COMPARATIVE GROWTH PERFORMANCE, NUTRIENT DIGESTIBILITY, AND ECONOMIC EFFICIENCY OF FIVE BROILER STRAINS FED A COMMON DIET

Authors' contributions

This research work was carried out in collaboration with all authors. All authors were responsible for the design and execution of this research work. All authors have carefully read and approved of the manuscript.

Original Research Article

Abstract

A 56-days study trial was designed to determine the growth, nutrients digestibility and economic response of five broiler breeds fed common diet. A total of 200 day-old broiler chickens comprising of 40 each of Cobb 500, Arbor acres plus, Ross 308, Hubbard classic, and Marshall representing T1, T2, T3, T4 and T5 respectively. The completely randomized design was used with each treatment (T) comprising of 4 replicates of 10 birds each. The result of the starter broiler chickens revealed superiority (P<0.05) of the Cobb 500 strain in average daily feed intake (28.02 g/day/bird) over the rest, with the final weight, average daily weight gain and feed conversion ratio similar across the strains. At the finisher phase, significant (P<0.05) variations were observed across the broiler strains in final weight, average daily weight gain (ADWG) and feed conversion ratio (FCR). The ADWG and FCR, a fairly consistent result was obtained. Higher final weight of 2362.50g/bird was recorded in the Arbor acre strain. This result also revealed that, Arbor acre, Ross 308 and Hubbard had significantly (P<0.05) higher ADWG (43.53, 40.11 and 39.36 g/bird/day respectively) with Arbor acre and Ross 308 strains having significantly (P<0.05) higher or better FCR (2.31 and 2.55). The digestibility of the proximate fractions by the different strains of finisher broiler chickens showed a similar result across the groups. The result of cost/kg feed was similar (702.44 ₦/kg) across the treatment groups. High revenue and profit were obtained in the Arbor acre strain of birds than the rest. Total production cost was also observed to be low in the Arbor acre followed by the Cobb strain. From the result of the study, it was concluded that Arbor acre and the Ross 308 strains had a higher body weight gain with a better efficiency in feed utilization thus, more economical for poultry farmers.

Keywords: growth; digestibility; economic of production, broiler strains; common diet

1.Introduction

Due to increase in population, urbanization, export drive and improved standard of living, the poultry industry has witnessed an unprecedented demand in meat and eggs in recent time. Because of this increase in demand, it is important that a serious attention with regard to the development of breeds of meat type chicken available with traits of quick growth and high feed conversion efficiency [1].The performance of this meat type chickens depends on a number of factors which are basically genetic and the environment in which the bird is reared. Broiler strains commonly supplied to the farmers in Benue state and most parts of Nigeria include Arbor-acre, Hubbard, Cobb 500, Ross 308 and Marshall which were developed in Asia and Europe, hatched and distributed by some companies in south western Nigeria [2].

According to [3], there are contradictory reports on the superiority of the most common strains of broilers (Cob, Arbor acre, Hubbard classic and Marshall) with regards to their growth performance and carcass traits. The poultry farmer is therefore worried of these variations in performances believing that when poor or good performances are recorded, it is attributed to the

source or strain of stock, neglecting management and other environmental factors that add up to the overall performance of the birds. Based on the above, tests with commercial strains of broiler chicken become fundamental since characteristics of economic importance and of market preferences may be different between genetic ones. In a quest to ascertain the productive performance of these commercial birds, it became necessary to conduct this experiment. Therefore, this study aimed at determining the performance of different broiler strains fed common feed.

2. Materials and Method

2.1 Experimental site

This study was carried out at the Poultry Unit of the Livestock Teaching and Research Farm, Joseph Sarwuan Tarka University, Makurdi, Benue State. Makurdi is located between latitude 7^0 44"N and longitude 8^0 21"E in the Guinea Savanna zone of Nigeria. This area has an annual rainfall of between 6-8 months (March – October) ranging from 508 -1016mm with a minimum temperature range of 24.20±1.4^{0}C and maximum temperature range of 36.33±3.70^{0}C. The relative humidity ranges between 39.50±202% and 64.00±4.0% [4].

