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Effects of sire additive genetic variance on growth rate within and between populations of Nigerian local chicken ecotypes.

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Abstract

The study was conducted at Akpehe poultry farm, Makurdi. Nigeria. Ten sires were mated to twenty dams each to evaluate the additive genetic effects of sires. Hatch and growth rate of their progenies were recorded weekly. The progenies were identified according to their dams and sire parents. The effects of sire on hatch weight and weight at week one were less varied. The interaction effects of sire and age groups were significant. Sire additive genetic effects were highly significant at weeks four, and increases significantly to week sixteen. At twenty weeks, the additive genetic effects of the sire were less varied, as environmental restrictions on the additive genetic potentials becomes more critical than additive genetic variability. Selection of superior males from sire lines for body weight gain can be applied at weeks four, and eight up to week sixteen.

Keywords: Additive-genetic-variance, Growth-rate, Local-chicken.

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Introduction

The native chickens constitute about 80% of the 12 million birds found in Nigeria kept under traditional family-based production system [1]. They contribute substantially to annual egg and meat production (up to 90%) for family consumption and for sale [1-3]. The indigenous chickens are also closely linked to the social and cultural lives of many communities. They are prepared during special banquets for distinguished guests, offered as gifts and cocks are used as alarm clocks in villages. Indigenous chicken ownership in the rural communities ensures varying degrees of sustainable farming and economic stability by minimizing risk of arable crop failures [4]. Thus the traditional sub-sector of poultry production can alleviate poverty, ensure food security, generate productive employment and promote the well-being of the human population of developing countries [1]. For a long time, Nigeria had depended on the importation of poultry inputs such as day old chicks, parent stocks, feed concentrates, drugs and vaccines as an improvement strategy for sustenance of the poultry industry [5]. This has however failed to yield the expected results due to the fact that farmers have not been able to afford the high input requirements of these introduced breeds [6]. Thus the traditional village sub-sector of poultry production based on scavenging indigenous domestic fowl (*Gallus domesticus*) remain predominant in Nigeria and African villages despite the introduction of exotic and crossbreed types [7].

This sub-sector is very important for the livelihood of most developing nations as it is mainly found in rural areas where over 80% of the nation's population resides and is the major source of readily available protein as well as source of income [8,9]. Unfortunately, the huge potential of the traditional sub-sector of poultry production has not been realized. Information on the potentials of sires, variation in additive and additive interactions of the sires effects on growth rate of the local chicken populations are not available. Aside the effects of inbreeding depression, potentials sires are not identified even when the flock populations are viable. The populations of the local chicken ecotypes thus continues to loss potential alleles through random sampling, allelic drift, migration and counter selections. The potentials of sires of most African native chicken populations have not been assessed. Omeje and Nwosu [10] observed that for a sustainable poultry production and improvement in the traditional sub-sector, it is necessary to use the indigenous chickens in seed stock development which can only be done when there is information on sire lines. The authors also noted that Nigerian indigenous chicken's posse's useful genetic attributes that could be utilized in cross breeding programmes for development of egg and meat type chickens. They however added that this will only be effective if there is information on genetic potentials of these populations on desirable traits from the sires and dam lines. The objectives of this study were to provide information on the additive genetic effects of the sire on body weight gain and variability of sire groups on body weight gain in local chicken ecotype populations.

Materials and Methods

About 600 day old chicks were used to evaluate growth trait such as Hatch weight Average weekly weight gain to six weeks Individual weekly weight gain from 6 weeks to age at first egg. Weekly growth rate (T) was estimated by

T 100 $[(W_2–W_1)/(\text{Time})]$.

Where

W_1=Average initial weight

T=Growth rate/week

W_2=Average final weight.

Growth performance

Daily body weights gain was taken from day 1 to 4 weeks; at weeks 6, 8, 12, 16, and 20. At day 1 to 5 weeks of age, a sensitive 500 g digital balance was used for weighing the chicks. At 6 to 8 weeks, the 4 kg capacity kitchen scale was used, while the 10 kg capacity kitchen scale was used at 12 to 25 weeks.

