chickens. The male broiler chicken was found to have a faster growth rate and higher slaughter weight than their female counterparts[17,21]. Studies have shown that sex significantly affected slaughter yield, percentages of wing and thigh and meat to bone ratio from the thigh[17,20,22]. Castellini *et al.*[23] however reported that carcass characteristics were not greatly affected by sex. There is therefore a need to compare the growth performance, carcass and organ characteristics and profitability of five-chicken strains in South-Western, Nigeria and the study is expected to make contributions to the literature. This is a novel study as it investigates the comparative cost structures and returns associated with the raising of indigenous chickens intensively in relation to their growth performance, carcass and organ characteristics. The result of the study will also guide the poultry farmers to select the most profitable chicken strain among the Nigerian indigenous genotypes for intensive rearing in South-Western Nigeria.

MATERIALS AND METHODS

Experimental site: The study was carried out at the Poultry Unit of the Teaching and Research Farm, the Federal University of Technology, Akure, Ondo State, Nigeria located between latitude 07°16^1 and 07°18^1 N and longitude 05°09^1 and 05°11^1 E. There is a bimodal rainfall patterns which start from February-July and September- October with average rainfall of 1,556 mm per annum. The average ambient temperature is about 30-32°C with relative humidity of 80%.

Pre-experimental management: The brooder's house was cleaned and disinfected with Lysol® prior to the chicks' arrival. All necessary brooding facilities were made available before the arrival of the chicks. On arrival, the initial weights of the chicks were taken and the birds were tagged individually for ease of identification, weighing and measurement. The weighed chicks were then distributed to the pens according to their strains and sexes. They were raised intensively on deep litter system for eight weeks.

Source of experimental birds, sample size and layout: A total of 300 birds comprising five strains which were normal feather, naked neck, frizzle feather, Fulani ecotype and Hubbard broiler were used for the experiment at 60 birds per strain. The experiment spanned through eight weeks and the birds were distributed based on their strains and sexes into 10 treatments of 30 birds with three replicates of 10 birds each. Each strain was made of ratio 30:30 males to females. At the end of 8th week, 12 birds (6 males and 6 females) were randomly selected for analyses.

Health management practices: Routine and occasional health management practices were strictly observed during the study period. All necessary vaccination and medications were administered accordingly.

Experimental diet: The diet used for the experiment was formulated at the Federal University of Technology Akure (FUTA) Teaching and Research Farm Feed Mill, Ondo State, Nigeria. The birds were fed the experimental diet *ad-libitum* during the period of the experiment. The gross composition of the diet was shown in Table 1.

Growth performance: The initial weights of all chicks were recorded at day old using a Campy model: EK5350 sensitive weighing scale (5 kg Max.) and the chicks were tagged individually for ease of identification, measurement and weighing. Subsequently, their body weights were taken weekly for eight weeks. Growth parameters were measured via; feed consumed, feed conversion ratio and weight gained for each strain and sex.

The following measurements were taken:

Body weight gain: Body weight gain was determined as a difference between the final live weight and the initial live weight (in grams) using a sensitive scale. Weight gain was calculated using the following formula:

$$WG = FBW-IBW$$

Where:

WG : Weight gain
FBW : Final body weight
IBW : Initial body weight

The body measurements were carried out early in the morning (between 6:30-10:00 am) before feeding. The birds were individually weighed; after which the mean body weight for all the birds based on their sexes and strains were computed.

Feed intake: Feed intake (FI) was determinedas the difference between the feed supplied and the weigh back on weekly basis. FI was calculated using the following formula:

Table 1: Gross composition of the experimental diet (g/100 g)

Ingredients	Mash
Maize	50.00
SBM	21.00
Wheat offal	14.90
PKC	2.00
GNC	6.60
Fish meal	1.50
Bone meal	1.50
Limestone	1.00
Methionine	0.40
Lysine	0.10
Premix	0.50
Salt	0.50
Total	100.00
Calculated analysis	
Crude protein (%)	20.40
ME = (kcal kg^{-1})	2666.67

SBM: Soybean meal, PKC: Palm kernel cake, GNC: Ground nut cake, ME: Metabolizable energy

$$FI = \text{Feed supplied-Weigh back}$$

Feed/gain ratio: Feed to gain ratio was determined by dividing the feed intake by weight gain. Feed to gain ratio was calculated using the following formula:

$$\text{Feed to gain ratio} = \frac{\text{Feed intake}}{\text{Weight gain}}$$

Feed conversion ratio: Feed conversion ratio (FCR) was obtained by dividing the weight gain by feed intake. FCR was calculated using the following formula:

