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Short term selection response on growth and reproductive traits in broiler lines of chicken

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Abstract

Broiler chicken is highly demanded to meet proteins needs of growing population. This research was designed to evaluate the effect of selection response on the growth and reproductive performance traits of broiler chicken lines. Broiler chickens were selected into male and female lines. Body weight, conformation traits, production and reproductive traits were evaluated. Heritability and selection differential were computed and were used to estimate selection response. Correlations among serum alkaline phosphatase (SAP), total protein (TP) and Acetylcholine esterase (AchE) and production and reproductive traits were estimated. Higher heritability estimates were obtained in the body weight and thigh length of the selected lines. Large selection differentials were obtained for body weight and body conformation traits. Responses to selection were largest in the selected lines, Highest and significant number of egg was reported in the dam selected line. The selected lines revealed higher egg weight. SAP was positively and significantly correlated with egg weight (r = 0.761, p = 0.001), fertility (r = 0.870, p = 0.0001) and hatchability (r = 0.915, p = 0.0001). Total protein and Acetylcholine esterase were positively correlated with egg number. It is therefore concluded in this study that, selection, could lead to improvement in growth and reproduction traits in broiler chicken and SAP, TP and AchE could be used as marker for selecting egg weight and egg number in broiler chicken.

Keywords: Broiler chicken; growth; reproduction; selection; serum

Réponse de sélection à court terme sur les caractéristiques de croissance et de reproduction dans les lignées de poulets de chair

Résumé

Le poulet de chair est très demandé pour répondre aux besoins en protéines d'une population croissante. Cette recherche visait à évaluer l'effet de la réponse de sélection sur les *caractéristiques de croissance et de performance reproductive des lignées de poulets de chair. Les poulets de chair ont été sélectionnés en lignées mâles et femelles. Le poids corporel, les traits de conformation, les traits de production et de reproduction ont été évalués. L'héritabilité et le différentiel de sélection ont été calculés et utilisés pour estimer la réponse de sélection. Les corrélations entre la phosphatase alcaline sérique (PAS), les protéines totales (PT) et l'acétylcholine estérase (AchE) et les caractères de production et de reproduction ont été estimées. Des estimations d'héritabilité plus élevées ont été obtenues pour le poids corporel et la longueur des cuisses des lignées sélectionnées. De grands différentiels de sélection ont été obtenus pour le poids corporel et les caractères de conformation corporelle. Les réponses à la sélection ont été les plus importantes dans les lignées sélectionnées. Le nombre d'œufs le plus élevé et le plus significatif a été signalé dans la lignée maternelle sélectionnée. Les lignées sélectionnées ont révélé un poids d'œufs plus élevé. PAS était positivement et significativement corrélé au poids des œufs (r = 0,761, p = 0,001), à la fertilité (r = 0,870, p = 0,0001) et à l'éclosion (r = 0,915, p = 0,0001). Les protéines totales et l'acétylcholine estérase étaient positivement corrélées au nombre d'œufs. Il est donc conclu dans cette étude que la sélection pourrait conduire à une amélioration des caractéristiques de croissance et de reproduction chez le poulet de chair et que PAS, PT et AchE pourraient être utilisés comme marqueurs pour sélectionner le poids et le nombre d'œufs chez le poulet de chair.*

Mots-clés : Poulet de chair; croissance; la reproduction; sélection; sérum
Running title: Selection response improved performance in broiler chicken

Introduction

Response to selection on body weight between a selected group of broiler chickens and a control group has been extensively studied due to the economic importance of fast-growing poultry breeds. Selective breeding aims to improve growth rates and body weight in broiler chickens for efficient meat production. Comparative study of growth performance and feed conversion ratio between broiler chickens from 1957 and 2001 when fed available diets was earlier elaborated (Havenstein *et al*., 2003). It was demonstrated that the substantial improvements in body weight were achieved through selective breeding over several decades (Havenstein *et al*., 2003). The research highlights the enhanced growth potential in modern broilers compared to their ancestors. The experiment conducted by Siegel *et al*. (2007) resulted into disappearance of dual-purpose fowl for commercial production. Modern poultry industry emerged whereby more specialized stock bred for either meat or egg purpose have taken the position of the dual-purpose chicken (Hunton, 2006). In addition, feed efficiency *per se* has been identified to be heritable trait that responds to genetic selection (Pym, 1990) and it has also been enhanced by selection (Siegel *et al.*, 2007).