2.2 Source of materials and day-old chicks

Day-old broiler strains were obtained from different hatcheries and farms within Nigeria. Cobb 500 and Arbor acres plus were obtained from Zartech Limited, Lagos State. Ross 308 day-old broiler chicks was obtained from Sayed farms Limited, Oyo state. Hubbard classic was obtained from Afrimash, Ibadan Oyo State. Marshall day old chicks was obtained from Obasanjo farms in Ogun State. Raw materials for feed formulation; soybean meal was purchased from Seraph oil company limited,Makurdi, groundnut cake and other materials were obtained from God for us Livestock shop High Level Makurdi.

2.3 Experimental birds management and design

The birds were raised in half-walled building, on deep litter system throughout the study. Management practices on the farm was intensive with the birds given feed and water *ad libitum* throughout the period of the study. Management practices followed standard procedures for broiler breeding and management in line with breeders' recommendations. Routine medication and vaccination schedules were strictly adhered to. A deep litter housing system with wood shavings 2-3 inches high from the floor was used during brooding and entire rearing period. The litters were replaced with clean litter every 2 weeks to keep the birds free from microbial invasion and infections. Feeders and drinkers were provided at spatial interval to avoid overcrowding.

Forty (40) day old broiler chickens for each of the five broiler breeds (Cobb 500, Ross 308, Hubbard classic, Arbor acres plus and Marshall) totaling to two hundred (200) chickens were purchased from the hatcheries and used for this study. They were randomly assigned (minimizing weight differences) to five experimental groups designated as T1 (Cobb 500), T2 (Arbor acre), T3 (Ross 308), T4 (Marshal) and T5 (Hubbard classic) on the bases of their respective breeds. Each group was replicated four times with ten (10) birds per replicate in a

completely randomize design (CRD). All experimental groups were assigned to the same diet (starter and finisher diets respectively).

2.3Parameters Measured

2.3.1 Growth performance

a). **Weight gain**; The initial body weights of the birds were taken at the start of the experiment and subsequently on weekly basis. The difference between the final and initial weights gave total weight gain (TWG). Average daily weight gain (ADWG) was calculated as shown below:

Average daily weight gain (ADWG): ADWG= [(FW – IW) ÷ duration in days]

b). **Feed intake**; A known quantity of feed was supplied each day and the leftover in the following day was weighed. The difference between the feed supplied and the leftover gave the quantity of feed consumed per week. The accumulative feed consumed gave total feed intake (TFI). Average daily feed intake (DFI) was calculated as shown below:

Average daily feed intake, ADFI= [(FS – LOF) ÷ duration in days]

C). **Feed conversion ratio**; Values generated from daily weight gain and daily feed intake was used to calculate feed conversion ratio (FCR) as shown below:

Feed conversion ratio: FCR =Feed Conversion Ratio (FCR) = $\frac{\text{Quantity of feed consumed}}{\text{Weight gain}}$

2.3.2 Digestibility

A known quantity of feeds was given to the birds selected for digestibility and the corresponding faeces voided was collected and oven dried. The digestibility trial lasted for five (5) days. Effort was made to prevent contamination of faeces. The dried faecal samples collected were pooled for each replicate, then milled and sub-samples taken for proximate analysis in accordance with the procedure outlined by (5). Digestibility was computed as shown below;

Apparent Nutrient Digestibility = $\frac{Amount\ of\ nutrient\ in\ consumed - Amount\ of\ nutrient\ voided}{Amount\ of\ nutrient\ consumed} \times 100$

2.3.3 Economics of production

The cost per kilogram of each experimental diet was calculated based on the current prices of feed ingredients in Makurdi. To calculate the cost per kilogram of feed, the price /kg of each ingredient was multiplied by the quantity in kg of that ingredient in 1kg of feeds, and these values for all ingredients were summed. The cost of feeding each bird was calculated as the product of the unit cost of feed and quantity of feed consumed by the bird (Cost / kg feed x FI). The unit cost of the diet was multiplied by feed conversion ratio (i.e. Cost/kg WG=Cost / kg feed x FI/WG) to get feed cost per kg weight gain. The total production cost (TPC) was estimated by summation of all expenses made during the study period. Revenue was gotten from the sale of the live broiler chicken (1 kg of bird was sold at ₦ 2200). Profit from production was estimated as difference between revenue and total cost of production.

2.4Statistical Analysis

Data collected were subjected to one-way Analysis of variance (ANOVA) for completely randomized design (CRD) and where significant differences were found, the differences in means were separated using Duncan Multiple's Range Test (DMRT) using the statistical package [6] as described by [7].