$$FCR = \frac{\text{Weight gain}}{\text{Feed intake}}$$

Measurement of carcass and organ traits: At the end of the experiment, 12 birds (6 males and 6 females) from each strain were randomly selected. The birds were carefully dissected into the various parts to determine the carcass yield to aid the value chain profitability of farmers through marketing of preferred parts and organs. The carcass traits measured were: live weight (LWT), dress weight (DWT), shank weight (SWT), drumstick weight (DSW), thigh weight (THW), breast weight (BRW), back weight (BAW), head weight (HWT), neck weight (NWT) and wing weight (WWT). The organ traits measured were liver weight (LIW), heart weight (HEW), lungs weight (LUW), spleen weight (SPW), gizzard weight (GIW), pancreas weight (PAW), proventriculus weight (PRW), bursal weight (BUW) and abdominal fat weight (AFW). All these traits were measured in grammes using Campy model: EK5350 electronic sensitive scale (5 kg Max).

Profitability analysis: The budgetary model was used to estimate the extent of profit generated from raising of the five-chicken strains. The budgetary model is also known as gross margin model and is used to estimate the total costs as well as returns within a production period. Other profitability indicators used to measure the extent of returns are net farm income, rate of return on investment (RROI) and benefit cost ratio. The mathematical notation for calculating the gross margin is shown in the equation below:

$$GM = p_i y_i - r_i c_i \quad (1)$$

$$GM = \text{Total revenue (TR)} - \text{Total variable cost (TVC)}$$

Where:

- GM : Gross margin (Naira)
- $p_i y_i$: Total revenue (₦)
- $r_i c_i$: Total variable cost (TVC)
- p_i : Price of dress weight of each of the five strains of chicken (₦)
- y_i : Quantity of dress weight of each of the five strains of chicken sold (kg)
- r_i : Unit price of each variable input used (₦)
- c_i : Quantity of each variable input used

$$\text{Total variable cost (TVC)} = x_1+x_2+x_3 \quad (2)$$

- x_1 : Cost of birds (₦)
- x_2 : Cost of feeds (₦),
- x_3 : Other Costs (₦)

The net farm income is derived as follows:

$$\pi = GM - TFC \quad (3)$$

Where:

- π : Net Farm Income (₦) per strain of chicken
- GM : Gross margin (₦) per strain of chicken
- TFC : Total Fixed Cost per strain of chicken

The Rate of Return on Investment (RROI), Benefit Cost Ratio was used to determine and compare the financial outcomes of each strains of chicken.

RROI was calculated using the following formula:

$$RROI = \frac{\text{Net farm income}}{\text{Total cost of production}} \times 100 \quad (4)$$

Benefit-cost ratio (BCR): This is the ratio of total costs to total revenue. The total revenue is otherwise refers to as benefit. BCR is also the ratio of discounted costs to discounted revenue. A BCR of greater than unity indicate that business is a profitable one. A BCR of lesser than unity implies that the business is not profitable. If a BCR is equal to unity, then it implies that the business is at break-even point (neither profitable nor loss).

Mathematically, BCR is stated as:

$$BCR = \frac{\text{Benefit}}{\text{Total costs of production}} \quad (5)$$

Statistical analysis: The data were analyzed using Statistical Analysis System (SAS)[24] Version 13. Completely randomized design (CRD) with a 2×5 factorial arrangement was used to analyse the chicken strains for growth performance, carcass and organ traits. Least Significant Difference (LSD) test was used to compare the difference among treatment means. The statistical model used is given below:

$$Y_{ijk} = \mu + G_i + S_j + GS_{ij} + \varepsilon_{ijk}$$

Where:

- Y_{ijk} : Observation of a bird for i^{th} strain in the j^{th} sex (n = 1- 300)
- μ : General mean for specific population;
- G_j : Effect of the i^{th} strain (j = 1-5)
- S_j : Effect of the j^{th} sex (i = 1-2)
- Gs_{ij} : Interaction of i^{th} strain and j^{th} sex of experimental chickens
- ε_{ijk} : Residual effect, which is normally, independently and randomly distributed with zero mean and common variance (σ^2)

RESULTS AND DISCUSSION

The effects of strain and sex on growth performance of the experimental birds is shown in Table 2. There was a significant difference (p<0.05) in the initial weight of the different strains. Hubbard broiler chickens wereweighed and found heavier than the Nigerian indigenous chickens. This could be due to rapid growth rate and body size compared to the Nigerian indigenous chickens. Hubbard chickensgained the highest (36.50 g) while FF chicken gained the lowest (27.58 g) initial weights. There were significant differences (p<0.05) in FWT and TWG of the birds. The variation observed in all these parameters indicated that Hubbard broiler (HB) chicken strains performed better than the Nigerian

