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Influence of age and weight at first egg on monthly egg production and quality traits of Bovans Brown Chickens

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***Target Audience:** Researchers, Livestock breeders and Poultry farmers*

Abstract

The influence of age and weight at first egg on monthly egg production and quality traits of Bovans Brown chickens was studied. The research was conducted at the Poultry Unit of the University of Maiduguri Livestock Teaching and Research Farm. Data collected from 50 Bovans Brown layers were analyzed using the general linear model of SPSS. Weight at first egg and most egg quality traits except egg length, yolk length and index had significant effect on egg number in the months of January and February. The laying birds were grouped into three (<1.60 Kg, 1.60 – 1.90 Kg and >1.90 Kg). Egg number was higher for birds weighing 1.60-1.90 Kg and greater than 1.90 Kg. The value of egg quality traits was higher in birds with longer days at first egg. The reverse was however the case with albumin length and Haugh unit. Age at first egg had a significant effect on egg production in January with birds that came into lay at a later period having higher egg number. Correlation coefficients between egg weight, length and width (0.92, 0.65 and 0.75 respectively) were generally high, positive and significant (P<0.01). an indication that when egg weight is improved egg length and width got better.

***Key words:** Age; Weight' Egg; Quality and Trait.*

Description of Problem

Poultry is a collective name used to designate species of bird (avian) that have been domesticated to reproduce and grow in captivity to produce meat, egg, feather, manure among others (11). Poultry production has an important economic, social and cultural benefits and plays a significant role in family nutrition in developing countries. It is estimated that 80% of the poultry population in Africa is found in scavenging system (15). In Nigeria, the population of poultry was put at 114.3 million. Other poultry birds include pigeons, ducks, guinea fowls and turkey (18). According to CBN (9), estimate for poultry meat and egg production as of 2002 in Nigeria were 107,000 tonnes and 515,000 tonnes respectively. In 2006, the egg production has increased by 4.2% to 604,300 tonnes (9). FAOSTAT (12) indicated that Nigeria has estimated poultry meat and egg of 240,000 tonnes and 640,000 tonnes respectively.

Egg production is one of the major performance parameters of layers, even though in Nigeria and some other countries, it is limited by inadequate knowledge of nutritional requirement of birds (17). Egg production in a flock of layers which are expected to start laying egg at 20 to 22 weeks of age, reaches its peak at 30 to 32 weeks of age (16). During the second year when the peak of production attained, the rate of production drops and sometimes may approach zero (19). Egg production depends on the genetic make-up of the bird as well as the nutrients intake and environmental temperature (1). Egg quality characteristics comprises of various traits which affect its acceptability to consumers (23). The age at which hens lay their first egg is often used as measure of age at sexual maturity (16). It is expected therefore, that age at first egg is earlier than age at sexual maturity. The effect of senescence in the hen can be seen about 6 to 10 weeks after the hen starts to lay, when there is a decrease in the clutch with age (24) which means that there is an increase in the lay with increase in time.

The fact that body weight at sexual maturity of laying chicken should be around 1.5 Kg, underweight and overweight birds have reduced performance (3). Proper management and nutritional interventions are necessary in other to achieve optimum body weight. Good growth allows for early sexual maturity. In contrast, when sexual maturity is triggered off by light stimulation, the body weight of the pullet has no effect on the age at first egg in such a situation those pullets with low body weight produced smaller eggs. When pullets are heavier, peal production, persistency and shell quality are adversely affected (13).