3.Results and Discussion

Table 1 showed the growth performance of five different strains of starter broiler chickens fed a common diet. The final weight, average daily weight gain and feed conversion ratios were observed to be significantly 0(P>0.05) similar across the broiler strains.The result of this study revealed superiority (P<0.05) of the Cobb 500 strain in average daily feed intake(28.02 g/day/bird)over the rest.

Table 1: Growth Traits of different Strains of Starter Broiler Chickens Fed a Common Diet

Parameters	Broiler Strains						
	1	2	3	4	5	SEM	P
Initial weight g	38.00	37.78	37.70	37.65	36.82	0.23	0.61
Final weight g	1126.95	1143.75	945.14	987.36	982.68	35.67	0.27
ADWG g	38.89	39.50	32.42	33.92	33.78	1.27	0.27
ADFI g	28.02^{a}	25.87^{b}	25.17^{b}	24.56^{b}	24.33^{b}	0.41	0.01
FCR	0.72	0.67	0.78	0.72	0.72	0.02	0.66

abc=means on the same row with different superscripts are significantly (P<0.05) different from each other, ADWG=average daily weight gain, ADFI-average daily feed intake, FCR=feed conversion ratio, 1=Cobb 500, 2=Arbor acre, 3=Ross 308, 4=Marshall, 5=Hubbard classi

Theinitial weights of the starter broiler chickensweresimilar (P>0.05) among the five strains of starter broiler chickens evaluated. This result contradicted with the findings of [8] who reported significant (P<0.05) differences between the breeds measured saved for the Marshall. This lack of difference in the initial weight of these breeds may be due to the fact that, the genetic base of these commercial breeds is the same and therefore the performance traits are likely to be similar among commercial breeds. However, there is evidence that there are genetic differences in growth rate between strains [9]. According to [10], strain of chicken affect mean of body weight and gain at different ages implying that, age and genotype could have accounted for differences in the initial weights, final weights and average daily weight gain. This observation was however not recorded in the present study. The initial weight recorded was in the range of 33.09 – 39.05 g reported by [8]. [11]also, reported a similar (P>0.05) initial weights among strains which was consistent with this study. The range of values (440.00, 450.00 and 485.00 g) reported for initial weights for Cobb, Ross and Arbor acre strains respectively by these authors however were higher the range of values recorded in the present study.

The present study revealed that, the final weights were also not significantly (P>0.05) affected by strains of broiler chickens. This implies that although the strains of broiler chickens may differ, there was absence of genetic variation which manifested in their comparable final weight at the starter phase. This observation affirms an earlier finding of [12] who reported that even though, there existed superiority in one of the strains (Ross 308)in initial weight over the Arbor Acre strain, at the end of the experiment, the final body weight, was not affected by treatments for both strains.

Contrary to the report of [12] however, this study revealed no significant variations in average daily weight gain. This result also was at variant with the observation of [11] who reported significant variation in the daily weight gain of the different strains of broiler chickens evaluated. Theresult of this work also disagrees the findings of [3] who got the highest weight gained for Cobb compared to other strains used in their study. Regarding feed intake, the result of this study was in favour of the Cobb strain. This differences between strains in feed consumption were confirmed by the results obtained by [13]. This differences in the quantity of feed consumed cannot be tied to genetic variability of the birds but, also to some environmental conditionssuch as management of the experimental birds. Confirming this observation, [14] affirm that there are several factors aside the breed/strainaffecting the productive and carcass performance of broiler chickens,and these factors include, nutrition, housing and stocking rate. Many reports [13, 14] indicate that genotype affects body weight, body weight gain, feed intake, and feed conversion ratio of broiler chickens. Feed conversion was however not affected resulting to a similar final weight.

The initial weight and average daily feed intake of the finisher broiler strains exhibited significantly (P>0.05) similar performances in all the strains. Result shown in Table 2 however, revealed that, significant (P<0.05) variations were observed across the broiler strains in final weight, average daily weight gain (ADWG) and feed conversion ratio (FCR). The ADWG and FCR, a fairly consistent result was obtained. Higher final weight of 2362.50g/bird was recorded in the Arbor acre strain. This result also revealed that, Arbor acre, Ross 308 and Hubbard had significantly (P<0.05) higher ADWG (43.53, 40.11 and 39.36 g/bird/day respectively) with Arbor acre and Ross 308 strains having significantly (P<0.05) higher or better FCR (2.31 and 2.55).