Table 2: Effects of genotype and sex on growth performance of experimental birds

	Parameter							
Genotypes	Sex	IWT (g)	FWT (g)	TWG (g)	WWG (g)	TFI (g)	WFI (g)	FCR
FE		28.98[b]	1840.99[b]	1812.02[b]	90.61[b]	3012.40[b]	150.62[b]	1.68[b]
FF		27.58[c]	1404.95[c]	1377.37[d]	68.87[d]	2512.00[e]	125.6[e]	1.89[c]
NF		28.71[b]	1391.11[d]	1362.41[d]	68.12[d]	2552.00[d]	127.62[d]	1.92[d]
NN		28.63[b]	1451.76[c]	1423.13[c]	71.16[c]	2597.00[c]	129.85[c]	1.88[c]
HB		36.50[a]	1966.80[a]	1930.30[a]	96.51[a]	3084.61[a]	154.23[a]	1.60[a]
±SEM		0.33	21.2	21.07	1.05	16.37	0.82	0.02
	F	27.20[b]	1727.91[b]	1700.71[b]	85.04[b]	3023.12[b]	151.16[b]	1.75[b]
	M	31.54[a]	2003.5[a]	1971.95[a]	98.59[a]	3100.31[a]	155.02[a]	1.54[a]
	±SEM	0.41	25.34	26.00	1.04	14.43	0.79	0.04
Genotype	*Sex							
FE	F	25.69[b]	1631.32[b]	1605.63[b]	80.28[b]	2729.56[c]	136.48[d]	1.67[a]
FF	F	25.16[c]	1597.66[c]	1572.50[c]	78.63[c]	2830.50[b]	141.53[c]	1.77[b]
NF	F	24.95[c]	1584.33[c]	1559.38[c]	77.97[c]	2838.06[b]	141.90[c]	1.79[b]
NN	F	26.28[b]	1537.38[d]	1511.10[c]	75.56[d]	2886.20[b]	144.31[b]	1.88[c]
HB	F	33.93[a]	2154.75[a]	2120.81[a]	106.04[a]	3562.97[a]	178.15[a]	1.65[a]
FE	M	31.77[b]	2017.40[b]	1985.63[b]	99.28[b]	3474.84[b]	173.74[b]	1.72[b]
FF	M	27.74[c]	1761.49[d]	1733.75[c]	86.69[d]	3207.44[c]	160.37[d]	1.82[c]
NF	M	27.69[c]	1758.32[d]	1730.63[c]	86.53[d]	3288.19[c]	164.41[c]	1.87[c]
NN	M	29.56[ab]	1877.06[c]	1847.50[b]	92.38[c]	2992.95[d]	149.65[e]	1.59[a]
HB	M	40.94[a]	2599.69[a]	2558.75[a]	127.90[a]	4068.41[a]	203.42[a]	1.56[a]
	±SEM	0.73	23.13	23.45	1.07	47.34	0.68	0.09

[a,b,c,d,e]Means in the same column bearing different superscripts are significantly different (p<0.05). FE: Fulani ecotype, FF: Frizzle feather, NF: Normal feather, NN: Naked neck, HB: Hubbard broiler, SEM: Standard error mean, IWT: Initial weight, FWT: Final weight, TWG: Total weight gain, WWG: Weekly weight gain, TFI: Total feed intake, WFI: Weekly feed intake, FCR: Feed conversion ratio, M: Male and F: Female

indigenous genotypes (NF, NN, FF and FE) in terms of growth performance. Hubbard (HB) presented the highest final weight (1966.80 g) and total weight gain (1930.30 g) while the NF had the lowest final weight (1391.11 g) and total weight gain (1362.41 g). Among the Nigerian strains, FE had the highest (1840.99 g) while NF had the lowest final body weight (1391.11 g) during the experimental period. Similarly, significant difference (p<0.05) in total feed intake (TFI) indicated that Hubbard chicken had the highest feed intake. Hubbard birds (HB) consumed the highest quantity of feed (3084.61 g) while FF had the least feed intake (2512.00 g) but FE had the highest values of TFI (3012.40 g) among the indigenous chickens. This showed that FE strain could generally be regarded as heavy chicken breed and could be incorporated into a meat producing indigenous chicken. Finally, FCR was significantly different (p<0.05) among all the genotypes, however, the exotic broiler strain utilized its feed more efficiently than the indigenous strains.