The Bovans Brown is a hybrid chicken, which is the result of crossing Rhode Island Reds and Rhode Island Whites (5). It is a hybrid, not a true breed and is known for its high egg production of approximately 300 eggs per hen in the first year of laying (10). The hybrid was developed in 1978 for egg production in France (15). These chickens are very good for first time chicken owners as they are good layers, less flighty and will not be able to escape with their wings clipped (17). The Bovans Brown was developed because there was apparent demand for consumption of brown eggs. This problem was evident in the egg industry, thus the need to develop strains of laying hens that lay better quality eggs (14). The Bovans Brown is a brown feathered, brown egg layers which has the ability to meet the expectations of a variety of egg producers with different objectives (10). These birds have shorter age of sexual maturity of 20 weeks (7). Butcher (7) reported the range of 20-22weeks. The hybrid reaches early age at sexual maturity. A Bovan Brown chicken can lay a total of 270 eggs per year (7). The chickens have good adaptability to various conditions and bred for long laying phases: 72-90 weeks of age. They lay a very heavy egg about 60-70 g (7). Buckley et al., (6) reported a range of 58-75g of egg weight. The chickens weighed 1.9 Kg at sexual maturity (14).

The objective of this study was to determine the influence of age and weight at first egg on egg production and quality characteristics of Bovans Brown chickens.

Materials and Methods

Experimental site

The research was conducted at the University of Maiduguri Livestock Teaching and Research Farm. Maiduguri is the capital city of Borno State and is located within the Sahelian (Semi-arid) region of West Africa in an elevation of 36m above sea level in the North-Eastern part of Nigeria. Maiduguri is on latitude $11^0$50` North and longitude $13^0$09` East (18).

Experimental Stock Management

Fifty (50) Bovans brown pullet sourced from ECWA Jos were brought to the farm and brooded for four weeks under deep litter system of management and later transferred to the battery cage system and fed commercial feed within energy and protein contents of 2700 Kcal and 16.5% CP respectively.

Data collection

A total of 50 Bovans Brown chickens were placed in battery cages, at one chicken per cage with length by width by height of 2 m x 2 m 1.6 m respectively. The age and weight at sexual maturity was closely monitored and recorded weekly using measuring scale (Mercury 100). The egg quality characteristics were measured from 100 eggs randomly selected from every week's collections for 12 weeks.

The eggs content was carefully emptied into a flat glass surface where the length, height, width of albumin and yolk were measured using Vernier Caliper calibrated in millimeter. Shells were washed and dried at room temperature for 2 days and weighed as described by Scott and Silver (22). The thickness of the shell was determined using a micrometer screw gauge calibrated in millimeter. Accuracy of shell samples at broad end middle and narrow end of the gauge calibrated in millimeter. The average shell thickness was then recorded in millimeter. The Haugh unit, Albumin index, Yolk index and Shape index were calculated using the following formula:

$Hu = 100\log(h - 1.7w^{0.37} + 7.6)$ (16)

Where:

Hu = Haugh unit

H = Observed height of the albumin in mm

w = weight of egg in grams

$$\text{Albumin index} = \left(\frac{\text{Albumin height}}{\text{Albumin width} + \text{width}/2}\right) \times 100$$

$$\text{Yolk index} = \frac{\text{Yolk height}}{\text{Yolk length}} \times 100$$

$$\text{Shape index} = \frac{\text{Egg width}}{\text{Egg length}} \times 100$$

Statistical Analysis

The data collected were analyzed using the general linear model of SPSS (17) with age and weight at sexual maturity of the chickens as fixed factors. The laying birds were grouped into three (<1.60 Kg, 1.60 – 1.90 Kg and >1.90 Kg). The age at first egg is 23 weeks and the sample size were 17, 18 and 15, respectively.

Significant means were separated by Duncan's multiple range test. The statistical model adopted was as follows:

$Y_{ijkl} = \mu + A_i + W_i + E_{ijk}$

Where:

Y_{ijkl} = Individual on age and weight at first egg of chickens

μ= Population mean

A_i = Age at first egg

W_i = weight at first egg

E_{ijk} = Random error

Results and Discussion

Effect of weight and age at first egg on monthly egg production

Least square means and standard error for effects of weight and age at first egg on monthly production are presented in Table 1. The results show that the means of egg produced per month within the period of five months (November, December, January, February and March respectively) were; 5.50, 22.72, 27.50, 24.78 and 11.62 respectively. There were significant differences (P<0.05) in weight at first egg affected by the month of January and February. Birds weighing between 1.60 - 1.90 Kg and greater than 1.90 Kg at first egg had higher egg number than birds weighing less than 1.60 Kg. This showed that chickens with higher weight at first egg between 1.60 - 1.90 Kg and greater than 1.90 Kg had higher production in January and February. However, weight at first egg did not affect total egg number in the study period.