Table 2: Growth Traits of different Strains of Finisher Broiler Chickens Fed a Common Diet

Parameters	Broiler Strains						
	1	2	3	4	5	SEM	P
Initial weight g	1126.95	1143.75	945.14	987.36	982.68	35.67	0.27
Final weight g	2261.25^{b}	2362.50^{a}	2076.56^{b}	1858.75^{c}	2084.79^{b}	47.81	0.00
ADWG g	31.78^{b}	43.53^{a}	40.41^{a}	31.12^{b}	39.36^{a}	1.35	0.01
ADFI g	105.40	100.84	102.89	103.44	104.68	0.68	0.18
FCR	3.26^{c}	2.31^{a}	2.55^{a}	3.30^{c}	2.66^{b}	0.62	0.00

abc=means on the same row with different superscripts are significantly (P<0.05) different from each other, ADWG=average daily weight gain, ADFI-average daily feed intake, FCR=feed conversion ratio, 1=Cobb 500, 2=Arbor acre, 3=Ross 308, 4=Marshall, 5=Hubbard classic

Results of final weights and average daily weight gainagreed with the report of (11) who observed differences in the final weights and average daily weight gain of the different strains of broiler chickens studied. The values reported for the final weights (1950.05 to 2538.19 g/bird) by the authors were comparable to those found in the present study. The ADWG in this study was also lower than 52.33 to 74.67 g/bird/day reported by these authors. The ADFI in this study compared well with the values (98.55-140.13 g/bird/day) reported by [11]. This study revealed significant variation in final weights, average daily weight gain and feed conversion by the different strains of broiler chickens at the finisher phase. This result was at variant with the findings of the starter phase and [11] who reported similarity in FCR across the different strains.

The differences recorded in finalweights, ADWG and FCR can be said to be due to genetic variability and age of the different strains of the finisher broiler chickens. This factor has been shown to have great influence on growth performance characteristics. According to [15], there is evidence that there are genetic differences in growth rate between strains and this factor affects body weight and gain at different ages, significantly altered feed intake, feed conversion and feed conversion ratio. The higher final weight of Arbor acre in the finisher phase might arise from the genetic make-up during the embryonic stages, which can lead to these strains having a superior growth potential than Cobb 500, Ross308, Marshall and Hubbard classic strains and it may be possible owing to strain effect and some other environmental factors such as management.

It appears there exist variation in the efficiency of feed conversion measured by FCR between the two phases/stage growth of the birds. Younger birds have lower FCR values than older birds. This observation is supported by the findings of [16] who also observed that, as broiler grows older and larger, they consume more feed to meet the increasing requirement for maintenance, growth and fat deposition. The feed conversion ratio increased with age which indicates a reduction in feed efficiency. Thus, birds require more energy to grow and probably deposit fat.

The estimates of digestibility of feed dry matter and nutrients are presented in Table 3.The digestibility of the nutrients in the diet by the five different finisher broiler strains were consistent among all the birds. The digestibility of dry matter (DM), was similar (P>0.05) in all the broiler strains of chicken. The DM values ranged between 91.38 to 94.87 %. Similarly, no significant (P>0.05) strain effect were observed in the digestibility of nitrogen free extract (NFE), crude protein (CP), ether extract (EE) and crude fibre (CF).

Table 3: Apparent Nutrients Digestibility by different Strains of Finisher Broiler Chickens Fed a Common Diet

Parameters (%)	Broiler Strains						
	1	2	3	4	5	SEM	P
DM	93.08	93.99	94.87	92.66	91.38	0.57	0.40
NFE	96.26	96.69	97.12	95.68	94.85	0.35	0.28
CP	91.06	89.60	94.31	90.45	88.85	0.81	0.25
EE	96.87	97.35	96.93	95.51	95.13	0.39	0.30
CF	78.08	80.36	81.78	71.88	69.79	2.04	0.26

DM= dry matter, NFE=nitrogen free extract, CP=crude protein, EE=ether extract, CF=crude fibre, 1=Cobb 500, 2=Arbor acre, 3=Ross 308, 4=Marshall, 5=Hubbard classic

The digestibility values of nitrogen free extract (NFE), crude protein (CP) and crude fibre (CF) obtained in this study were higher than values (77. 98-88.98, 84.01-87.74 and 43.74-51.71 %) reported by [17] who utilized fermented *Mucuna pruriens* seed meal in the diet of finisher broiler chickens. Digestibility values of ether extract however, were similar to the range 85.75-90.85 % reported by these authors.