The sex was significantly different (p<0.05) in all the parameters. Male chickens had higher values and thus were heavier than their female counterparts. Initial weight for male was 31.54 g while for female was 27.20 g, the values recorded for FWT and TWG in males were higher than that of the females. The TFI, WGI and FCR of males were significantly different (p<0.05) from that of the females. The interaction between the sex and genotype showed significant differences (p<0.05) among the birds for the parameters. The initial weight of the birds was significantly different (p<0.05). Hubbard male and female had the highest value (40.94 and 33.93 g) among the chicken genotypes. The normal feather (NF) male and female had the lowest value (27.69 g and 24.95 g). The results of final weight and total weight gain were also significantly different (p<0.05). For male, The HB male had the highest final weight (2599.69 g) and total weight gain (2558.75 g) and while NF had the lowest final weight (1758.32 g) and total weight gain (1730.63 g). The HB female had the highest final weight (2154.75 g) and total weight gain (2120.81 g) while the NN had the lowest final weight (1537.38 g) and total weight gain (1511.10 g). Results of interaction showed that the HB male was the highest feed consumer with TFI (4068.41 g) and WFI (203.42 g) while NN male consumed the lowest quantity of feed with TFI (2992.95 g) and WFI (149.65 g). Similarly feed intake was the highest in HB female with TFI 3562.97 g and WFI 178.15 g. The feed intake was the least in FE female with TFI 2729.56 g and WFI 136.48 g. The interaction of FCR showed that HB male had the best FCR while NF had the poorest. Similarly, HB female had the best FCR (1.65) while NN female had the poorest FCR (1.88).

The results showed that the initial weights of indigenous birds were lower than those of the exotic chickens. Previous studies had reported the lower initial weights of indigenous birds compared to the exotic ones[25,26]. The results of this study agree with the findings of Ejekwu *et al.*[27] who reported that initial weights of indigenous chicken was between 25-32 g. The present study showed that the growth performance of exotic chickens was better than indigenous genotypes. The average final weight recorded in the present study was higher than those reported by Apuno *et al.*,[28]. Similar result was reported by Mopate and Lony[29] for scavenging indigenous chickens of N'djamena, Chad. Significant differences among the body measurements were in line with the results of several previous studies[30-33]. Results of the present study also agree with Fayeye *et al.*[34] who reported significant differences among chicken genotypes and their linear body dimensions. The present The present study agrees with the findings of Atansuyi *et al.*[35] who reported that exotic chicken breeds were heavier than their indigenous counterparts. Patra *et al.*[36] reported that naked neck chickens were heavier than their normal feather counterparts. Similarly, Galal[37] reported the superiority of naked neck and frizzle genes over normal feather chickens in body weight which disagree with the present study because the result showed no significant difference in their weights. Also, the result of this study are in line with the findings of Adebambo *et al.*[38]; Olawumi and Dudusola[39] who reported significant differences in feed efficiency among different chicken strains. Badubi *et al.*[40], Msoffe *et al.*[41] reported differences in live weights between Botswana and Tanzania ecotypes respectively. The reason for fluctuation in different results and especially low live weight in indigenous chicken has been attributed to poor management[40]. Aganga *et al.*[42]; Badubi *et al.*[40]; Mwalusanya *et al.*[43] suggested genetic, nutritional and parasitic problems as possible reasons for variation. The variations recorded in the growth performance of the birds in this study were probably due to their genotypes. Major genes have been reported to show pronounced effect on the performance of indigenous chicken in the tropics[44]. Feed intake was the highest in the Hubbard birds followed by Fulani ecotype. Atansuyi *et al.*[35] reported that feed intake was the highest in naked neck among the indigenous chickens and this result was not in agreement with the findings of the present study. According to some previous reports, frizzle feather and naked neck genes had the better feed conversion ratio when compared to their normal feather counterpart[44,45]. This result agrees with a previous study by Garces *et al.*[46] who reported that there was no significant differences in the performance of these two indigenous chickens. The smaller body size of indigenous chickens has been considered important as it reduces maintenance requirements and conferred better efficiency of temperature. It had been reported that the use of sex-linked dwarf genes (dw) causes 20-30% reduction in size in poultry improvement programme[9]. Generally, males were bigger than the females. This was not too surprising as body weight accounted for the largest dimorphism in all the chicken genotypes used for this study. According to Remes and Szekeley[47], difference in sizes of males and females was a key evolutionary feature that was related to ecology, behaviour and life histories of organisms. Such dimorphism had been reported in indigenous chickens in some African countries[34,48] and in turkey[49].

Table 3 shows the effect of strain and sex on the carcass characteristics of the experimental birds. Hubbard meat type chicken strain had the highest and significant ($p<0.05$) yields among the carcass traits in this study. However, Fulani ecotype (FE) took the lead among the parameters for the indigenous chickens, followed by naked neck (NN), frizzle feather (FF) and least with normal feather (NF). This showed that strain is a significant factor in the growth, development and carcass yield of animals especially chickens. Some important carcass traits in chickens [live weight (LWT), drumstick weight (DSW), thigh weight (THW) and breast weight (BRW)] were significantly ($p<0.05$) different among the indigenous chicken genotypes. Some carcass traits were the highest in FE [(2149.60) LWT, (230.50) DSW, (249.50) THW and (436.00) BRW]. Some carcass traits were the lowest in NF [(1389.30)LWT, (134.63) DSW, (153.50) THW and (237.75) BRW]. Breast weight (BRW) was the heaviest in carcass traits among the chicken strains.