Egg production indicates the number of eggs that a hen produced when placed in the laying house. Egg numbers and sizes are indices of egg production enterprise and these are the major objectives of most farmers. Egg sizes and number have been closely associated in the poultry industry. Egg production is usually improved by good nutrition combined with good genetic make up. The number and sizes of egg are mostly enhanced through genetic improvement which are mainly by crossing, selective breeding and molecular techniques. Egg number was improved when Rhode Island was crossed with Fayoumi in all the three ways (Zaman *et al.,* 2004; Rahman (1995)). Best performance in egg production has ever been achieved between the cross of Rhode Island Red and Fayoumi when compared with other crosses of chicken such as Lohmann Brown, Fayoumi, Rhode Island Red, and White Leghorn breed (Rahman *et al.*,1997). Rhode Island Red x Fayoumi seems to have a better genetic combination than the others used. Egg weight and egg number has closely associated in the poultry industry. Higher rate of lay in crossbreds had been reported than in pure breeds in commercial production systems and the highest was obtained for Rhode Island Red and Fayoumi cross (Nawar and Abdou, 1999). Egg weight and egg number has closely associated in the poultry industry. According to Adeyinka (1999) egg weight has been considered a very important correlated trait in any population of chickens selected for egg production. Eggs which are too small will not be given the premium consideration. Wondmenah *et al. (*2011*)* reported highest value of egg weight (g) for Potchefstroom Koekkoek (53.23±0.2) and Lohmann Silver breed (52.65±0.2), followed by fayoumi (44.23±0.5) and least being Horro (41.65±0.4). In the report of Kinney (1969), maternal and dominant effects have been observed to have influence on pullet weight.

When it comes to breeders' stock, fertility is on one of the important things usually considered. Fertility is the proportion of eggs that can develop into chicks out of the number set for incubation. Fertility is determined by candling on the 7th day or 18th day of incubation. A major problem encountered with commercial broiler breeder flocks has often been the decrease in fertility during the later part of the laying period especially after 50 weeks of age (Kirk *et al.,* 1980; Walsh and Brake, 1997). It has been generally observed that this reduction in fertility was caused largely by the heavy body weight and poor physical condition of older males (Hocking, 1990). However, other evidence has suggested that metabolizable energy deficit was a more likely the cause of such male fertility problems (Buckner *et al.,* 1986; Sexton *et al.,* 1989, Cerolini *et al.,* 1995; Bramwell *et al.,* 1996).

In addition, another single most critical factor to consider in the hatchery sector is hatchability. It denotes the percentage of eggs hatched into viable chicks after 21 or 22 days of incubation (Yassin *et al.,* 2008). Hatchability is either determined based on all eggs (% hatch) or fertile eggs after candling. Yassin *et al.* (2008) reported significant differences in hatchability among eggs from different flocks. They also noted that hatchability was significantly affected by age, egg, storage length, strain, feeding, season, year as well as hatchery condition. Hatchability was greater during the late summer than during spring. According to Yassin *et al.* (2008), the average estimated differences in hatchability among strains and feeding regime of the breeder flocks were 8 and 2% respectively. Based on the relations found in them, optimization of hatchery result depends on management at hatchery and hatching egg quality. Few reports are available of how selection has affected egg production and this necessitated this study. In this study, we aimed at testing the hypothesis that selection improved growth and reproductive performances of selected lines of broiler chicken. This research was therefore designed to evaluate the effect of selection response on the growth and reproductive performance traits of broiler chicken lines.

Materials and Methods

Experimental Site

The research was carried out at the Poultry Research Unit of National Animal

Production Research Institute (NAPRI) Shika, Zaria, Kaduna State, Nigeria. Shika lies between latitude 11^0 12`N, longitude 7$^0$ 33`E and at altitude of 640m above sea level. The area falls within the Northern Guinea Savannah having an average annual rainfall of 1100mm which starts from the late April or early May to mid-October, followed by a dry period (which is divided into early and late dry periods). The early dry period is characterized by cold period and lasts from February to April. The mean temperature is about 24.4^{0}C (14.5 – 39.5^{0}C) with the lower humidity of 21% and 72% occurring during the early dry and wet seasons respectively as in (Akpa and Jokthan,1996).

Experimental Birds and Management

The birds used for this study comprised of 4 groups each of sire line, dam line, sire control and dam control line developed from a collapsed group of Hubbard and Anak broiler birds in National Animal Production Research Institute (NAPRI). Collapsed Hubbard and Anak group was to achieve high genetic variabilities to increase hybrid vigor in order correct the inbreeding depression effect experienced after being bred for a long time. Sire and dam line were allotted to 20 pens each. While dam and sire control were allotted to 10 pens each. The mating ratio adopted was 1:6 (1 sire mated to 6 dams). From these groups, a total of 350 birds, which consisted of 100 birds each for sire and dam line and 75 birds each for sire control and dam control were obtained as progeny and used for this study. At hatching chicks were tagged, weighed individually, and vaccinated against Marek's disease using Marek's vaccine as well as Newcastle Disease Vaccine (intra-occular) after which they were taken to the brooding pens. Brooding pens were washed, disinfected and covered with polythene nylon to provide warmth. The floor was covered with wood shavings and newspapers. Drinkers and feeders were washed and disinfected. Before arrival of chicks, heat source (electric bulbs, lanterns and charcoal pots) was put in place. After arrival, the chicks were administered antistress in water (vitalyte) for five days while Gumboro vaccine (IBDV) was given again on the 10th and 15th day, Newcastle Vaccine on the 21st and Coccidiostat on the 28th days. Broiler starter mash with crude protein of 24.96% and energy of 2767.62kcal/kg was given to the chicks at the first four weeks while broiler finisher mash with crude protein of 23.23% and energy of 2839.64kcal/kg was given at the last four weeks of age. The same type of feed was given to all the groups. Water and feed were provided *ad-libitum.*

The percentage composition and calculated analysis of the experimental diets

Table 1 shows the percentage composition and calculated analysis of the diets used in this study. The values of the crude protein for the broiler starter (24.96) and the layers (17.17) are within the range obtained in most literatures. Both the broilers and layers diets are being formulated from the feed mill of the Institute (NAPRI). This study lasted for six months consecutively from egg collection to blood analysis.