Table 1: Least Square Means ± Standard Error of Effects of Weight and Age at First Egg on Monthly Egg Production

Variables	November	December	January	February	March	Total Egg
Overall Mean (kg)	5.50±1.34	22.72±1.18	27.50±0.50	24.78±0.42	11.62±0.40	92.12±3.84
Weight at first egg (kg)						
	Ns	ns	*	*	ns	ns
<1.60	7.63±6.07	22.75±5.33	25.38±2.25[b]	23.63±1.89[b]	11.00±1.82	90.38±11.12
1.60-1.90	4.32±2.53	23.13±2.22	29.03±0.94[a]	25.81±0.79[a]	11.94±0.76	94.23±4.63
>1.90	4.91±4.55	21.55±4.00	28.18±1.68[a]	24.91±42[ab]	12.45±1.37	92.00±8.34
Age at first egg (weeks)	Ns	ns	*	ns	ns	ns
23	10.50±6.57	21.25±5.77	25.25±2.43[b]	24.00±2.04	11.25±1.97	92.25±12.04
24	5.40±5.14	24.80±4.52	26.60±1.90[b]	24.20±1.60	11.20±1.54	92.20±9.43
25	7.44±3.91	24.33±3.44	29.78±1.4 [a]	26.00±1.22	11.89±1.17	99.44±7.17
26	3.00±4.00	21.00±3.51	28.38±1.48[ab]	26.13±1.25	11.00±1.20	89.50±7.33
27	3.56±3.91	24.22±3.44	29.00±1.45[a]	25.33±1.22	12.11±1.17	94.22±7.17
28	2.25±3.73	22.50±3.28	28.25±1.38[ab]	25.50±1.16	13.13±1.12	91.63±6.84
29	5.57±5.02	20.29±4.41	28.14±1.86[ab]	24.43±1.56	12.14±1.51	90.57±9.21

ab = means in the same column with different superscripts are significantly ($P<0.05$) different * = ($P<0.05$)
ns = not significant

Age at first egg also revealed significant effect ($p<0.05$) on the month of January. The age at first egg 25 and 29 weeks had higher egg number than other weeks this implies that chickens that came into lay later laid more eggs than those that came into lay earlier. This is contrary to the report of Zaman et al., (26) who observed 22 weeks of age at first egg. The variation might be due to protein balance of the feed, environmental factors and genetic differences of the birds (25). This underline the general expectation that sexual maturity depends on the physiological age of the organism and if this process is postponed, probably by lack of food it will be reflected in a later start of lay as reported by Rahman et al., (19).

Weight and age at first egg on egg quality traits

The results of effects of weight and egg on egg quality traits are presented in the Table 2. The means of the egg quality traits are 59.68, 55.98, 43.17, 39.12, 18.10, 5.68, 0.33, 82.38, 59.09, 0.49, 0.13, 1.81 and 78.13 for egg weight, egg length, egg width, yolk length, yolk depth, shell weight, shell thickness, albumin length, haugh unit, York index, albumin index, albumin depth and shape index respectively.

Weight at first egg significantly ($P<0.05$) affected egg weight, egg width, yolk depth, shell weight, shell thickness, albumin length, Haugh unit, albumin depth, and shape index. Birds weighing 1.60 – 1.90 Kg and greater than 1.90 Kg had higher egg weight, shell weight, shell thickness and albumin depth than those weighing less than 1.60 Kg. Similarly, those weighing greater than 1.90 Kg had higher egg width, yolk depth and Haugh unit. This implied that as the weight of the first egg increased, egg weight, shell weight, shell thickness, albumin depth, egg width, yolk depth and shape index also increased while it is the reverse in egg weight, shell weight and shell thickness as the body weight at first egg increase are in agreement with Roland et al., (21). The decrease in Haugh unit as the weight at first egg increase showed that the chicken laid heavier eggs of low capacity and higher albumin depth as the weight at first egg decreased which is in line with what Asuquo et al. (4) reported.

