INTERRELATIONSHIPS EXISTING BETWEEN BODY WEIGHT AND EGG PRODUCTION TRAITS IN OLYMPIA BLACK LAYERS

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ABSTRACT

Forty 76 weeks old Olympia Black layers were randomly selected, individually caged and intensively reared for a period of 16 weeks to study the effect of body weight on some egg production traits. The analysis of variance revealed significant effect of body weight on production traits investigated ($P < 0.01$) except egg index ($P > 0.05$). The correlation analysis showed that the body weight was positively and non-significantly ($P > 0.05$) correlated with egg length, egg breadth, shell weight, yolk weight, albumen weight, shell thickness and significantly with egg weight, ($P < 0.01$) and negatively with egg index ($r = 0.016$). The second-degree (quadratic) equations for estimates of optimum 76 week body weights suggested 1.271 to 1.801 as required body weight range in kilograms for satisfactory performance. The body weight range at this age is attainable through breeding, good feeding and other management practices.

Keywords: Olympia black layer, body weight, egg traits, second-degree equation, interrelationships.

INTRODUCTION

Body weight influence on quality traits is obvious. These traits and body weight contribute significantly to the life time performance of the animal. Researches conducted into relationships between body weight and quantitative traits are well observed for meat-type poultry (Draper *et al.*, 1961; Ayeni *et al.*, 1983; Monsi, 1992; Ebangi and Ibe, 1994; Ayorinde *et al.*, 1994) and egg-type poultry (Omeje and Nwosu, 1984; Ayorinde *et al.*, 1988; Oni *et al.*, 1991 and Adenowo *et al.*, 1995). The functional relationships of the

body weight to production traits need further clarification from breeders. The challenge before the breeders is therefore to develop the desired production traits especially high egg production and big body size (Ayorinde *et al.*, 1988) using selection and breeding practices as tools. Such selection will mean selecting production traits that are highly and positively correlated and hence producing animals that are capable of high performance. Differences in performance brought about by non-genetic factors namely age, maternal effect, feeding, disease, management and climate cannot be overlooked. It is also note worthy that genetic factors show greatest influence. This explains the situation where within the same breed, strain or variety, individual variations in performance are common observations. Such individuals that are capable of high performance should be exploited in selection and breeding practices.

The paper reports on the association between body weight and some egg production traits in Olympia Black layers. It further attempts to predict performance from mature body weight using models or indices in the study.

MATERIALS AND METHODS

Experimental Location and Bird Management

The site of the experiment is the Teaching and Research Farm (poultry section) belonging to Federal University of Technology, Akure in Ondo State Nigeria. One thousand and fifty Olympia Black chicks were brooded on deep litter floor, with *ad libitum* feeding using commercial chick mash and regular water supply for the first five weeks. Medication and vaccination programmes were carefully

followed during brooding and rearing. At six weeks of age, the rationing of feed using commercial growers mash of 16% crude protein and 4.07k cal/g ME started and continued until they were 16 weeks of age when some were transferred to battery cages. Each cage housed about three birds until they were 75 weeks of age. At 75 weeks of age, 40 layers were randomly selected from the cages and were housed individually per cage measuring 46 x 39.3 x 44cm. They were allowed to acclimatize for 5 days before data collection which commenced when the birds attained 76 weeks of age. A commercial layers mash containing 90.95% dry matter, 9.05% ash, 16.85% crude protein, 4.80% fat, 3.98% crude fibre and 56.27% NFE was fed at 0.114kg per hen per day, while water was supplied regularly throughout the 16 weeks experimental period.

Data collection and statistical analyses

The birds were weighed at the beginning of the experiment and at weekly intervals. Egg production of each layer was recorded from 76 weeks up to 91 weeks of age, and each egg collected was marked according to cage number and the production was summarized on weekly and individual basis. All eggs laid by each layer were weighed and their length and breadth measured using vernier calipers. Egg index was determined as the ratio of egg breadth to egg length. One egg randomly selected from the total weekly egg laid by each hen was carefully broken and the contents poured into standard egg separator. The albumen and yolk were separated and weighed using Ohaus Electronic scale. The shell weight was also taken. A micrometer screw gauge was used to determine the shell thickness.

Variations in each of the parameters due to body weight, were examined for statistical difference using the completely randomized design (Steel and Torrie, 1980). Correlations between the traits and body weight were computed using the Pearson Correlation Module according to Statistical Package for Social Science (1986) procedures. The

associations between 76-week body weight and each trait was described by a quadratic equation following a polynomial distribution (Younger, 1985). The second-degree or quadratic equation used was $Y = a + bx + cx^2$ where the dependent variable (y) = various egg traits; the independent variable (x) = 76-week body weight; a, b and c are numerical values or constants obtainable from the data so that the response variable or dependent variable (y) can be predicted by simply substituting its size (x) into the regression equation. The quadratic relationship analyses were used in attempts to disentangle and measure the effects of different x – variables on some response Y since in many areas of research, such as this study the controlled experiments are not practicable (Snedecor and Cochran, 1976).

