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Comparative evaluation of growth parameters of four strains of broiler chickens fed two different feed types

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Target Audience*: Feed millers, Broiler producers, Feed producers, Researchers*

Abstract

Broiler production has evolved greatly in the last three decades, with advances in genetic improvement, nutrition and disease control. Feed and feeding have been the greatest cost of broiler production and efforts are geared at minimizing this cost, by improving feed utilization and feed conversion efficiency. This study examines the influence of feed type (crumbled or mash), strain and sex on the final weight, total weight gain and average daily gain. Four strains (Arbor Acre, Cobb, Marshall and Ross) of day-old chicks were studied, with 76 chicks from each strain all totalling 304 birds. The birds were grouped into two by feed type, and two replicates for each feed type comprising 76 chicks each across the strain were reared for 10 weeks. At the end of the study, 211 chicks comprising Arbor Acre (45), Cobb (49), Marshall (61) and Ross (56) were analysed to evaluate the effects of the studied variables on the chicks' growth parameters. Feed type, strain and sex exerted significant ($P<0.05$) influence on final weight, total weight gain and average daily gain, albeit at different levels. The crumbled composite feed (3-in-1) consistently outperformed the conventional starter-grower-finisher combo. The Marshall breed had lowest values on all growth parameters and the male birds recorded better performance in all growth parameters. Interactions among the fixed factors was not significant ($P>0.05$) in all growth parameters. The study revealed that the newly introduced Hybrid special 3-in-1 feed is a superior alternative to the conventional feeding method for broilers.

Keywords*: Broilers, Growth Parameters, Crumbled Feed, Ground Mash, Strain*

Description of Problem

The efficiency of broiler production has increased greatly in recent years, and this can be attributed to advancements in the areas of breeding, management, nutrition, and disease control (1). Improvement of management practices, and advances in nutrition and disease control as means of providing broiler birds with optimum environmental conditions have been aggressively pursued for maximal output.

Effect of several factors such as breed or strain, nutrition, sex, housing, and stocking density have been investigated and reported to affect the growth performance and carcass characteristics of broiler chickens (2, 3, 4, 5). Although, intensive genetic selection for fast growth in broiler chickens has dramatically shortened the growing period, some undesirable correlated selection responses such as excessive feed intake and consequently extreme carcass fatness have also occurred (6).

Breeders of meat-type chickens have become interested in adult body weight, which positively impacted heavier birds at early age in order to attract better price at market and greater profit margin. Live body weight at market age is known to be the most important traits in determining profit from

broiler enterprise. To this end, poultry breeders and researchers have tried to establish relationships between biochemical traits, body weight and body conformation traits as reflected on the growth and development of the broiler birds (7, 8).

Feed as a major component of input in broiler production needs to be monitored in terms of quality and quantity to minimize wastages and improve feed conversion efficiency in growing birds. Commercially compounded feeds for broilers are commonly produced in mash form targeted at different age group of birds, however recently some commercial feed mills are producing broiler feed in other forms that can be fed at all ages. Different types of feed forms (mash, pellet or crumbled) have been evolved in broiler production and the physical form of feed is a crucial factor in meat yield of broiler. One of such method is by pelleting to improve farm animal performance. While mash is a form of a complete feed that is finely ground and mixed so that birds cannot easily separate out ingredients; each mouthful provides a well-balanced diet. Pellet is a modification of the mash by mechanically pressing the mash into hard dry pellets or "artificial grains". It is also a form of complete feed that is compacted and extruded to about 1/8 inch in diameter and 1/4 inch in long. Crumbled however is prepared by pelleting the mixed ingredients and then crushing the pellet to a consistency coarser than mash, this feed type is becoming popular in broiler production due to its convenience of feeding. Aside from the conventional broiler age-based feeding of broilers by Starters – Growers – Finisher feed, some commercial feed millers have devised a "one-size fit-all" feed that are not age-based and need not be changed throughout the rearing period.

This study therefore aims to evaluate the effects of different feed types (mash / crumbled) on growth characteristics of four strains of broilers and to recommend the best feeding strategy to maximize profit.