Average daily weight gain/growth rate

The average daily weight gain was estimated from the following relations

DWG=W2–W1/28, 30, 31, 7

Or

WWG=W2–W1/7

Where

DWG=Daily weight Gain

W2=Final weight in the month/week

W1=Initial weight in the month/week.

WWG=Daily weight Gain/week

7, 28, 30, 31=Number of days in the week and months.

Evaluation of growth data of the ecotypes

Body weights: Data collected on body weight at hatch (0 week), 1 week, 2 weeks, 3 weeks , 4 weeks, 8 weeks, 12, 16 weeks and twenty weeks of age were analyzed in two stages using a two ways analysis of variance in a completely randomized design. The generalized linear model procedure of statistical analysis system (SAS) (1998) was used in each case with the following models.

Body weight gain from day old–1 week, weeks 4, 8,12,16 to 20 of age.

$$Y_{ijk}=\mu+E_i+e_{ij}$$

Where

Y_{ij}=Body weight of the i^{th} individual in the j^{th} ecotype.

μ=Population mean.

S_i=effect of the i^{th} sire (1,2 , 3 …………………..10).

E_{ij}=residual random error with mean zero and variance that of the population.

Body Weight at 16 to 24 Weeks of Age

$$Y_{ij}=\mu+A_i+S_j+(SA)_{ij}+e_{ijk}$$

Where

Y_{ij}=Individual birds body weight observation.

=population mean.

S_i=Effect of sire (1,2 ,3……………………………………10)

e_{ij}= residual random error with mean zero and variance that of the population.

Results

Effect of sire on hatch weight

The effect of sire on hatched weight was less varied. The interaction of sire by hatched weight was highly significant (P<0.01). The effect of sire on hatched weight was ranked into (6) six subsets. Most of the sires ranked within group two and three. The least sire was sire one while sire 11 was outstanding followed by sire 9.

Effect of sire growth rate

The effect of sire on growth rate at week 1 did not vary except for sire 11 that varied significant (P<0.05) Table 1. At weeks 4,8,16 and 20, there were significant (P<0.05) variation in the effect of sire on growth rate at these ages Table 1. The effect of interaction of sire by age group was also significant (P<0.001) (Table 2).

Effect of sire on growth rate at the various age groups of the local chickens

The effect of sire on growth rate at the various age groups were ranked into subsets. On growth rate at week 1, sire 5 was least while sire 11 was outstanding Table 3. Within the Fulani ecotype sire 4 was outstanding, sire 11 maintained it superiority within the Tiv ecotype Table 3. The sire ranking at week 4 indicated that sire 5 within the Fulani ecotype was least while sires 11 and 12 were most superior among the Tiv ecotype Table 4. At week 8, the sire ranking indicated sires 5 and 6 as the least while sire 9 was superior followed by sire 11 Table 5. At week 12, sires 5,1 and 3 were ranked as inferior while sire 9 was most superior followed by sire 11 Table 6. At week 16, the sire ranking indicated significant (P<0.01) effect of sire on weight at week 16. Sires 1,5 and 3 were ranked as the least while sire 11 was outstanding followed by sire 12 Table 7. At week 20, the effect of sire on growth rate was ranked into two groups. There were significant (P<0.05) difference between sire 9 and the other sires. Sire 9 was also ranked as the outstanding sire at this age Table 8. The interactive effect of dam by age group showed significant (P<0.001) effect of dam on all the age groups except at week 20 (Table 9).

Discussion

Effect of sire on body weight at various weeks

The low variability observed on body weight at week 1 due to sire were due to limiting effect of egg environment. At hatch and week one, the growth potentials of the growing chicks were restricted by the common environment due to the dam. This environmental effects were body weight of the dam, which influences egg size, weight, nutrient contents and delivery systems. Others were shell quality and yolk volume. These parameters determine nutrients contents and deliveries to the growing chicks. The additive genetic potential of the sire was less critical at this age compared to the maternal environment which play major role on hatch weight and weight at week one. This was why the effect of sire on hatch weight and weight at week one were less varied. This implied that the genetic