The equations used are:

$$\begin{aligned} \Sigma Y_i &= na + b\Sigma X_i + c\Sigma X_i^2 \\ \Sigma X_i Y_i &= a\Sigma X_i + b\Sigma X_i^2 + c\Sigma X_i^3 \\ \Sigma X_i^2 Y_i &= a\Sigma X_i^2 + b\Sigma X_i^3 + c\Sigma X_i^4 \end{aligned}$$

The value of X (76 week body weight) that will give the maximum value of each of the egg traits (y) was determined from the equation $X_{\max} = b/2c$ (Little and Hills, 1978).

RESULTS AND DISCUSSION

The population parameters are given in Table 1. About 3016 eggs laid by the 40 layers over a period of 16 weeks were used to determine egg weight, egg length, egg breadth, egg index and hen-day production. While 640 eggs representing a total number of eggs randomly selected from weekly egg production of each layer were broken and used to determine albumen weight, shell weight, yolk weight and shell thickness. The first four weeks of the experiment recorded consistent increase in body weight gain attributable to increases in maintenance requirement. Its rising and falling in subsequent weeks probably resulted from body weight maintenance and egg formation processes sharing the available nutrient. Duplessis and Erasmus (1972) and Ayorinde *et al.*

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TABLE 1: EGG PRODUCTION TRAITS RECORDED ON FORTY OLYMPIA BLACK LAYING HENS

Traits	No of Observations	Mean	Standard Error	Min	Max
Egg length (cm)	3106	6.24	0.0158	5.92	6.43
Egg breadth (cm)	3106	4.98	0.0122	4.43	4.83
Egg index	3106	0.763	3.589 ⁻⁰³	0.71	0.81
Egg weight (g)	3106	63.06	0.1924	59.28	66.15
Albumen weight (g)	640	37.91	0.279	35.58	40.07
Yolk weight (g)	640	16.89	0.1202	16.51	17.66
Shell weight (g)	640	7.85	0.0538	7.45	8.35
Shell thickness (mm)	640	0.31	2.372 ⁻⁰³	0.30	0.32
Body weight (g)	640	1726.25	6.275	12.71	18.01
Hen-day (%)	3106	69.33	0.0893	61.07	76.79

(1988) reported consistent reduction in body weight which they attributed to an increased use of physiological reserves to meet egg production demands.

There were observed increases in egg weight, length, breadth, albumen weight and hen-day production in the first three weeks. These were similar to those severally reported in literature (Gerstmayr and Hors, 1990; Olori and Sonaiya, 1992; Austic and Nesheim, 1990; Asuquo, 1994).

These traits assumed rising and falling trend in subsequent weeks of the experiment. The egg index, shell weight, yolk weight and shell thickness maintained similar trends during the study period.

The mean squares and degree of freedom from analyses of variance for effect of body weight on egg production traits are presented in Table 2. The body weight exerted significant influence on production traits investigated ($P < 0.01$) except egg index ($P > 0.05$). These were in line with research findings published in literature (Ricklefs, 1983; Ayorinde *et al.*, 1988).

Figures 1 and 2 show relationship between body weight and egg production traits. Egg

length, index, weight, albumen weight and shell weight rose between 1473 and 1626g body weight, assumed undulating trend between 1626 and 1822g body weight and finally declined between body weight range of 1822 and 1923g. The yolk weight dropped within the body weight range of 1473 and 1626g. There were no differences in the shell thickness in the body weight range of 1473 to 1650g. These findings showed no appreciable disagreement with Funk (1994), Briggs and Nordskog (1967) and Ayorinde *et al.* (1988) who reported that egg production traits changed with body weight.

Body weight was lowly, positively and non-significantly correlated with egg length, breadth, yolk weight, albumen weight and shell thickness ($P > 0.05$); significantly with egg weight (< 0.01) and negatively with egg index (Table 2). Similar correlated values for body weight and some production traits had been reported by Harms *et al.* (1982) and Ricklefs (1983).

There appeared to be a general direct relationship between body size and egg size. The positive significant correlation between body weight and egg weight was corroborated by Ayorinde *et al.* (1988) indicating egg weight increases with body weight contrary to

Singh (1990) who reported that decreased body size could lead to increased egg size. Nordskog (1960) reported positive correlation between body weight and egg weight and

further pointed out that the rate of increase was not directly proportional to the increase in body weight.