Materials and Methods

Experimental Site: This experiment was conducted at the Broiler Rearing Pen of the Poultry Research Farm at Lagos State University, Ojo, Lagos, Nigeria, located at latitude 6° 27' 59.99" N and longitude 3° 10' 60.00" E in the humid tropics of south west Nigeria.

The pen consisted of four equally demarcated but contiguous parts with adjoining space for brooding, filled with wood shavings as deep litter system where the animals were kept throughout the study. The litters were replaced with clean aseptic litter every 2 weeks to keep the birds free from microbial invasion and infections. Feeders and drinkers were provided at spatial interval to avoid crowding, thereby minimizing mortality due to stampeding and overcrowding.

Management Practices: The farm is semi-intensive with the birds given feed and water *ad- libitum* throughout the period of the study and routine medication and vaccination schedules were strictly adhered to. Management practices on the farm followed standard procedures for semi-intensive deep litter rearing, for broiler breeding and management in line with breeders' recommendations, where birds were fed two different commercially compounded broiler feed using the Hybrid Feeds. The treatments were feed types used as the Hybrid 3 in 1 (3-in-1) crumbled feed for the first group and the Hybrid Starter and Finisher (SFC) mash feed for the second group. Feed for both treatment groups were equally measured and offered the birds at the same regimen.

Experimental Units: Four strains of day-old commercial broiler birds comprising Arbor

Acre, Cobb, Marshall and Ross were obtained from a reputable commercial hatchery in Ibadan, Oyo State. On arrival, there were 76 chicks for each of the four strains, all totalling 304 birds. On arrival after hatching, the birds were all tagged with identification number indicating their breed, and were subsequently weighed as soon as they are tagged, while the initial weight was immediately recorded.

Treatments: The feed types used in the study are the commercially produced Hybrid Feeds comprising the composite Hybrid Special 3 in 1 (3-in-1), Starter and Finisher feeds with the respective proximate composition as presented in Table 1.

Table 1: Proximate composition of the feed used as treatment[+]

Constituents	Hybrid Special 3-in-1	Hybrid Super Starter	Hybrid Broiler Finisher
Crude Protein	23%	22%	19.5%
Fat	5.5%	5.1%	5.5%
Crude Fibre	3.0%	4.3%	3%
Calcium	1.2%	1.2%	1.2%
Available Phosphorus	0.5%	0.45%	0.44%
Methionine	0.56%	0.56%	0.5%
Lysine	1.3%	1.3%	1.2%
Metabolizable Energy	3050Kcal/kg	3000Kcal/kg	3100Kcal/kg

[+]Source: Hybrid Feeds Limited

Table 2: Least Squares Mean and Standard Error of Growth Parameters

Variables	N	Mean ± SE Final Weight	Mean ± SE FWG	Mean ± SE ADG
Feed Type				
3-in-1	104	3087.92 ± 65.2[a]	3050.86 ± 65.1[a]	43.58 ± 0.93[a]
SFC	107	2657.35 ± 39.9[b]	2620.19 ± 39.8[b]	37.43 ± 0.57[b]
Strain				
Arbor Acre	45	3077.58 ± 87.5[a]	3039.75 ± 87.5[a]	43.43 ± 1.25[a]
Cobb	49	3101.61 ± 77.2[a]	3063.47 ± 77.4[a]	43.76 ± 1.11[a]
Marshall	61	2302.34 ± 44.9[b]	2269.59 ± 44.9[b]	31.42 ± 0.64[b]
Ross	56	3009.02 ± 66.5[a]	2969.12 ± 66.4[a]	42.42 ± 0.95[a]
Sex				
Male	86	2940.82 ± 64.5[a]	2903.60 ± 64.4[a]	41.48 ± 0.92[a]
Female	125	2804.45 ± 52.5[b]	2767.36 ± 52.4[b]	39.53 ± 0.75[b]
Overall	211	2837.50 ± 40.6	2800.50 ± 40.5	40.01 ± 0.58

Means with different superscript within the same column are statistically different ($P<0.05$)
FWG = Final Weight Gain (g), ADG = Average Daily Gain (g)?

