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Research Article

Evaluation of Productive Traits of Nigerian Heavy Local Chicken Ecotype Selected For Six Generations through Selection Index

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Abstract: A multiple selection programme was designed and carried out to further determine the genetic response of productive traits of the Nigerian heavy local chicken ecotype (NHLCE) using selection index from fourth to sixth generations. A total of 270 pullets (23 week old) from a random breeding population of heavy local chicken ecotype were used for the study. The birds have been subjected to three generations (G_1, G_2 and G_3) of index selection. The parameters measured included Body Weight at First Egg (BWFE), Average Egg Weight (AEW), and Total Egg Number (TEN). The hens were housed individually in cages and fed layers ration G_4 and G_5: 110g/hen/day; G6: 125g/hen/day. Water was also given *ad libitum* for 16 weeks egg production (short term egg production). A control population was established to monitor for environmental (rE) effects and estimate genetic responses. Data on BWFE, AEW, and TEN were evaluated using Analysis of Variance (ANOVA). Selection response indicators namely, Selection differential (ΔS), expected, predicted and realized genetic gains were determined for each trait. Direct selection responses namely expected, predicted and realized genetic gains were all positive for all the traits selected. Expected average genetic gain per generation for BWFE, TEN and AEW were 66.2g, 4.19 and 1.01g respectively. For gain in index traits due to selection on index score, a mean value of 1.96 eggs was recorded for TEN, 0.14g for AEW and 11.65g for BWFE. The ratio for realized to expected genetic gains were all positive across the three generations with values of 0.96 for BWFE, 1.42g for AEW and 1.62 for TEN. It was concluded that the method applied for selection improved the traits of interest, hence, selection index is recommended for multiple trait selection.
Keywords: Sixth generation, performance evaluation, productive traits, local chicken ecotype and selection index.

Introduction

The local chickens of Nigerian play major roles through their contributions to food security, household income, employment and quick funds in emergencies (Adedokun and Sonaiya, 2001; Momoh, 2005; Momoh *et al*., 2010). Hence the desire for the development of Nigerian breed of egg chicken, integration and commercialization into the production systems through selection for productive traits. The improvements of the indigenous chicken genetic resources require sustained and painstaking approach to make Nigeria self-sufficient in poultry products. Biochemical genetics/genetic engineering biotechnology and more recently genomics offers useful information to breeders with regard to poultry improvement; however, they are not likely to replace the conventional methods of selection (Nordskog, 1981; FAO, 2003). The novel methods could augment the traditional methods such that information obtained could be incorporated into an overall selection index to make selection more effective. Thus, for Nigeria to develop her own indigenous breed of egg-type chicken, selection is the basic technology and a better option (Agbo *et al*., 2013). Therefore, this study was designed to determine the genetic response of productive traits of the Nigerian heavy local chicken ecotype (NHLCE) using selection index.

Materials and Methods

Study site

The study was conducted at the Department of Animal Science Teaching and Research Farm, University of Nigeria Nsukka. Nsukka lies in the derived Savannah region, and is located on longitudes 7^0 24^1E and latitudes 5^0 22^1N with annual rainfall range of 986-2098mm. The climate is of humid tropical setting with relative humidity range of 56.01-100%. The average diurnal minimum temperature ranges between 20.99-37^{0}C (Okonkwo and Akubuo, 2007). Nsukka is characterized by two seasons of the year. The rainy season extends from April-October while the dry season spans from November-April with no sharp demarcation.

Management of Experimental Animals

Artificial insemination technique was used to generate the foundation stock. Six (6) heavy local chicken ecotype cocks and sixty (60) hens were randomly selected from the reference population and housed in a battery cage system in the Teaching and Research farm of the Department of Animal Science, University of Nigeria, Nsukka, in a mating ratio of one cock to ten hens (1:10). The cocks (sires) and hens (dams) were identified with sire and dam numbers using tags: sire identification were 1, 2, 3, 4, 5 and 6, while dams were in groups of tens group A, B, C, D, E and F. Semen was collected according to the massage technique Burrows and Quinn (1937) from each of the cocks and diluted or extended using sodium citrate dehydrate. The dams were artificial inseminated according to dam group to produce generation four (G_4). Fertile eggs were collected and hatched to produce the day old chicks. The management system adopted was as described by Stanfield (1969), from day-old (0–8weeks), (9–22weeks) and (23–39weeks) of age. Formulated rations were fed according to each growth phases. The layer's ration contained 16.5% crude protein and 2,600 Kcal ME/kg at the rate of 110g/hen/day in G_4 and G_5 generations. The layer's ration was fed 125g/hen/day in G_6 due to improvement in body weight. Water was given *ad libitum*, while routine vaccinations were administered at each growth phase.