FIG 1: RELATIONSHIP BETWEEN WEIGHT AND EGG PRODUCTION TRAITS

FIG 2: RELATIONSHIP BETWEEN WEIGHT AND EGG PRODUCTION TRAITS

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TABLE 2: MEAN SQUARES (MS) AND DEGREE OF FREEDOM (D.F.) FROM ANALYSES OF VARIANCE FOR EFFECT OF BODY WEIGHT ON VARIOUS EGG PRODUCTION TRAITS

Egg Length		
Source of Variation	D.F	Mean Squares
Between groups	39	3.8315**
Within groups	600	0.8857
Egg Breadth		
Source of Variation	D.F	Mean Squares
Between groups	39	2.2985**
Within groups	600	.4979
Egg Index		
Source of Variation	D.F	Mean Squares
Between groups	39	1620.2258. n.s
Within groups	600	1611.4680
Yolk weight		
Source of Variation	D.F	Mean Squares
Between groups	39	51.8319**
Within groups	600	7.4988
Albumen weight		
Source of Variation	D.F	Mean Squares
Between groups	39	246.3564**
Within groups	600	43.5326
Shell weight		
Source of Variation	D.F	Mean square
Between groups	39	11.7553 n.s
Within groups	600	1.5201
Shell thickness		
Source of Variation	D.F	Mean square
Between groups	39	0.0148**
Within groups	600	0.0023

** - Significant at 1%

n.s. – Not significant at 5%

The positive correlation coefficient for body weight and shell thickness obtained in the study, disagreed with Ayorinde *et al.* (1988) report that body weight was negatively correlated to shell thickness. Previously also, Nordskog (1960) and David (1980) observed that hens with small body sizes laid smaller sized eggs and irrespective of egg size, the amount of shell was the same. Ricklefs (1983) further pointed out that larger body size resulting in large egg length, width and mass could affect egg weight and that lighter body weight birds laid eggs with thinner shell.

However, a fixed amount of shell deposited on large eggs would tend to be thinner because the quantity of shell deposited either remained constant or increased slightly as the layer aged (Nwosu *et al.*, 1987).

The positive correlated values for body weight and egg length and breadth (Table 3) agreed with Ricklefs (1983) findings that larger mature body size resulted in longer and broad eggs. The negative correlation between body weight and egg index might be attributed to the more positive response of egg breadth to

TABLE 3: CORRELATION COEFFICIENTS, CONSTANTS AND MAXIMUM VALUES FOR EACH OF THE EGG TRAITS

CONSTANTS					
Traits (y)	r	a	b	c	Xmas. (kg)
Egg length	0.0847 n.s	0.61480	6.61535	-1.92142	1.721
Egg breadth	0.0846 n.s	0.50293	4.91177	-1.42482	1.724
Egg index	-0.0160 n.s	-4.10837	12.97252	-5.10326	1.271
Egg weight	0.1243**	1.61206	69.13729	-19.19785	1.800
Albumen weight	0.0649 n.s	4.05713	40.06824	-11.70979	1.711
Yolk weight	0.0711 n.s	2.11937	17.38652	-5.05424	1.720
Shell weight	0.087 n.s	0.65499	8.36932	-2.40366	1.741
Shell thickness	0.0554 n.s.	0.04129	0.32732	-0.09712	1.720

r – correlation coefficients

n.s. – Not significant at 5%

** - Significant at 1%

a, b, c, - Constants for predicting y (egg traits) by substituting X (body weight into the regression equation Xmax – value of x (body weight) for the maximum value of y (egg traits) determined from $b/2c$.

changes in body weight than did egg length. This implies that as egg index decreases with an increase in body weight, the eggs will be more oblong in shape.

The correlation between body weight and egg production might be positive (Render *et al.*, 1984) or negative (Nozchev and Kunev, 1973 and Harms *et al.*, 1982) as observed by the named workers. Nordskog (1960) asserted that the negative association could be due to fat deposition in large bodied hen.

The association between body weight and different egg production traits in the study was non-linear. Such non-linearity might be related to a direct functional association between those variables or from the confounding of two or more simpler relationships, which though would be themselves linear. This was similar to the report of Ayorinde *et al.* (1988) that body weight and egg traits was non-linear. A significant quadratic relationship between total egg production and body weight at sexual maturity in the White Leghorn had been observed by Du plisses and Erasmus (1972).

The correlation coefficients; and constants in the equations for predicting 76 week body weight (x) from the egg traits (y) are given in Table 3. The equations indicate optimum body weight below or above which the different egg traits would decrease as 1.721, 1.724, 1.271, 1.800, 1.711, 1.720, 1.741 and 1.720kg for egg length, breadth, index, weight, albumen weight, yolk weight, shell weight and shell thickness respectively. These results suggest that maintaining the body weight range of 1.720 to 1.800kg in Olympic Black Hens through breeding, good feeding and management practices will ensure satisfactory egg production, weight, shape and shell quality.

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