Experimental design: There were two treatment groups (3-in-1 and SFC), with each treatment having 2 replicates, and the birds were randomly selected and randomly assigned to each of the replicates within and between treatment groups.

The birds were all subjected to the same environmental conditions except the difference in feed types which is being studied. The four replicates were randomly assigned 19 birds from each of the four strains, making a total of 76 birds in each replicate and two replicates were randomly assigned to each treatment. A check on the

average weight and variability within each replicate indicated there was no significant difference (P>0.05) in the initial weights across the four replicates.

Data Collection: Body weight of the birds were taken on a weekly basis and recorded by their identification number, using a 0.00g sensitive digital scale for 10 weeks. All the weekly weights along with the final weight of the birds were consistently recorded.

Statistical Analyses: All recorded data were entered in Microsoft Excel® worksheet. Aside from the weekly body weight measurements taken, indices such as final weight gain and average daily gain were computed from measured variables.

Final weight gain (FWG) was computed as $FWG = (Wt_f - Wt_0)$ and average daily weight gain (ADWG) was derived as $ADWG = \frac{(Wt_f - Wt_0)}{Length\ (Days)}$ where Wt_f is final weight and Wt_0 is initial weight.

All statistical analyses were done using the exploratory modules (boxplots, descriptive), general linear model analysis of variance and post-hoc tests (9). Further post-hoc test was done when an effect is significant using the Tukey's Honestly Significant Difference (HSD).

The statistical model describing the final analysis of variance is given as:

$$Y_{ijk} = \mu + F_i + B_j + S_k + (FB)_{ij} + (FS)_{ik} + (BS)_{jk} + (FBS)_{ijk} + e_{ijkl}$$

Where Y_{ijkl} is the recorded measure or index on each bird

μ is the overall mean

F_i is the i^{th} effect of the feed type (i = 2; 3-in-1, SFC)

B_j is the j^{th} effect of the strain (i = 4; Arbor Acre, Cobb, Marshall, Ross),

S_k is the k^{th} effect of the sex (i = 2; Male, Female)

$(FB)_{ij}$ is the effect of interaction of i^{th} feed type x j^{th} strain

$(FS)_{ik}$ is the effect of interaction of i^{th} feed type x k^{th} sex

$(BS)_{jk}$ is the effect of interaction of j^{th} strain x k^{th} sex

$(FBS)_{ijk}$ is the effect of interaction of i^{th} feed type x j^{th} strain x k^{th} sex

e_{ijkl} is the residual error assumed to be normal, independent and random

Results

Final Weight

The overall mean final body weight was 2837.50 ± 40.6g, ranging from 1444.0g to 4443.0g, with a coefficient of variation of 20.83% (Table 2).

Feed Type Effect: Feed type was highly significant (P<0.001) on final weight of broilers in this study (Table 3) accounting for 13.03% of the total variation observed in final body weight, with the composite 3-in-1 feed exerting superior influence compared to the conventional SFC (Table 2), and was 16.2% better than the SFC.

Strain Effect: Effect of strain of bird had the largest contribution to the variability in final weight (Table 3), accounting for 31.41% of the total variation, and was highly significant (P<0.01). Three of the strains studied (Arbor Acre, Cobb and Ross) had values that were not significantly (P>0.05) different, but Marshall had the least final weight and was statistically different from the other three strains (Table 2).

The effect of the strain became noticeable in the final weight (Wt10) distribution, where the normal curves for the three other strains (Arbor Acre, Cobb and Ross) almost overlap, while the curve for Marshall was skewed to the left, narrower and taller than for other strains (Figure 2).

Sex Effect: Sex of bird was significant (P<0.05) on final weight of birds (Table 3). The male birds were about 5% heavier than female birds on the average, however, both groups were fairly homogenous (Table 2).

Interaction Effect: None of the four interactions between the fixed factors included in the model (Feed x Strain, Feed x Sex, Strain x Sex and Feed x Strain x Sex) was significant (P>0.05) on final weight of birds.