Data Collection and Measurement

A simplified linear selection index according to Nordskog (1981) in the relative economic weights and heritability of the traits was constructed and used as weighing factors for phenotypic values. All hens belonging to the G_4 generation were subjected to selection using a selection index incorporating, BWFE, AEW and TEN. The phenotypic performance of each hen in these traits was represented in the index as X_1, X_2, and X_3 for BFWE, AEW, TEN respectively. The index score (1) for each hen became a univarite character (trait) subjectable to selection. The index score (1) thus, enabled the ranking of the hens for the purpose of selection and a hen which attained the index score or above the score was selected for the next generation.

The general form of the index is given as

$$\mathrm{I} = \sum \mathrm{bix_i} = \sum \mathrm{aih_1^2\,X_1^1} + \mathrm{a_2h_2^2X_1^1} + ---- \mathrm{aihiX_i^1}$$

Where $\mathrm{bi} = \mathrm{aih_i^2}$

ai = the relative economic weight of the trait in the index

$\mathrm{h_i^2}$ = heritability estimate of the trait in the index

Xi = standardized phenotypic value of the ith trait in the index BWFE, AEW & TEN
I = Index

The standardized variable xi was obtained according to Oluyemi and Roberts (2000) as $xi = \frac{xi - \bar{x}i}{\sigma xi}$

Where xi = Record of the performance of an individual in the trait of the index
$\bar{x}i$ = mean of the performance of the whole population in the ith trait of the index
σxi = population phenotyphic standard deviation for the ith trait

Results and Discussion

The results of the expected direct response (Ri), Cumulative (CUMR), expected average ($\bar{R}i$) and per generation response across the three generations is presented in table 1. The result shows that the expected direct response did not increase progressively in BWFE as it did in TEN and AEW. However, all the traits showed positive responses across the generations. The values obtained for average expected direct genetic response ($\bar{R}i$) across generations in this study indicated positive selection response after three generation of index selection with a value of 68.44g for BWFE, 6.46 TEN and 1.20g AEW which were however higher than the G_3 base population. The values obtained in this study were higher than values reported by Ogbu (2010) who worked on generations zero, one and two of the Nigerian Heavy local chicken ecotype.

Table 1. Expected Direct Response (Ri), Cumulative (CUMRi) and Average Genetic Response for selected traits across G_4, G_5 and G_6 generation.

Trait	Gen.	Ri(g)	CUMRi (g)	$\bar{R}i$ (g)	Ri/yr (g)
BWFE	G_4	66.26	66.26	68.44	66.26
	G_5	68.13	82.39		68.13
	G_6	70.94	53.33		70.94
AEW	G_4	1.01	1.01	1.20	1.01
	G_5	1.08	2.09		1.08
	G_6	1.50	3.59		1.50
TEN	G_4	4.19	4.19	6.46	4.19
	G_5	6.09	10.28		6.09
	G_6	9.11	19.39		9.11

BWFE = Body Weight at First Egg, AEW = Average Egg Weight, TEN = Total Egg Number, G_4, G_5, G_6 = Generation four, five and six, **Ri =** Expected Direct Genetic Response, CUMRi = Cumulative Genetic Response, $\bar{\mathbf{R}}\mathbf{i}$ = Average Genetic Response per Generation, **Ri/yr** = Expected Direct Genetic Response per year

The results of the predicted genetic response (RPi) and the realized genetic gains (ΔGR) for the index selected traits across the three generations are presented in table 2. The result shows that for BWFE, the predicted genetic gain was negative across the three generations while TEN and AEW were fluctuating. However, for AEW both predicted response and realized genetic gains were positive and increased from G_4 (0.198) and (0.590) respectively before dropping to (0.093) and (0.18) in G_4 with appreciable increase to (0.217) and (0.37) in G_6 above G_5; for the TEN, there was progressive increase from G_4 (0.030) and (0.51), G_5 (0.732) and (3.27) and G_6 (1.089) and (2.41) for both the predicted genetic gain and the realized genetic responses.