The effect of sex on the chicken strains was significantly different ($p<0.05$) between the two sexes for each strain among the parameters. However, males generally weighed more than the females in all the parameters. This showed that the sex hormones characteristically determined the growth pattern, carcass composition and meat yield of male animals. Similar trend was observed in the interaction effect of strain and sex for the carcass traits.

The present study showed that live, dressed, eviscerated weights and carcass yields were significantly different ($p<0.05$) among the genotypes considered in this study. This result agree with the findings of Cömert *et al.*[50] who recorded significant differences ($p<0.05$) in the live weight and all carcass composition across different genotypes. Also, Devatkal *et al.*[51] observed significant differences ($p<0.05$) in the yield of various cut-up parts of four indigenous chicken genotypes. In the present study breast muscle yield was the highest in HB across the five chicken genotypes. This result was similar to the previous studies conducted by Fotsa and Manjeli[52], Fotsa *et al.*[53], Kokoszyński and Bernackic[54] and Fotsa[55] who obtained a better growth in the improved chicken

Table 3: Effects of genotype, sex and their interaction on carcass characteristics of experimental birds

	Parameter										
Genotype	Sex	LWT (g)	DWT (g)	SWT (g)	DSW (g)	THW (g)	BRW (g)	BAW (g)	HWT (g)	NWT (g)	WWT (g)
FE		1840.99^{b}	1663.89^{b}	99.13^{a}	230.50^{b}	249.50^{b}	436.00^{b}	342.63^{a}	51.50^{a}	91.37^{a}	187.75^{a}
FF		1404.95^{c}	1250.55^{c}	59.75^{c}	122.00^{e}	129.75^{e}	232.00^{d}	183.50^{c}	36.37^{c}	61.50^{b}	111.50^{c}
NF		1391.11^{c}	1248.21^{c}	69.50^{bc}	134.63^{d}	153.50^{d}	237.75^{d}	190.38^{bc}	42.12^{b}	63.37^{b}	127.13^{c}
NN		1451.76^{c}	1308.46^{c}	71.63^{b}	194.13^{c}	166.63^{c}	302.38^{c}	249.75^{b}	43.37^{b}	62.25^{b}	161.75^{b}
HB		1966.80^{a}	1832.30^{a}	105.50^{a}	246.00^{a}	261.75^{a}	504.75^{a}	346.63^{a}	55.50^{a}	91.37^{a}	189.38^{a}
±SEM		109.35	102.41	6.33	15.12	14.38	25.47	21.65	2.76	6.62	9.80
	F	1727.91^{b}	1582.01^{b}	67.30^{b}	153.85^{b}	167.95^{b}	303.55^{b}	232.15^{b}	40.30^{b}	61.95^{b}	137.10^{b}
	M	2003.50^{a}	1872.20^{a}	94.90^{a}	217.05^{a}	216.50^{a}	381.60^{a}	292.75^{a}	51.25^{a}	85.85^{a}	173.90^{a}
	±SEM	103.66	98.24	4.70	12.93	14.17	28.36	20.28	1.98	4.61	8.50
Genotype*	Sex	1631.32^{b}	1471.02^{b}	80.75^{b}	191.25^{b}	214.75^{b}	343.25^{b}	309.00^{b}	45.50^{b}	79.00^{b}	161.00^{b}
FE	F	2017.40^{a}	1823.40^{a}	117.50^{a}	269.75^{a}	308.750^{a}	528.75^{a}	376.25^{a}	57.50^{a}	103.75^{a}	214.50^{a}
FF	F	1597.66^{b}	1433.36^{b}	48.00^{b}	99.25^{b}	118.75^{b}	218.50^{b}	159.50^{b}	32.50^{b}	55.00^{b}	99.00^{b}
	M	1761.49^{a}	1616.99^{a}	71.50^{a}	144.75^{a}	140.75^{a}	245.50^{a}	207.50^{a}	40.25^{a}	68.00^{a}	124.00^{a}
NF	F	1584.33^{b}	1460.33^{b}	59.75^{b}	111.75^{b}	141.25^{b}	219.00^{b}	166.25^{c}	37.00^{b}	59.75^{b}	112.00^{b}
	M	1758.32a	1596.52^{a}	79.25^{a}	157.50^{a}	165.75^{a}	256.50^{a}	214.50^{a}	47.25^{a}	67.00^{a}	142.25^{a}
NN	F	1537.38^{b}	1399.08^{b}	63.50^{b}	168.50^{b}	159.00^{b}	293.50^{b}	218.00^{b}	40.25^{b}	51.75^{b}	146.00^{b}
	M	1877.06^{a}	1728.86^{a}	79.75^{a}	219.75^{a}	174.25^{a}	311.25^{a}	281.50^{a}	46.50^{a}	72.75^{a}	177.50^{a}
HB	F	2154.75^{b}	1967.05^{b}	84.50^{b}	198.50^{b}	206.00^{b}	425.75^{b}	308.00^{b}	46.25^{b}	64.25^{b}	167.50^{b}
	M	2599.69^{a}	2433.69^{a}	126.50^{a}	293.50^{a}	293.00^{a}	583.75^{a}	384.00^{a}	64.75^{a}	117.75^{a}	211.25^{a}
	±SEM	108.13	100.47	5.11	13.42	15.02	27.17	27.11	2.65	6.38	10.04