Table 3: Least Squares Analysis of Variance of factors affecting growth parameters

Sources	df	Mean Squares Final Weight	Mean Squares TWG	Mean Squares ADG
Feed Type	1	***8552508	***8559862	***1746.91
Strain	3	***7910616	***7802740	***1592.40
Sex	1	*857959	*856253	*174.75
Feed x Strain	3	380318	379583	77.47
Feed x Sex	1	17855	17116	3.49
Strain x Sex	3	338578	338907	69.16
Feed x Strain x Sex	3	134633	134369	27.42
Error	195	187552	187647	38.30

*** = P < 0.001 ** = P < 0.01 * = P < 0.05

TWG = Total Weight Gain ADG = Average Daily Gain

Total Weight Gain

The total weight gain ranged from 1417.0g to 4408.0g throughout the study with an overall mean of 2800.50 ± 40.5g and a coefficient of variation of 21.03% (Table 2).

Feed Type Effect: The mean values for the 3-in-1 feed type treatment group was almost 16.5% superior to the SFC feed type (Table 1). Feed type effect alone accounted for 13.10% of the total variation observed in total weight gain, and the complete model accounted for almost half (49.8%) of the observed variation in total weight gain (Table 3).

Strain Effect: Strain of bird alone accounted for 31.11% of the variation in total weight gain, and the Marshall strain had significantly (P<0.001) lower total weight gain when compared to the other three strains (Arbor Acre, Cobb and Ross) as presented in Table 2.

Sex Effect: Sex of bird was significant (P<0.05) on total weight gain (Table 3) in the final model where other variables were included in the model. The male birds outperform the female bird across the feed types and strain.

Interaction Effect: The interactions included in the model did not statistically (P>0.05) affect total weight gain of birds, since they all contributed minute impact on the total weight gain of broiler birds.

Average Daily Gain

This parameter follows exactly the same trend as the total weight gain. The mean average daily gain in this study was 40.01 ± 0.58 with a coefficient of variation of 21.03% (Table 2).

Feed Type Effect: Average daily gain (DGAIN) of birds differed by feed types, where the 3-in-1 feed was superior to the SFC by 16.4% (Table 2). Feed type alone accounted for 13.10% of total variation and was statistically significant (P<0.05) on average daily gain.

Strain Effect: Strain of birds also exerted highly significant (P<0.001) influence on average daily gain (Table 2) and strain alone accounted for 31.11% of the total variation in average daily gain (Table 3).

Sex Effect: Sex of bird was also significant (P<0.05) on average daily gain

and it follows exactly the same trend as total weight gain. The male birds had superior average daily gain compared to the female (Table 2).

Interaction Effect: None of the interactions included in the model exhibited noticeable influence on average daily gain.

Discussion

Final Weight

Feed Type Effect: Despite the fact that the 3-in-1 feed was recently introduced to the market, its crumbled nature makes it preferred to the chick and wastages were minimal. This study revealed that it is a better feed than the conventional mash in the final body weight of the birds.