The significance of index selection on the three selected characters have shown much genetic progress which one can physically see in the size and number of eggs produced by the heavy local chicken ecotype.

The values obtained for expected direct genetic response (Ri) in this study were higher than values reported by Ogbu (2010) in body weight at first egg. However, for average egg weight (AEW) and total egg number (TEN) the values reported by Ogbu 2010 were higher across generations. Similar trend was also demonstrated in cumulative genetic response (CUMRi) and expected direct genetic response per year.

Table 2. Predicted Genetic Response (RPi) and realized genetic gain (ΔGR)

Trait	Gen.	RPi (g)	ΔGR (g)
BWFE	G_4	-8.80	-12.87
	G_5	-2.66	-22.94
	G_6	-3.17	-10.06
AEW	G_4	0.198	0.59
	G_5	0.093	0.18
	G_6	0.217	0.37
TEN	G_4	0.030	0.51
	G_5	0.732	3.27
	G_6	1.089	2.41

BWFE = Body Weight at First Egg, AEW = Average Egg Weight, TEN = Total Egg Number, G_4,G_5,G_6 = Generation four, five and six, RPi = Predicted Direct Genetic Response, ΔGR = Realized Genetic Gain/Response

The results of the expected genetic gain/response in index traits as a result of selection on index score and the ratio of realized to expected genetic gain in index traits for G_4, G_5 and G_6 generations are presented in table 3. The observed expected genetic response in the index traits as a result of selection on the index score was positive for the three traits selected across the three generations.

The BWFE decreased from 13.27g in G_4 to 11.94g G_5 and finally dropped to 9.753g in G_6 while the average genetic gain per generation was 11.65g. The values for AEW presented similar trends ranging from 0.17g in G_4 to 0.18g in G5 before dropping to 0.07g in G_6 generation with average of 0.14g. For TEN, the genetic gain recorded were 0.52 eggs in G_4, 4.37 eggs in G_5 and 0.98 eggs in G_6 with average per generation of 1.96 eggs. The values obtained in this study on expected genetic gain, cumulative genetic gain per generation and realized direct genetic gain were lower than the values recorded by Ogbu (2010).

The lower values may be attributed to some losses on the genetic gain on Generation 3, where selection did not take place and as a result, genetic gains were lost. However, the results revealed that among the three index-selected traits, BWFE reflected the largest response in all the three generations of the study though it had the least economic weight associated with it. Hicks *et al*. (1998), reported that a trait that had the highest economic weight tends to dominate the index. The present study, however failed to present such scenario and this could be traced to the large genetic and phenotypic variances of BWFE when compared to other traits in the index.

Table 3. Expected Genetic Gain / Response in Index traits as a Result of Selection on Index Score

Trait	Gen.	ΔGi (g)	CUMΔGi (g)	ΔGR/ΔGi
BWFE	G_4	13.27	13.27	0.97
	G_5	11.94	25.21	1.00
	G_6	9.73	34.95	0.91
Average/Gen		11.65	-	-
AEW	G_4	0.17	0.17	3.47
	G_5	0.18	0.35	1.00
	G_6	0.07	0.42	0.91
Average/Gen		0.14	-	-
TEN	G_4	0.52	0.52	1.00
	G_5	4.37	4.37	0.75
	G_6	0.98	5.87	2.50
Average/Gen		1.96	-	-

BWFE = Body Weight at First Egg, AEW = Average Egg Weight, TEN = Total Egg Number, G_4,G_5,G_6 = Generation four, five and six, ΔGi= Expected Genetic Gain/Response, CUMΔGi = Cumulative Genetic Gain per Generation, ΔGR = Realized Direct Genetic Gain

Conclusion

The method of selection used for BWFE, AEW and TEN was effective in improving the traits as the genetic responses were positive and relatively high. The selection intensity pressure applied improved the traits studied and significant genetic variations exist which provide room for future selection responses in subsequent generations.

Recommendation

It is therefore, recommended that selection based on an index should be applied in breeding programmes for the development of the Nigerian heavy local chicken ecotype for increased egg production traits.

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Conflicts of interest: The authors declare no conflicts of interest.

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