[a,b,c,d,e]Means in the same column bearing different superscripts are significantly different (p<0.05), FE: Fulani ecotype, FF: Frizzle feather, NF: Normal feather, NN: Naked neck, HB: Hubbard broiler, SEM: Standard error mean, LWT: Live weight, DWT: Dress weight, SWT: Shank weight, DSW: Drumstick weight, THW: Thigh weight, BRW: Breast weight, BAW: Back weight, HWT: Head weight, NWT: Neck weight and WWT: Wing weight

stock. However, FE was the highest among the indigenous chicken genotypes. Similar observations were seen in drumstick and thigh muscle mass. The findings of this study are in line with those of Cömert *et al.*[50] and Devatkal *et al.*[51]. In this study, males were generally heavier in live, dressed and eviscerated weights, breast yields and other cut-parts. This could be as a result of differences in growth performance. The interaction between strain and sex were significantly different (p<0.05) in this study.

The body weight and breast yields of both sexes recorded in this study agree with the findings of Kidd *et al.*[56]. These changes have driven the poultry industry to put an emphasis on the improvement of breast meat yield and muscle mass development[57]. For these reasons, the breeder industry constantly strives to improve the genetic selection criteria for better growth performance and carcass traits of poultry[58]. Indeed, according to Sante *et al.*[59] the breast weight in relation to carcass weight is an important selection criterion in poultry production. Thus, Fulani ecotype and naked neck chickens had the higher carcass weight and breast meat and might be incorporated into a meat producing indigenous chickens as compared to the other indigenous chickens used in this study.

Table 4 shows the organ characteristics of the chicken genotypes used in this experiment. The chicken genotypes used in this study were statistically different (p<0.05). The gizzards were found to be the heaviest in all the organ parameters and were significantly different (p<0.05). The gizzard of Hubbard chicken was the largest (44.62 g) followed by naked neck (35.25 g) and least was in frizzle feather chickens (26.12 g). Likewise, the Hubbard chickens had higher share (22.00 g) of abdominal fats followed by frizzle feather (18.75 g) and least in naked neck chickens (11.25 g). Abdominal fats were significantly different (p<0.05) among the chickens.

The gizzard and abdominal fats were not significantly different (p>0.05) between the chicken sexes among the genotypes. Male chickens had significantly higher weight of Gizzard and abdominal fats (36.00 and 14.88 g) than those of the female chickens (31.70 and 14.82 g) respectively.

The interaction between genotype and sex showed that the gizzards had higher weight in males Hubbard meat-type chickens (44.00 g) and in frizzle feather (28.75 g) than those of the female Hubbard chickens (43.25 g) and frizzle feather (23.50 g). The effect of sexual dimorphism and hormonal differences might have accounted for this variation. Also, AFW was the highest in HB chickens compared to the other genotypes. Among the indigenous chickens, abdominal fat weight was the highest in male (19.50 g) and female (18.00 g) frizzle feather (FF). This might invariably affect the meat quality of FF chicken carcasses.

Gizzard and abdominal fat were seen to be higher in females than those of the males and did not follow any particular trend. According to the literature, the mean yield for slow-growing chickens ranged from 4-17% for abdominal

Table 4: Effect of genotype, sex and interaction on organ characteristics of experimental birds