Table 1: Composition of the Experimental Diets

Ingredients	Broiler Starter	Broiler Finisher	Layers
	PERCENTAGE		
Maize	45.00	52.00	57.97
Groundnut cake	30.00	30.00	10.00
Soyabean meal	15.00	10.00	14.00
Maize offal	4.60	2.50	8.00
Limestone	3.00	1.50	7.00
Bone meal	1.50	3.00	2.00
Salt	0.30	0.30	0.30
Lysine	0.15	0.20	0.20
Methionine	0.15	0.20	020
Premix*	0.25	0.30	0.30
Total	100	100	100
Calculated analysis			
ME/Kal (Kg)	2767.62	2839.64	2755.01
Crude Protein (%)	24.96	23.23	17.17
Crude Fibre (%)	3.82	3.45	3.70
Ether Extract (%)	5.16	5.22	3.86
Methionine	0.47	0.50	0.45
Methionine + Cysteine	0.85	0.86	0.70
Lysine	1.20	1.13	0.90
Calcium	1.75	1.74	3.44
Phosphorous available	0.90	0.89	0.65

*The premix used in this study supplied the following nutrients (Kg/diet): Vit A: 20,000,00, IU Vitamin E. 500 I, thiamin (B) 2,000mg, Riboflavin (B2) 3500mg, Vit (B3) 20000mg, Panthothenic acid (B5) 6,600ml, Pyridoxine (B6) 3600mg, Vitamin (B12) 20mg, folic acid 400mg, Vitamin 20000mg, Methionine 10,000mg, antioxidant 12.5g, Ca 18%, P.Mn 8.0g, Zn ug Iodine 0.12g.

Heritability estimates and selection response

Body weights were evaluated using electronic weighing scale and the body conformation traits were obtained using measuring tapes. Heritability for body weight and linear body measurements was computed using the expression described by Falconer (1989):

$$h^2 = \frac{4\ \sigma^2 s}{\sigma^2 T}$$

Where; h^2 = Heritability estimates; $\sigma^2 s$ = Variance due to sire, $\sigma^2 T$ = Total phenotypic variance.

Selection response was estimated using the product of selection differentials and heritability estimates. Selection differentials were computed by deducting the means of the original population from the means of the selected population.

Production and Reproduction Traits

Egg number and egg weight were considered as production traits while fertility, hatchability, dead in shell and clear eggs were considered as reproductive traits and were calculated as follows:

$$\text{Percentage fertility} = \frac{\text{Total number of fertile eggs}}{\text{total number of egg set}} \times 100$$

$$\text{Percentage hatchability} = \frac{\text{Total number of chickens hatched}}{\text{Total number of fertile eggs}} \times 100$$

Blood biochemical analysis

For the biochemical parameters (serum alkaline phosphatase, acetylcholine esterase and total protein). Blood samples were taken from the wing veins humanely (Badmus *et al*., 2022) of the 6 birds sampled from each group and stored in free anticoagulant tube for serum analysis of Alkaline phosphatase, Total Protein (TP) and Acetylcholine esterase (AChE). For the SAP, AchE and TP, blood samples were allowed to coagulate and the serum was centrifuged for 16 hours to separate the serum. The serum was then frozen (-20ºC) until analysis. Methods described by Bassey *et al.* (1946), George *et al.* (1961) and Abd El Azim (2012) were adopted for the analysis of (SAP), (Ach) and (TP) respectively. These analyses were carried out at Ahmadu Bello University Teaching Hospital Shika, Zaria.

Statistical Analysis

Data on growth traits, body linear measurements, reproductive and production traits were subjected to tests of normality using log transformation test, and they satisfied the conditions for normal distribution curves. The assessment of histogram distribution and quartile (Q) plots for the model residual were used for the assumption of normality (Badmus *et al*. 2022). The normalized data were analyzed using General Linear Model procedure of SAS (2002). Heritability was estimated using variance component of SAS (2002). The products of heritability estimates were used to estimate selection responses among the selected traits. Significant differences among means were separated using Duncan's Multiple Range Test (Duncan, 1955). Phenotypic correlation among biochemical traits and egg productive and reproductive traits were obtained by the analysis of covariance using the Pearson correlation procedure of SAS 9 (Falconer, 1989). The multiple hypothesis correction was conducted for all the variables using the Benjamini–Hochberg (BH) correction method ($p < k/m \times \alpha$) (Badmus *et al*. 2022).