***Table 1.** Effect of sire on hatch weight and weight at weeks 1,4,8,12,16, and 20 weeks.*

Sire	Hwt	Wk 1	Wk 4	Wk 8	Wk 12	Wk 16	Wk 20
1.	22.010^{a} ± 0.77	28.070^{a} ± 0.83	68.290^{a} ± 1.550	230.600^{a} ± 1.887	543.300^{a} ± 14.830	560.900^{a} ± 16.874	790.200^{a} ± 17.902
2.	21.378^{a} ± 052	31.40^{a} ± 0.62	76.057^{b} ± 3.330	252.204^{b} ± 5.580	616.274^{b} ± 10.553	649.844^{b} ± 17.818	782.870^{a} ± 19.052
3.	19.833a ± 1.35	26.833^{a} ± 1.34	65.850^{a} ± 2.087	233.294^{a} ± .465	568.167^{c} ± 16.133	622.833^{c} ± 12.929	738.500^{b} ± 24.639
4.	21.600^{a} ± 0.63	32.00^{a} ± 1.37	72.133^{c} ± 2.425	267.333^{c} ± 7.775	614.683^{b} ± 18.493	650.667^{b} ± 16.745	801.667^{a} ± 11.218
5	16.300^{b} ± 0.00	22.60^{b} ± 0.00	62.100^{d} ± 0.00	217.400^{d} ± 3.41	534.320^{a} ± 15.342	602.600^{d} ± 2.750	701.400^{c} ± 0.60
6	26.233^{c} ± 0.75	32.41^{a} 7 ± 0.98	87.20^{e} ± 1.69	225.175^{a} ± 14.487	584.792^{c} ± 16.386	671.242^{e} ± 22.962	1226.583 ± 52.688
7	27.857^{c} ±1.010	33.500^{a} ±0.71	84.686^{f}± 5.985	312.043^{d} ±31.810	695.314^{d} ±41.065	766.286^{f} ±20.641	2891.145^{e} ±14.864
8	21.00^{a} ± 0.00	30.00^{a} ± 0.00	83.875^{f} ± 1.245	249.425^{b} ± 7.871	590.575^{c} ± 0.390	783.500^{f} ± 5.362	1267.500^{f} ± 4.787
9	31.10^{c} ±1.12	36.610^{c} ± 0.89	101.580^{g} ± 4.641	299.000^{e} ± 1.352	670.290^{d} ± 10.435	856.240^{g} ± 18.593	1442.50^{g} ± 42.877
10	21.150^{a} ± 0.51	33.300^{a} ± 1.021	103.938^{g} ± 4.945	248.438^{b} ± 5.358	587.600^{c} ± 1.897	814.525^{h} ± 3.091	1093.874^{h} ± 17.423

a,b,c,d,e,f,g,h, figures with different superscripts down the group are significant (P<0.05); Hwt, hatch weight and wk1, wk 4, wk8, wk12, wk16, and wk20 are body weight at weeks 1,4,8,12,16 and 20.

***Table 2.** Interactive effect of sire by hatch weight and age on growth traits of local chickens.*

Growth traits	d.f	S.s	Ms	F
Hwt x sire	9	1474.864	163.874	15.356***
Error	93	992.452	10.672	
Wk 1 x sire	9	1183.090	131.454	
Error	93	1073.547	11.544	11.388***
Wk 4 x sire	9	17351.340	1927.927	
Error	93	12530.035	134.732	14.309***
Wk 8 x sire	9	7427.117	8252.457	7.114***
Error	93	107883.04	1160.033	
Wk 12 x sire	9	196685.70	21853.966	7.081***
Error	93	287030.09	3086.345	
Wk 16 x sire	9	807239.19	89693.244	22.824***
Error	93	365463.83	3929.719	
Wk 20 x sire	9	31277083	3475231.441	3.593***
Error	93	89958840	967299.359	

***Significant at (P<0.001); Hwt, hatch weight and wk1, wk 4, wk8, wk12, wk16, and wk20 are body weight at weeks 1,4,8,12,16 and 20.