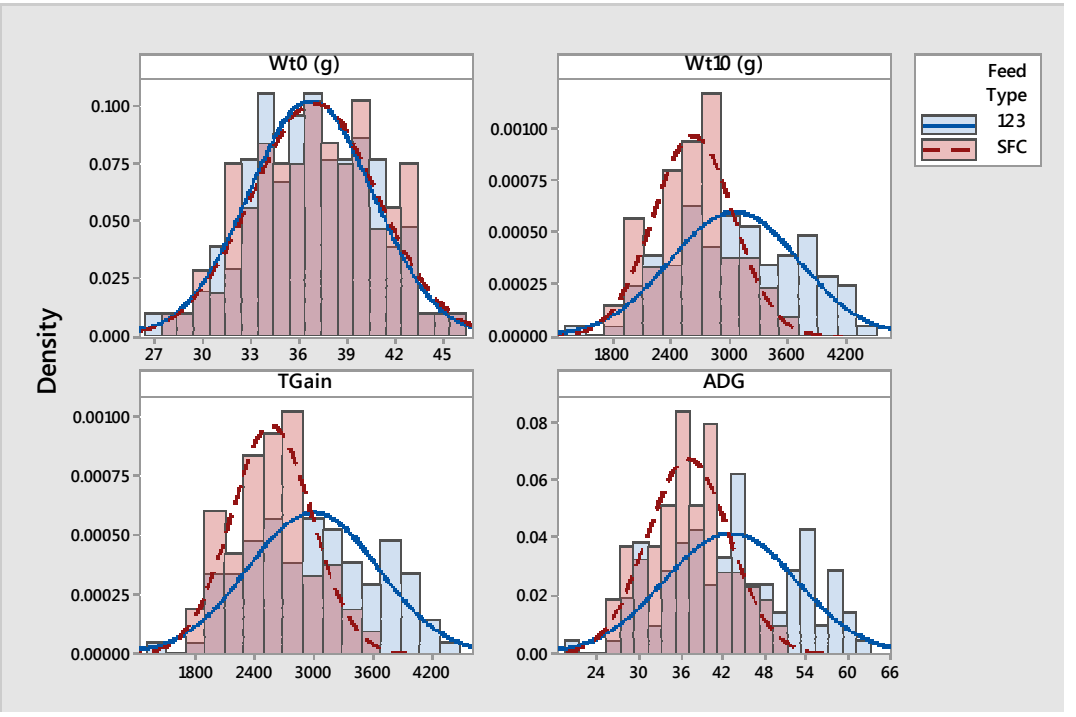

Figure 1: Histogram with normal curve fit of growth parameters by feed type

It is also worthy of note that the 3-in-1 has a better fitted normal curve compared to the SFC which is both left skewed and kurtotic with a height farther away from the normal curve, despite the fact that both curves were similar at the commencement (Wt0) of the experiment (Figure 1). This implies that differences in final weight curves (Wt10) can only be attributed to the difference in the 3-in-1 and SFC feed. Despite the lower values obtained in the SFC, it is noteworthy that variability within the treatment group is less than the variability in final weight of birds on the 3-in-1 feed, indicating that growth was fairly more homogenous in the SFC group. These differences can be attributed to two features of the Hybrid 3-in-1 feed, which are its crumbled nature that encourages effective pick up by birds, with resultant less wastage, and its consistency in form and proximate composition all through the experiment because the feed was never changed.

Strain Effect: The reason that can be

adduced to this observation is the fact that modern day broilers emerged from about the same origin from which different broiler breeders sourced their great grandparent stock. Unlike other strains that have fully evolved with the temperate background, the Marshall strain was developed to suit the inimical environment of the tropics. This is in consonance with earlier reports (2, 4, 10, 11, 12, 13, 14, 15) where strain or breed has been advanced as reasons for differences in broiler bird performance.

Sex Effect: This report corroborates earlier researches which indicated that sex of bird influenced the growth rate and final weight of birds, whereby the male birds mostly outperform their female counterparts (16, 17, 18, 19, 20, 21).