Results and discussion

Variance components and heritability

Variance components and the heritability estimates of body weights and conformation traits of the selected lines and the controls were revealed in Table 2 and 3 respectively. The results showed that heritability estimate for body weight was medium in sire selection but lower in dam selection and the controls. It was however higher for the body length in dam control but medium in sire control. Higher heritability was reported in thigh length for sire selection but very low for others. Medium heritability was reported for keel length and shank length in both sire and dam selection. Sire control and dam control also revealed medium heritability for keel length and shank length (Table 3). Medium to high heritability obtained in this study implies that most variabilities observed were due to genetic differences and not environmental and this means that high genetic gains or responses to selections could be expected when selection differentials are high. Heritability has been observed to be a very important tool in quantitative genetics because it is used to estimate the response to selection (Hans-Peter and Mo¨hring, 2007) and this denotes how a population will respond to selection. The moderate to high heritability estimates obtained in this study could be attributed to the effect of high variabilities resulting from collapsing the Hubbard and Anak. Adeyinka *et al.* (2006) observed low heritability estimates ranging from 0.01 to 0.12 for body linear measurements and moderate for body weights ranging from 0.20 to 0.32 in the naked neck broiler chickens and their reports were in conformity with that of Singh and Julian (2007) who reported low to moderate heritability for body linear measurements in Van-Cob broiler strains of chickens. However, high heritability estimates (0.436 and 0.575) for keel length and shank length respectively were obtained by Singh *et al.* (2008) at 6 weeks of age in a synthetic broiler strain. Going by Ayorinde *et al.* (1988), it was noted that the size of heritability values were not affected by the size of the body. Body weight was however observed to have been influenced by maternal effect or dominance or both effects up to maturity as revealed by steady higher heritability estimates from dam variance components as opposed to those obtained from sire components. Sex linked effect on body weight was formerly described by Jerome *et al.* (1956) and heritability estimates of body weight was noted to vary from one study to another (Kinney 1969). Kolstad (1980) observed heritability records of 0.68 for body weight.

Table 2: Variance components of body weights and conformation traits of the selected lines and control at week 8

Traits	Variance Components	Sire Selection	Dam Selection	Sire Control	Dam Control
Body weight	$\sigma^2 s$	88940.0	19137.2	21512.8	62896.6
	$\sigma^2 E$	1205271.8	409872.7	466920.8	462047.7
	$\sigma^2 T$	1294211.8	429609.9	488433.6	524944.3
Body length	$\sigma^2 s$	-0.14	2.34	-0.87	0.32
	$\sigma^2 E$	8.56	12.19	9.96	6.35
	$\sigma^2 T$	8.42	14.53	9.09	6.67
Thigh length	$\sigma^2 s$	0.40	-0.17	0.75	-0.13
	$\sigma^2 E$	1.57	3.40	54.65	2.56
	$\sigma^2 T$	1.97	3.23	55.40	2.43
Keel length	$\sigma^2 s$	0.12	0.15	0.24	0.01
	$\sigma^2 E$	1.38	1.92	2.65	2.01
	$\sigma^2 T$	1.50	2.07	2.80	2.02
Shank length	$\sigma^2 s$	0.17	-0.09	-0.01	-0.10
	$\sigma^2 E$	1.53	1.13	1.07	1.08
	$\sigma^2 T$	1.70	1.04	1.06	0.98

Note: $\sigma^2 s$ = Variance due to sire, $\sigma^2 T$ = Total phenotypic variance ($\sigma^2 s + \sigma^2 E$).

Table 3: Heritability (± SE) of selected lines and the control at week 8

	Sire selection	Dam selection	Sire control	Dam control
Body weight	0.30 ± 1.31	0.18 ± 1.66	0.18 ± 1.66	0.05 ± 1.98
Body length	0.06 ± 1.69	0.64 ± 0.62	0.32 ± 1.54	0.19 ± 1.54
Thigh length	0.81 ± 1.27	0.19 ± 0.55	0.05 ± 1.54	0.19 ± 1.54
Keel length	0.31 ± 1.27	0.30 ± 1.24	0.33 ± 1.85	0.03 ± 1.85
Shank length	0.40 ± 1.10	0.30 ± 1.24	0.04 ± 1.26	0.39 ± 1.26

Selection differential was presented in Table 4 and showed that the means difference of body weight and body conformation traits between the original (base) population and the selected population was higher in all the groups (selected and control) except for keel length in sire control where negative selection differential was obtained. It was rather exceptionally higher in both the sire selection and the dam control for the body weight. Response to selection was highest and meaningful for body weight in the sire selection (Table 5). Dam and sire selection revealed closed response to selection. However, it was lowest in dam control. Dam selection revealed the highest response to selection for body length. Dam control revealed response to selection that was close to unity. Response to selection for thigh, keel length and shank length were poor in all the groups of the broiler chicken (selected and control) considered.

Response to selection on body weight between a selected group and a control group has been a topic of interest in various research studies. The aim is to understand how genetic or environmental factors influence body weight and how selective breeding can impact the phenotype. In this study, we carried out selections which were aimed at increasing the genetic gain in body weight rather than in the body conformation traits with consequential effect on reproductive and production traits. Togashi *et al*. (2019) directed their selection toward increasing genetic gain in milk production than towards body conformation traits. Development of stocks that outshined in production of either meat and eggs have been successful due to the knowledge of hybrid vigour coupled with large population and intense selection (Siegel, 1989). The result of selection has been wonderful in facilitating expression of growth and egg production traits (Havenstein *et al*., 2003; Flock *et al*., 2005) and as such global production of meat and eggs (Windhorst, 2006). Moreover, genetic gain in body weight in dam selected group was moderate as too much weight gain in broiler female line might be impactful on production and reproduction traits. Selection response in growth performance traits in the selected groups (Sire and Dam) were higher than those obtained in the control (Sire and Dam). Response to selection in the body conformation traits were much smaller in all the groups as compared to the expected measurements. Emmerson (1997) discussed the growth performance, genetic changes, and the impact of selection on various traits, contributing to our understanding of the development of fast-growing broiler strains.