This similarity in performance between broiler strains is an indication that the diet contained similar level and types of nutrients and thus, shows that the birds digested these nutrients in a similar way. The values for these basic digestibility indices were higher than those observed by [18] who utilized toasted *Mucuna pruriens* seed meal in the diet of finisher broiler chickens. It is therefore evident in this study that, genetic base of these commercial breeds did not have any effect on the digestibility of these nutrients.

Table 8 showed the economics of production of different strains of broiler chickens fed a common diet. The result of cost/kg feed was similar (702.44 ₦/kg) across the treatment groups, while the result of cost of feed consumed, cost/kg weight gained, cost of production, revenue and gross revenue showed variations across the groups. High revenue and profit were obtained in the Arbor acre strain of birds than the rest. Total production cost was also observed to be low in the Arbor acre followed by the Cobb strain.

Table 8: Economics of Feeding different Strains of Finisher Broiler Chickens Fed a Common Diet (1-8weeks of feeding)

Parameters	Broiler Strains				
	1	2	3	4	5
Final weight (kg)	2.25	2.36	2.08	1.86	2.08
TFI (kg)	3.74	3.65	3.89	4.02	3.82
FCR	1.68	1.57	1.90	2.20	1.86
Cost of feed (₦/kg)	702.44	702.44	702.44	702.44	702.44
Feeding cost (₦/bird)	2627.13	2563.91	2732.49	2823.81	2683.32
Feeding cost (₦/kgWG)	1180.10	1102.83	1334.64	1545.37	1306.54
Cost/ Bird (₦/Bird)	1000	1000	1050	1000	1000
Medication (₦/Bird)	38.50	38.50	38.50	38.50	38.50
Miscellaneous (₦/Bird)	36.44	36.44	36.44	36.44	36.44
Total production cost (₦/Bird)	3702.07	3638.85	3857.43	3898.75	3758.26
Revenue (₦/Bird)	4950.00	5192.00	4576.00	4092.00	4576.00
Gross profit (₦/Bird)	1247.93	1553.15	718.57	193.25	817.74

TWG=total weight gain, TFI-total feed intake, FCR=feed conversion ratio, 1=Cobb 500, 2=Arbor acre, 3=Ross 308, 4=Marshall, 5=Hubbard classic, 1kg of broiler live weight=₦2200

The similar cost per kilogram of the feed observed in this study was expected owing to the fact that the diet offered through this period of study contained similar level of ingredients and nutrients composition, hence termed a common diet. Rather than the diet, the strains of the birds constituted the treatment similar to the design of (11). Contrary to the findings of (11), however, this study observed a high revenue and gross profit with a reduction in feeding cost, cost per

kilogram weight gain and total production cost in the Arbor acre strain compared to Cobb 500 and the others. It could be seen in this study however that, cost of day-old chick was high in Ross 308, implicating both genetic and environmental factors (the farm and cost of production).

The high final weights obtained from the Arbor acre accounts for the high revenue and profits recorded of this strain. Lower feed consumed resulted to a similar reduction in the cost of feeding recorded in Arbor acre and Cobb 500 strains of birds. The cost to gain a kg of weight was less in Arbor acre strain followed by Cobb 500. This is a manifestation of the feed to gain ratio of the experimental birds which is a reflection of a commensurate weight gained from low quantity of feed consumed (high efficiency) by these strains of birds. The contributions of total cost of production observed in the Marshall strain can be accounted for by the high cost of feeding which represents the product of the cost per kilogram of the feed and the amount feed consumed. Therefore, high amount of feed consumed will result to high cost of feeding thus, diets are formulated to promote the desired intake of all nutrients and to improve the growth rate at reasonable cost (11).

4.1 Conclusion

From the result of the study, it was concluded that Arbor acre and the Ross 308 strains had a higher body weight gain with a better efficiency in feed utilization thus, more economical for poultry farmers.

Competing Interests

Authors have declared that no competing interests exist

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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