	Parameter									
Genotype	Sex	LIW (g)	HEW (g)	LUW (g)	SPW (g)	GIW (g)	PAW (g)	PRW (g)	BUW (g)	AFW (g)
FE		32.00^{b}	8.75^{b}	12.75^{a}	1.75^{c}	33.50^{b}	3.00^{b}	9.50^{b}	2.50^{a}	11.42^{d}
FF		28.87^{c}	7.75^{c}	7.37^{e}	1.87^{c}	26.12^{c}	2.62^{c}	6.25^{c}	2.00^{a}	18.75^{b}
NF		24.12^{d}	6.00^{d}	9.37^{d}	1.62^{d}	29.75^{c}	2.25^{c}	6.37^{c}	2.37^{a}	13.25^{c}
NN		25.00^{d}	7.75^{c}	10.00^{c}	2.00^{b}	35.25^{b}	3.25^{a}	6.75^{c}	1.62^{b}	11.25^{d}
HB		36.00^{a}	9.25^{a}	11.50^{b}	2.62^{a}	44.62^{a}	3.62^{a}	10.25^{a}	2.12^{a}	22.00^{a}
±SEM		2.07	0.9	1.34	0.30	2.81	0.24	0.62	0.25	3.62
	F	27.25^{b}	7.00^{b}	7.95^{b}	1.70^{b}	31.70^{b}	2.90	6.90^{b}	2.05^{b}	14.82
	M	31.95^{a}	8.80^{a}	12.45^{a}	2.64^{a}	36.00^{a}	3.00	8.7^{a}	2.2^{a}	14.88
	±SEM	1.66	0.69	0.79	0.85	2.18	0.18	0.51	0.17	2.29
Genotype*	FE	Sex								
	F	28.50^{b}	6.25^{b}	8.25^{b}	1.75	28.25^{b}	2.75^{b}	8.75^{b}	2.50	10.25^{b}
	M	39.50^{a}	10.25^{a}	14.25^{a}	1.75	38.75^{a}	3.25^{a}	11.25^{a}	2.50	13.00^{a}
FF	F	29.50	8.25^{b}	6.50^{b}	1.50^{b}	23.50^{b}	2.50^{b}	5.75	2.25^{a}	18.00^{b}
	M	28.25	7.25^{a}	8.25^{a}	2.25^{a}	28.75^{a}	2.75^{a}	6.75	1.75^{b}	19.50^{a}
NF	F	22.25^{b}	5.50^{b}	7.00^{b}	1.50^{b}	28.55^{b}	2.00^{b}	5.50^{b}	2.00^{b}	16.75^{a}
	M	26.07^{a}	6.50^{a}	11.75^{a}	1.75^{a}	31.25^{a}	2.50^{a}	7.25^{a}	2.75^{a}	9.75^{b}
NN	F	22.50^{b}	7.75	8.75^{b}	1.50^{b}	33.25^{b}	3.50^{b}	6.25	1.75	13.25^{a}
	M	27.50^{a}	7.75	11.25^{a}	2.50^{a}	37.25^{a}	3.00^{a}	7.25	1.50	9.25^{b}
HB	F	33.50^{b}	7.25^{b}	9.50^{b}	2.25^{b}	43.25	3.75	9.25^{b}	1.75^{b}	18.33^{b}
	M	38.50^{a}	11.25^{a}	13.75^{a}	3.00^{a}	44.00	3.50	11.25^{a}	2.50^{a}	24.75^{a}
	±SEM	2.43	1.01	1.36	0.39	3.45	0.33	0.72	0.34	3.20

^{a,b,c}Means in the same column bearing different superscripts are significantly different ($p<0.05$), FE: Fulani ecotype, FF: Frizzle feather, NF: Normal feather, NN: Naked neck, HB: Hubbard broiler, SEM: Standard error mean, LIW: Liver weight, HEW: Heart weight, LUW: Lungs weight, SPW: Spleen weight, GIW: Gizzard weight, CRW: Crop weight, PAW: Pancreas weight, PRW: Proventriculus weight, BUW: Bursal weight and AFW: Abdominal fat weight

fat[60-63]. The results obtained in this study were within the range of abdominal fat cited in literature. The extremely low abdominal fat found in this study was similar to the result of Fotsa[55] who observed that the carcasses of Label Rouge and local chickens raised in similar conditions in Cameroun were extremely lean, without abdominal fat. The low fat contents in Hubbard chickens observed in this study may be due to their high metabolic rate in converting fats to muscle.

Table 5 shows the analysis of profitability in Naira for the five-chicken strains. The single most expensive item of variable cost was feeds cost. The cost of feed constituted the greatest share of the total variable cost and it is accounted for 43% of the total variable cost among the five strains of chicken. This is in consonance with the findings of Onyenweaku and Effiong[64] who found that feed is the single most expensive item associated with poultry production. This increase is due to the high cost of poultry feed ingredients such as maize, groundnut cake, soybean meal and scarcity of wheat and corn offal. The summation of cost of birds and feeds accounted for a higher proportion (82%) of the total variable expenses. The depreciated average fixed cost for raising each of the five strains of chicken was found to be ₦3,222.78. The cost of poultry pen construction was the single most expensive item of fixed cost. The depreciated cost of pen construction for each of the five strains of chicken accounted for higher proportion (81.35%) of the depreciated average fixed cost. The total cost incurred in the production of each of the chicken strain was ₦35,722.78.