Table 4: Selection differential of body weights and conformation traits of the selected lines and the control at 8 weeks

	Sire selection	Dam selection	Sire control	Dam control
Body weight	949.39	559.99	596.57	909.74
Body length	2.72	2.26	1.72	4.81
Thigh length	0.61	1.46	-0.29	2.18
Keel length	1.12	0.75	1.38	1.97
Shank length	0.38	0.45	0.73	1.27

Table 5: Selection response of body weights and conformation traits of the selected lines and the controls at 8 weeks

	Sire selection	Dam selection	Sire control	Dam control
Body weight	284.82	100.80	107.38	45.49
Body length	0.14	1.43	0.55	0.91
Thigh length	0.49	0.28	-0.01	0.41
Keel length	0.35	0.21	0.46	0.06
Shank length	0.15	0.13	0.03	0.50

Reproductive and Productive Traits

The results of the reproduction and production traits of sire line, dam line, dam control and sire control are shown in Table 6. No significant (P>0.05) difference was seen in percentage fertility and values ranged from 90.20 to 94.50%, percentage dead-in shell (20.17 to 32.74%) and percent clear eggs (8.62 to 13.38%) in all the lines but there was significant difference in percentage hatchability with values ranging from 67.26 to 81.59%. Sire and dam lines showed the highest and significant differences in hatchability compared to sire control and dam control. Dam control showed significantly lowest value but both sire line and dam have shown no significant (P>0.05) differences in hatchability. Dam lines significantly (P<0.05) had the highest number of eggs (3.26) per day followed by sire control and dam control which showed non-significant (P>0.05) difference value from each other. Sire line had the lowest and significant (P<0.05) number of eggs (2.74). The sire line, dam line and dam control showed higher values of egg weight ranging from 60.17 to 60.81g than sire control (57.98g) though their values were significantly (P>0.05) not different from each other. Schütz, *et al.* (2001) study focused on the effects of domestication and selective breeding on body weight-related traits in poultry. It compares the behavior, foraging strategies, and fear responses of the red junglefowl (the wild ancestor of domestic chickens) with a modern layer strain. The study discussed how artificial selection for increased body weight can lead to changes in behavior and physiology Schütz, *et al.* (2001).

Fertility depends on various factors such as breed, season, pre-incubation holding period, level of nutrition and time of mating. Hatchability may also be influenced by several factors such as genetic factors, care of hatching egg, storage age of brooding birds and nutrition. Non-significant differences obtained in fertility of the birds used in this study revealed that line had no effects on these traits. The results of this study are therefore in line with the fact that fertility and hatchability performance of egg depend on genetic factors in addition to other factors. The results of this study also indicated that differences in lines had significant effect on hatchability parameters. This implies that hatchability is genetically controlled (Merat, 1990). There were also significant effects of line on both egg number, and egg weight meaning that theywere both influenced by genetics and selection. It has been observed that genetic advancement in broiler breeding influenced body weight and production efficiency (Aggrey and Kanuah, 2018).

The values obtained for percent fertility ranging from 85.55±3.22 to 94.50±4.46% for all the groups in this study is within the range reported by Wondmenah *et al.* (2011) for Fayoumi (84.23±0.05%) and Lohmann Silver (85.56±0.5%) breeds of chicken but above the value obtained for Horro (77.00±0.1%) and Potchefstroom Koekkoek (77.70±0.5%) breeds of chicken. Also, the values for the percent hatchability ranging from 67.26±5.10 to 81.59±5.10%

were within the range obtained for Fayoumi, Lohmann Silver and Potchefstroom Koekkoek breed ranging from 68.80±0.91 to 81.98±0.7% but higher than the value obtained for Horro (43.80±0.9%) (Wondmeneh *et al.,*2011). The value ranging from 57.98±0.06 to 60.81±0.06%) for all groups were all higher than the values obtained by Wondmeneh *et al. (*2011) for all the breeds ranging from 41.65±0.4 to 53.23±0.2%. The differences could be as a result of genetic differences due to breed effect and line effect. In this study therefore, selection has improved the hatchability of the selected lines. It is recommended that a hatchability of 80% is considered normal but a range between 75 to 80% is satisfactory and anything falls short of 75% is considered poor. The control groups of chicken were noticed with hatchability of less than 75%, a condition considered as poor hatchability. This report revealed that hatchability was grossly affected by genetics and could be improved by selection.