***Table 3.** Sire ranking based on the effect of hatched weight.*

Sire	N	1	2	3	4	5	6
5.00	5	16.3000^{a}					
3.00	18		19.8333^{b}				
10.00	4		21.0000^{b}	21.0000^{bc}			
12.00	8		21.1500^{b}	21.1500^{bc}			
2.00	23			21.3783^{c}			
4.00	6			21.6000^{c}			
1.00	10			22.0100^{c}			
6.00	12				26.2333^{d}		
9.00	7					27.8571^{e}	
11.00	10						31.1000^{f}

N=Number of observations; a, b, c,d,e,f figures with different superscript across the groups are significant (P<0.05); 1,2,3,4,5 & 6 are sire ranking due to hatch weight.

potentials of the sire were not fully exhibited to allow selection of sire at this age. This also suggested that, the additive genetic variance is low for body weight gain in the early period of growth in the Nigerian local chickens. Adeleke et al. [11] also reported low heritability estimates for body weight in the early period of growth.

***Table 4.** Sire ranking based on the effects of weight at week 1.*

Sire	N		1	2	3	4	5
5.00	5	22.6000^{a}					
3.00	18		26.8333^{b}				
1.00	10		28.0700^{b}				
10.00	4			30.0000^{c}			
2.00	23			31.4000^{c}	31.4000^{cd}		
4.00	6				32.0000^{d}	32.0000^{de}	
6.00	12				32.4167^{d}	32.4167^{de}	
12.00	8					33.3000^{e}	
8.00	7					33.5000^{e}	
11.00	10						36.6100^{f}

N=Number of observations; a,b,c,d,e,f figures with different superscript across the groups are significant (P<0.05); 1,2,3,4,5 & 6 are sire ranking due to weight at week 1.

The significant (P<0.05) variation in the effect of sire on body weight gain at weeks 4,8,12,16 and 20 was because, the additive genetic potential of the birds enhancing body weight gain were higher at later growth periods. The common maternal effects on hatch weight and body weight at earlier ages had even out. The additive genetic potential enhancing body weight gain becomes very critical and determines body weight gain. This was why the additive genetics effects of the sires becomes critical and significantly affected weight gain at weeks four and above. Selection for body weight gain can be attempted at these ages for genetic improvement of body weight of the local chickens. The significant variations that grouped the sires into subsets was possible because, the additive genetic variance and the additive genetic interaction of the sires were expressed at these ages. The superiority and inferiority of the additive genetic effects of the sires and their variability were also expressed, assessable and measurable at these ages. Selection can be carried out on local chickens at these ages. The significant (P<0.05) effect of interaction of sire by age group was also connected to the above observation. The significant effects of sire by age of the local chicken interaction effects on growth rate at higher ages was possible. This was due to the graded levels of the inferiority or superiority of the sires additive genetic variance, the

Table 5. *Sire ranking based on the effect of weight at week 4.*

Sire	N	1	2	3	4	5	6	7
5.00	5	62.1000^{a}						
3.00	18		65.8500^{b}					
1.00	10		68.2900^{b}					
4.00	6			72.1333^{c}				
2.00	23				76.0565^{d}			
10.00	4					83.8750^{e}		
9.00	7					84.6857^{e}	84.6857^{ef}	
6.00	12						87.200^{f}	101.5800^{g}
11.00	10							103.9375^{g}
12.00	8							

N=Number of observations; a,b,c,d,e,f,g figures with different superscript across the groups are significant (P<0.05); 1,2,3,4,5,6 &7 are sire ranking due to weight at week 4.

Table 6. *Sire ranking based on the effect of growth rate at week 8.*

Sire	N						
		1	2	3	4	5	6
5.00	5	217.4000^{a}					
6.00	12	225.1750^{a}	225.1750^{ab}				
1.00	10		230.6000^{b}				
3.00	18		233.2944^{b}				
12.00	8			248.4375^{c}			
10.00	4			249.4250^{c}			
2.00	23			252.2043^{c}			
4.00	6				267.3333^{d}		
11.00	10					299.0000^{e}	
9.00	7						312,0429^{f}

N=Number of observations; a,b,c,d,e,f,g figures with different superscript across theg groups are significant (P<0.05); 1,2,3,4,5 &6 are sire ranking due to weight at 8weeks