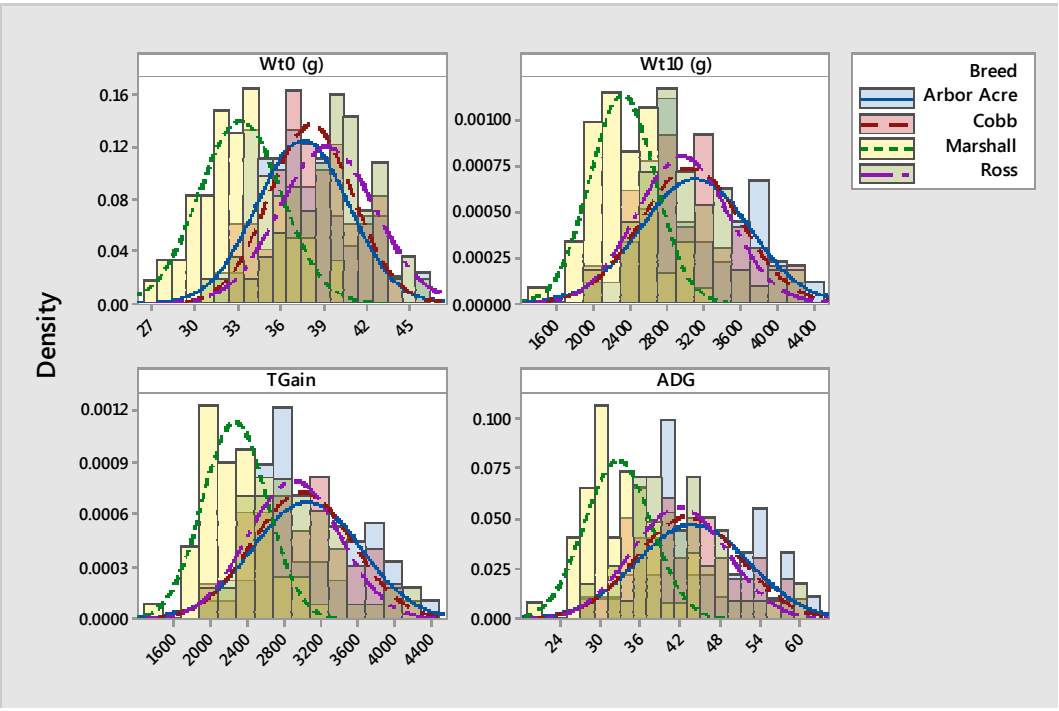

Figure 2: Histogram with normal curve fit of growth parameters by bird strain

Total Weight Gain

Feed Type Effect: As expected from the effect of feed type on final weight, the effect of feed type on total weight gain followed similar trend. This is because total weight gain was computed as the difference between the final weight and initial weight of the birds. This similarity is projected in the shape of the normal curves of feed type on the total gain (TGAIN) as depicted in Figure 1. This further confirms the superiority of the 3-in-1 feed over the SFC, which may be due to not just the ingredients contained in the feed but also due to the form (crumbled) in which the feed was presented, thereby eliminating wastages and effectively improve the animal weight.

Strain Effect: The normal curve fit for the four strains in Figure 2, suggested that the other three strains had fairly similar values while the Marshall distinctly differ in total weight gain (TGAIN) as presented in the graph. The Marshall breed has not evolved to the stage of the other commercial broilers

because the development of suitable strains of broiler chickens for the tropical environment has been ongoing in the past decade (22). This observation is in line with earlier reports on the effect of strain or breed on the performance traits of broiler chickens (4, 11, 23, 24).

Sex Effect: The male birds marginally gained 4.9% over and above the female birds. This trend is similar to what was recorded from the effect of sex on final weight of chicken. This observation is in consonance with earlier investigations on effect of sex on weight gain of broiler birds (16, 17, 18, 19, 20, 21).

Average Daily Gain

Feed Type Effect: The normal curve fit of average daily gain for feed type followed exactly the same trend as that of total weight gain (Figure 1). The smaller coefficient of variation recorded in the SFC indicated that average daily gain in this treatment group is fairly homogenous compared to the 3-in-1 feed group, and this further confirms the superiority of the 3-in-1 feed over the SFC.

Strain Effect: Aside from the Marshall strain that was statistically ($P<0.05$) different, other strains studied (Arbor Acre, Cobb and Ross) were not significantly ($P>0.05$) different. The normal curve fit of average daily gain by strain (Figure 2) also indicated that the other three strains formed a cluster that was distinct from the Marshall strain.

This observation of differences in average daily gain is in consonance with other earlier reports (2, 3, 4, 11, 17, 19, 20, 23, 25, 26).

Sex Effect: Male birds on the average gained 4.9% more than the female as reported by earlier researchers who worked on effect of sex on growth parameters (16, 17, 18, 19, 20, 21).

Conclusion and Application

1. The crumbled composite 3-in-1 Hybrid feed is superior to the conventional Starter – Grower – Finisher mash combo in rearing broilers for optimum weight gain.
2. Differences among the four strains studied was a significant source of variation in all parameters studied, although the only noticeable difference was in the Marshall strain.
3. This study also confirms earlier reports of superiority of male birds over female in growth parameters.
4. Despite the significant influence of the three factors (Feed Type, Strain and Sex) on all growth parameters studied, it was observed that interactions of all these variables were not significant.
5. Further research should be conducted on the influence of the composite 3-in-1 feed on fitness and carcass quality of broilers to assess its biochemical and nutritional potentials.

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