The total revenue is the amount obtained from sale of dress weight of chicken (kg). It is obtained by multiplying the dress weight of each of the five strains of chicken by their corresponding market price. The total revenue (₦135,000) accrued from sale of Hubbard broiler genotypes was found to be slightly higher than the Fulani ecotype (₦127,500) among the Nigerian indigenous genotypes. This slight variation in total revenue from the two strains of chicken was due to high dress weight of the Fulani ecotype of chicken which compares favourably with Hubbard broiler genotypes (HB) which is an exotic strain of chicken. The higher dress weight and increased in total revenue showed that Fulani ecotype genotypes could generally be regarded as heavy breed chicken and could be incorporated into a meat producing indigenous chicken. The total revenue obtained from other Nigerian indigenous genotypes was ₦97,500;₦97,500;₦90,000 for naked neck, frizzle feather and normal feather respectively. The variation in total revenue observed in the five strains of chickens could be attributed to the variation in their dress weight.

The four profitability indicators used to measure the extent of returns from the production of the five strains of chickens were gross margin, net farm income, rate of return on investment (RROI) and benefit cost ratio. For Fulani ecotype, the gross margin, net farm income, RROI and benefit cost ratio

Table 5: Profitability analysis of five experimental chicken strains

Variables	Treatments Fulani ecotype (FE)	Frizzle feather(FF)	Normal feather (NF)	Naked neck (NN)	Hubbard broiler (HB)
Variable cost	Mean value (₦)	Mean value (₦)	Mean value (₦)	Mean value (₦)	Mean value (₦)
Cost of birds	12500	12500	12500	12500	12500
Cost of feed	14000	14000	14000	14000	14000
Other costs	6000	6000	6000	6000	6000
Total variable cost (TVC)	32500	32500	32500	32500	32500
Fixed cost (depreciated cost)					
Cost of poultry pen	2621.87	2621.87	2621.87	2621.87	2621.87
Cost of drinkers	250.34	250.34	250.34	250.34	250.34
Cost of feeders	350.57	350.57	350.57	350.57	350.57
Total fixed cost (TFC)	3222.78	3222.78	3222.78	3222.78	3222.78
Total cost	35722.78	35722.78	35722.78	35722.78	35722.78
Revenue					
Dress weight (Kg)	1.7	1.3	1.2	1.30	1.8
Price per kg (₦)	1500	1500	1500	1500	1500
Total revenue(₦)	127500	97500	90000	97500	135000
Profitability indicators					
Gross margin (TR - TVC)	95000	65000	57500	65000	102500
Net farm income (TR-TC)	90726.68	60726.68	53226.68	60726.68	98226.68
RROI (NFI/TC)×100)	246.72	165.14	144.74	165.14	267.11
Benefit cost ratio (BCR) = TR/TC	3.47	2.65	2.45	2.65	3.67

were estimated to be ₦95,000, ₦90,726.68, 246.72% and 3.47 respectively. The corresponding values for the Hubbard broiler genotypes were ₦102,500; ₦98,226.68; 267.11% and 3.67. Thus, the results were comparable and do not show any considerable difference in profitability between Fulani ecotype which is one of the Nigerian indigenous genotypes and Hubbard broiler genotypes (exotic strain). The gross margin, net farm income, RROI and benefit cost ratio were found to be similar for frizzle feather and naked neck with the value of ₦65,000; ₦60,726.68; 165.14% and 2.65 respectively. The results obtained for normal feather was lower than those of the other Nigerian indigenous genotypes. For normal feather the gross margin, the net farm income, the RROI and the benefit cost ratio was ₦57,500,₦53,226.68,144.74% and 2.45 respectively. The higher values of profitability indicators for Fulani ecotype suggested that raising of Fulani ecotype as meat type of chicken is more profitable for poultry farmers compare to other Nigerian indigenous genotypes.

CONCLUSION AND RECOMMENDATIONS

The results of the study showed that strain and sex had significant effects on growth performance, carcass and organ characteristics. Most of the parameters showed that Hubbard meat type chickens were better in growth performance. Among the indigenous strains, Fulani ecotypes were superior to others while normal feather chickens were the inferior in terms of growth performance, carcass and organ characteristics and profitability evaluations. The males generally performed better than females in most parameters studied and were more profitable to rear. The higher values of profitability indicators such as gross margin, net farm income, rate of return on investment and benefit cost ratio suggested that raising of Fulani ecotype as meat type indigenous chicken would be more profitable for poultry farmers than the other Nigerian indigenous chicken strains. The study suggested that Fulani ecotype strain could be regarded as heavy breed chicken and might be incorporated into a meat producing indigenous chicken in Africa and Nigeria in particular if improved upon.

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