Table 7. *Sire ranking based on the effect of growth rate at week 12.*

Sire	N					
		1	2	3	4	5
5.00	5	534.3200^{a}	543.3000^{ab}			
1.00	10	543.3000^{a}	568.1667^{b}	568.1667^{bc}		
3.00	18			584.7917^{c}		
6.00	12			587.6000^{c}	587.6000^{cd}	
12.00	8			590.5750^{c}	590.5750^{cd}	
10.00	4				614.6833^{d}	
4.00	6				616.2739^{d}	
2.00	23					670.2900^{e}
11.00	10					695.3143^{e}
9.00	7					

N=Number of observations; a,b,c,d,e, figures with different superscript across the groups are significant (P<0.05); 1,2,3,4,& 5 are sire ranking due to weight at 12 weeks.

covariance between the intact genotypes and the environment, the interaction between the genotypes and the environment which at this stage becomes more critical than the genetic variability. The degrees of tolerance enhancing adaptation and susceptibility determines the levels of expression or hindrance of expression of body weight gains by the sires additive genetic variances in the genomes of the birds at these ages. It is also possible that, certain gene sequences or genes may be only suggestive at certain ages or only expressed themselves when cells requiring their functions had been produced from mitotic cell divisions.

Sewalem et al. [12] also reported that some chromosomes for body weight affected body weight gain at two ages while others affected body weight again at all the ages investigated. Sewalem et al. [12] further reported that some body weight gain chromosomes were not detected at certain ages while some were suggestive at certain ages. For instance, the quantitative trait loci (QTL) for body weight gain at week 6 and 9 on chromosome 2,4 and 8 were not detected at week 3, and the QTL for week 3 body weight gain was suggestive at week 6 but not detected at week 9.

Different sets of genes were therefore involved in the growth of chickens. It is possible that these genes were involved in the development of digestive organs or skeletal growth. The later growth of muscle which is the major component of body weight gain as the chicken grow, was influenced by another set of genes. This may explain the trend in the variability of sire effect on body weight gain across different ages of the local chicken ecotype used in this study [13-15].

A selection method targeting weight gain of the sire at 8 and 16 weeks when the additive genetic variance is fully exhibited will identify superior sires. The identified superior sires could be selected as parent of the next generation in order to improve body weight gain in the local chicken ecotypes populations.

Conclusion and Recommendation

Conclusion

The effects of additive genetic variance of the sire on body weight gain begins to be expressed at four weeks and increases progressively up to sixteen weeks. The effects of the additive genetics effects of sire on body weight were not expressed at hatch and at week one and two. At week twenty, environmental challenges becomes more critical, and places more restrictions on the additive genetic potentials of the birds on growth rate.

Table 8. *Sire ranking based on the effect of growth rate at week 16.*

Sire	N	1	2	3	4	5	6	7
1.00	10	560.9000[a]	602.6000[b]					
5.00	5		622.8333[b]	622.8333[bc]				
3.00	18			649.8435[c]	649.8435[cd]			
2.00	23			650.6667[c]	650.6667[cd]			
4.00	6				671.2417[d]			
6.00	12					766.2857[e]		
9.00	7					783.5000[e]		
10.00	4						814.5250[f]	
12.00	8							865.2400[g]
11.00	10							

N=Number of observations; a,b,c,d,e,f,g figures with different superscript across the groups are significant (P<0.05); 1,2,3,4,5 ,6 & 7 are sire ranking due to weight at week 16.

Table 9. *Sire ranking based on the effect of growth rate at 20 weeks.*

Sire	N	1	2
5.00	5	701.4000[a]	
3.00	18	738.5000[a]	
2.00	23	782.8696[a]	
1.00	10	790.2000[a]	
4.00	6	801.6667[a]	
6.00	12	1266.5833[a]	
10.00	4	1267.5000[a]	
12.00	8	1277.3750[a]	
11.00	10	1442.5000[a]	
9.00	7		2891.1429[b]

a,b figures with different superscripts across the groups are significant; N=Number of observations.

Recommendation

Selection for genetic improvement of body weight gain of the local chicken from sire line can be carried out at weeks eight, twelve and sixteen.

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