Table 6: The least squares mean (± SE) for reproductive and productive traits for sire line, dam line, sire control and dam control

Traits	Sire line	Dam line	Sire control	Dam control
Percentage Fertility (%)	94.50±4.46	91.88±3.22	85.55±3.22	90.20±4.45
Percentage Hatchability (%)	81.59±5.10^{a}	80.85±3.69^{a}	73.74±3.69^{ab}	67.26±5.10^{b}
Percentage Dead in shell (%)	23.62±4.44	20.17±3.21	26.80±3.21	32.74±4.44
Percentage clear eggs (%)	10.50±5.68	8.62±4.11	13.38±4.11	10.50±5.68
Eggs number/day/pen	2.74±0.15^{b}	3.26±0.15^{a}	2.81±0.15^{ab}	3.11±0.15^{ab}
Egg weight /day/pen	60.81±0.60^{a}	60.17±0.60^{a}	57.98±0.60^{b}	60.17±0.60^{a}

^{a,b,c} = Means with different superscript within the same row are significantly (P<0.05) different,

SE= Standard Error

Phenotypic correlations among blood biochemical traits and egg production and reproductive traits were displayed in Table 7. The results revealed negative, high, and significant correlation between serum alkaline phosphatase (SAP) and acetylcholine esterase (AchE) (r = -0.974, p = 0.0001), SAP and total protein (TP) (r = -0.948, p = 0.0001) and SAP and egg number (r = -0.934, p = 0.0001) for both the sire and dam selection. However, SAP was positively correlated with egg weight (r = 0.761, p =0.001), fertility (r = 0.870, p = 0.0001) and hatchability (r = 0.915, p = 0.0001) for both sire and dam selection. Meanwhile, TP and AchE were negatively correlated with SAP, egg weight, fertility, and hatchability for both sire and dam selection but positively correlated with each other and egg number.

Phenotypic correlation among blood biochemical traits and egg production and reproductive traits were displayed in Table 8. The results revealed negative, high and significant correlation between serum alkaline phosphatase (SAP) and acetylcholine esterase (AchE) (r = -0.937, p = 0.0001), SAP and total protein (TP) (r = -0.865, p = 0.001) and SAP and egg number (r = -0.973, p = 0.0001) for both the sire and dam selection. However, SAP was positively correlated with egg weight (r = 0.256, p > 0.05), fertility (r = 0.994, p = 0.0001) and hatchability (r = 0.954, p =

0.0001) for both sire and dam selection. Meanwhile, TP and AchE were negatively correlated with SAP, egg weight, fertility, and hatchability for both sire and dam selection but positively correlated with each other and egg number.

Abd El Azim (2012) reported no significant difference due to heat treatment in alkaline phosphatase in all the groups of the animals under study. They observed that exposure of chicken to heat treatment did not cause any changes to the tested criterion. They failed to relate the changes in serum alkaline phosphatase to genetic influence. However, it has been observed that serum alkaline phosphatase showed a moderate and significant correlation with body weight adjusted to total bone mineral density (0.12) (Srivastava *et al.,* 2004). Alm El Dein *et al.* (2008) reported positive correlation between plasma alkaline phosphatase and body weight at 8weeks and 12 weeks, age at sexual maturity and egg weight. They also indicated that birds with higher plasma alkaline phosphatase activity gave significantly high body weight at 12, 16 and 20 weeks of age greater than the birds with lower level of plasma alkaline phosphatase activity. According to the authors, birds with higher levels of plasma alkaline phosphatase activity had significantly earlier attainment of sexual maturity and higher body weight at sexual maturity than those of lower values. Moreover, Marcela *et al. (*2008) indicated negative but moderate correlation between serum alkaline phosphatase and total protein (-0.26) in their experimental broiler chickens. Negative and moderate correlation were still observed between serum alkaline phosphatase and total protein in the control group. Positive correlation between SAP and egg weight means that selection for SAP could lead to improvement in reproductive traits in broiler chicken. In addition, positive correlation between TP and AchE and egg number implies that selecting for TP and AchE could lead to improvement in egg number.

Table 7: Phenotypic correlation among the biochemical traits and egg production and reproductive traits in sire selection and dam selection at 8 weeks

	SAP	AchE	TP	Egg No.	Egg wt	Fertility	Hatchability
SAP	1	-0.974**	-0.948***	-0.934***	0.761**	0.870***	0.915***
AchE	-0.971***		0.911***	0.932***	-0.775**	-0.855***	-0.889***
TP	-0.913***	0.911***		0.884***	-0.721**	-0.869***	-0.906***
EggNo.	-0.975***	0.985***	0.933***		-0.942***	-0.820***	-0.853***
Eggwt	0.930***	-0.950***	-0.854***	-0.957***		0.670*	0.689**
Fert	0.962***	-0.970***	-0.944***	-0.974***	0.920***		0.966***
Hatch	0.880***	-0.897***	-0.823***	-0.936***	0.914***	0.895***	

SAP= Serum Alkaline phosphatase, AchE = Acetylcholine esterase, TP = Total protein, EggNo. = Egg number, Eggwt = Egg weight, Fert = Fertility, Hatch = Hatchability,
Sire selection = Below diagonal, Dam selection = Above diagonal

Table 8: Phenotypic correlation among the biochemical traits and egg production and reproductive traits in sire control and dam control

	SAP	AchE	TP	Egg No.	Egg wt	Fertility	Hatchability
SAP		-0.937***	-0.865**	-0.973***	0.256	0.994***	0.954***
AchE	-0.962***		0.936***	0.972***	-0.276***	-0.959***	-0.974***
TP	-0.861**	0.872**		0.918***	-0.262	-0.900**	-0.958***
EggNo.	-0.976***	0.985***	-0.899**		-0.138	-0.979***	-0.980***
Eggwt	0.718*	-0.692*	-0.686*	-0.785*		0.262	0.223
Fert	0.943***	-0.936***	-0.893**	-0.959***	0.703*		0.967***
Hatch	0.690*	-0.763*	-0.506	-0.703*	0.494	0.634*	

SAP = Serum Alkaline phosphatase, AchE = Acetylcholine esterase, TP = Total protein, EggNo. = Egg number, Eggwt = Egg weight, Fert = Fertility, Hatch = Hatchability
Sire selection = Below diagonal, Dam selection = Above diagonal

Conclusion

Short term selection has been observed to be responsible for the improvement in some traits of economic importance in chicken. Growth, reproductive and productive perfromances were noticed to be higher in the selected groups of broilers (Sire and Dam) compared to the controls. These results could be attributed to improvement gained from selection processes. In addition, selection response was responsible for the higher egg number and egg weight in the selected population. It is however asserted from this study that collapse of the Hubbard and Anak groups could be responsible for the high heritability estimates resulting from high genetic variabilities due to crossing between the two breeds of the chickens. Positive correlation between SAP and egg weight, TP and egg number and AchE and egg number are associated with SAP, TP and AchE and could be as a result of pleiotropy and linkage effect and this implies that egg weight associated. Therefore, SAP, TP and AchE could be used as markers for selecting egg weight and egg number in broiler chicken.

References

Abd El Azim (2012). Improve Heat Tolerance of Broilers through heat treatment during the first two weeks. *Egyptian Poultry Science* 32 (III):483-495.

Adeyinka I. A, Oni O. O., Nwagu, B. I. and Adeyinka F. D. (2006). Genetic parameter estimates of body weight of naked neck broiler chickens. *International Journal of Poultry Science* 5(6):589-592.

Adeyinka I. A. (1999). Short term response to selection in layer type chickens. Ph.D Thesis. Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria, pp. 16-19

Akpa, G.N., and Jokthan, G.E. (1996). Effect of feeding and routine management in rabbit production in Zaria area of Kaduna State, Nigeria. *Agricultural System in Africa*. 6(1):60-64

Aggrey, S. E., and Karnuah, A. B. (2018). Genetic changes in poultry production: a review. *Poultry Science,* 97(11), 3669-3680.

Alm El Dein, A.K., Abd El Ghany, F.A., Awaden, N. and Soliman, M.M. (2008). Prediction of productive performance of laying hens by measurement of some blood constituents. *Egyptian Poultry Science*. Vol. (28) (III): (849 – 866).

Ayorinde, K.L; Oluyemi J.A. Ayeni, J.S.O. (1988). Growth performance of four indigenous helmeted guinea fowl variety (numidra meleagris galeta pallas). In: *Nigeria-Belletin of animal health and production in Africa* 36:356-360

Badmus, K.A., Idrus, Z., Goh, Y.M., and Mamat-Hamidi, K. (2022). Telomere length diversity under the influence of heat and feed restriction stresses in broiler chicken (*Gallus gallus domesticus*). *European Poultry Science*, 20(366): 1-17.

Badmus, K.A., Zulkifli, I., Goh, Y.M. and Mamat-Hamidi, K. (2021). Telomere Length, Apoptotic, and Inflammatory Genes: Novel Biomarkers of Gastrointestinal Tract Pathology and Meat Quality Traits in Chickens under Chronic Stress (Gallus gallus domesticus). *Animals*, 11: 3276.

Bassey O.A., Lowry O.H., and Brock M. (1946). A method for the rapid determination of alkaline phosphatase with five cubic millimetre of serum. *Journal of Biochemical Chemistry*, 614: 321 – 329.

Bramwell, R.K., McDoniel, C.D., Burke, W.H., Wilson, J.L., and Howarth, B. (1996). Influence of male broiler breeder dietary energy intake on reproduction and progeny growth. *Poultry Science Journal* 75:765-775.

Buckner, R.E., Renden, J.A. and Savage, T.F. (1986). The effect of feeding programs on reproductive traits and selected blood chemistries of caged broiler breeder males. *Poultry Science Journal* 65:85-91

Cerolini, S., Mantovani, C., Bellagamba, F., Mangiagilli, M.G., Cavalchini, L.G. and Reniero, R. (1995). Effect of restricted and adlibitum feeding on semen production and fertility in broiler breeder males. *Broiler Science* 36:677-682.

Duncan, D.B. (1995). Multiple range and multiple F Tests. Biometrics 11:1-42

Falconer, D.S. (1989). Introduction to Quantitative Genetics, 3rd Edition. Longman Scientific and Technical London.

Flock, D.K., Laughlin, K.F. and Bentley, J. (2005). Minimizing loses in poultry breeding and production: How breeding companies contribute to poultry welfare. *World's Poultry Science Journal* 61, 227–237.

George, L.E.,Diane, K.C., Valentino, A. JR. and Robert, M.F. (1961). A new and rapid colorimetric determination of acetylcholinesterate activity. *Biochemical Pharmacology* 7:88-95.

Hans-Peter, P. and Mo¨hring, J. (2007). Computing Heritability and Selection Response From Unbalanced Plant Breeding Trials. *Genetics* 177: 1881–1888.

Havenstein, G. B., Ferket, P. R., and Qureshi, M. A. (2003). Growth, livability, and feed conversion of 1957 vs 2001 broilers when fed representative 1957 and 2001 broiler diets. *Poultry Science*, 82(10), 1500-1508.

Hocking, P. M. (1990). The relationships between dietary crude protein, body weight, and fertility in naturally mated broiler males. *Broiler Poultry Science.* 31:743-757.

Hunton, P. (2006). 100 years of poultry genetics. *World's Poultry Science Journal* 62, 417–428.

Jerome, F. N., Henderson, C.R. and King, S.C. (1956). Heritability and gene interaction and correlation associated with certain traits in the domestic fowls. *Poultry science* 35:995-1013.

Kinney, T.B. (1969). A summary of reported estimates of heritability, genetic and phenotypic correlations for traits of chickens USDA. *ARS Agric handbook* No. 369.

Kolstad, N. (1980). Scandinavian selection and cross breeding experiment with laying hens II result from Norwegian part of the experiment. *Acta Agriculture Scandinavia* 30:261-287.

Marcela, C., Koesarova, A., Arpasora, H. and Massanyi, P. (2008). Blood Biochemical Dynamics and Correlations in Laying Hens after Experimental Nickel Administration. *International Journal of Poultry Science* 7(6): 538-547.

Merat, P. (1990). Pleoitropic and associated effects of major genes In: *Poultry Breeding and Genetics*. Crawford R. D. (E.d) Elsevien, Amsterdam, the Netherlands, pp: 429-467

Nawar, M.E. and Abdou, F.H. (1999). Analysis of heterotic gene action and maternal effects in crossbreed Fayoumi chickens. *Egyptian Poultry Science Journal* 19:671-689

Pym, R.A.E. (1990). Nutritional genetics. In: Crawford, R.D. (ed.) *Poultry Breeding and Genetics*. Elsevier, New York, pp. 847–876.

Rahman, M., Sorensen, P., Jensen, H.A. and Dolberg, F. (1997). Exotic hens under semi scavenging conditions in Bangladesh. *Livestock Research For Development*. Volume 9 (3) http://www.cipav.org.co/lrrd/lrrd9/3/bang931.htm

SAS (2002). Statistical analysis system multiple incorporation. Users' Guide Statistical version Cary, NC. USA.

Sexton, K.J., Renden, J.A., Marple, D.N. and Kempainene, R.J. (1989). Effects of dietary energy on semen production, fertility, plasma testosterone, and carcass composition of broiler-breeder males in cages. *Poultry Science Journal*. 68:1688-1694.

Singh, C. B. and Julian M. H. (2007). Genetic and non genetic factors affecting body conformation traits in Van-Cob broiler strain. *Indian Journal of Animal Research*. 41(2):29.

Singh, V., Talia, S.P. and Jain, L.S. (2008). Genetic study of body conformation traits in a synthetic broiler strain. *Indian Journal of Animal Research* 42(1); 13.

Siegel, P. B. (1989). The genetic – behaviour interface and well-being of poultry. *British Poultry Science* 30, 3–13.

Siegel, P. B. and Gross, W.B. (2007). General principles of stress and well-being. In: Grandin, T. (ed.) *Livestock Handling and Transport*. CAB International, Wallingford, UK, pp. 19–29.

Siegel, P. B., Honaker, C.F. and Rauw, W.M. (2015). Selection for High Production in Poultry. Resource Allocation Theory Applied to Farm Animal Production. CAB International, Wallingford, UK, pp. 230-242

Schütz, K. E., Forkman, B. and Jensen, P. (2001). Domestication effects on foraging strategy, social behaviour and different fear responses: a comparison between the red junglefowl (Gallus gallus) and a modern layer strain. *Applied Animal Behaviour Science*, 74(1), 1-14.

Strivastava, A. K., Masnide, G.,Yu, H., Baylink, A. J. and Mohan, B. (2004). Mapping quantitative traits loci that influence blood levels of alkaline phosphatase in MRL/MPJ and SJL/J mice. *Bone* 35 (5):1086-94.

Togashi, **K.**, **Osawa**, T., **Adachi, K.**, **Kurogi, K.**, **Tokunaka**, K., **Yasumori, T.**, **Takahashi, T and Moribe, K.** **(2019)**. Selection on milk production and conformation traits during the last two decades in Japan. *Asian-Australasian Journal of Animal Science*, Vol. 32, No. 2:183-191.

Windhorst, H.-W. (2006). Changes in poultry production and trade worldwide. *World's Poultry Science Journal* 62, 585–602.

Wondmenah, E., Dawud, I. and Adey, M. (2011). Comparative Evaluation of Fertility and Hatchability of Horro, Fayoumi, Lohmann Silver and Potchefstroom Koekeek Breeds of chicken. *Asian Journal of Poultry Science.*5:124-129.

Yassin, H., Velthius, A. G. J., Boerjan, M., Riel, J. and Huirne, R. B. M. (2008). Field study on broiler egg hatchability. *Poultry Science Journal*.87:2408-2417.

Zaman , M. A., Sorensen, P. and Howlider (2004). Egg production performances of a breed and three crossbreeds under semi scavenging system of management. *Livestock Research for Rural Development*.16(8) 2004.

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