Table 2: Least Square Means ± Standard Error of Effects of Weight and Egg on Egg Quality Traits

	Egg weight	Egg length	Egg width	Yolk length	Yolk depth	Shell weight	Shell thickness	Albumin length	Haugh unit	Yolk index	Albumin index	Albumin depth	Shape index
Overall Mean	59.68±0.26	55.98±0.10	43.71±0.80	39.12±0.63	18.10±0.07	5.68±0.03	0.33±0.33	82.38±0.45	59.09±0.37	0.49±0.00	1.13±0.00	1.81±0.01	78.13±0.14
Weight at first egg (kg)	*	Ns	*	ns	*	*	*	*	*	ns	*	*	*
<1.60	57.41±0.72^{b}	56.00±0.28	42.95±0.23^{c}	38.50±1.76	17.96±0.20^{b}	5.41±0.10^{b}	0.32±0.01^{b}	84.84±1.26^{a}	61.49±1.04^{a}	0.49±0.01	0.12±0.00^{b}	1.80±0.02^{b}	76.74±0.04^{c}
1.60-1.90	59.82±0.17^{a}	56.03±0.06	43.63±0.05^{b}	40.21±0.41	18.03±0.05^{b}	5.83±0.02^{a}	0.34±0.01^{a}	81.73±0.29^{b}	58.92±0.24^{b}	0.48±0.00	0.12±0.00^{b}	1.83±0.01^{a}	77.91±0.00^{b}
>1.90	61.67±0.30^{a}	56.12±0.11	44.38±0.10^{a}	40.00±0.73	18.34±0.08^{a}	5.87±0.04^{a}	0.34±0.01^{a}	81.35±0.52^{b}	56.77±0.43^{c}	0.49±0.01	0.13±0.19^{a}	1.83±0.01^{a}	79.13±0.10^{a}
Age at first egg (weeks)	*	*	Ns	Ns	ns	*	Ns	'	*	*	Ns	ns	*
23	59.44±0.49^{b}	57.00±0.19^{a}	43.22±0.16	40.02±1.20	17.98±0.14	5.72±0.07^{d}	0.33±0.01	82.88±0.86^{ab}	58.98±0.71^{ab}	0.47±0.01^{b}	0.12±0.00	1.80±0.01	75.85±0.01^{e}
24	59.73±0.51^{b}	55.62±0.20^{b}	45.84±0.16	39.97±1.25	17.98±0.14	5.64±0.07^{d}	0.33±0.01	81.01±0.90^{bc}	59.59±0.73^{a}	0.47±0.01^{b}	0.13±0.00	1.80±0.01	78.84±0.27^{ab}
25	59.75±0.42^{b}	55.86±0.16^{b}	43.80±0.13	39.87±1.02	18.06±0.12	5.79±0.00^{c}	0.34±0.01	80.00±0.073^{bc}	59.61±0.60^{a}	0.48±0.01^{b}	0.12±0.00	1.81±0.01	78.43±0.28^{bc}
26	59.57±0.40^{b}	55.97±0.61^{b}	43.65±0.13	39.41±1.02	18.18±0.12	5.76±0.05^{bcd}	0.33±0.01	82.40±0.73^{ab}	59.64±0.60^{a}	0.48±0.01^{ab}	0.13±0.00	1.82±0.01	78.01±0.23^{c}
27	61.27±0.40^{a}	55.74±0.15^{b}	44.15±0.13	39.85±0.98	18.22±0.11	5.90±0.05^{ab}	0.40±0.01	79.36±0.71^{c}	56.73±0.58^{c}	0.48±0.01^{ab}	0.12±0.00	1.82±0.01	79.24±0.23^{a}
28	60.92±0.42^{a}	56.62±0.16^{a}	43.78±0.13	39.67±1.03	18.04±0.12	5.98±0.06^{a}	0.41±0.01	82.22±0.73^{ab}	57.44±0.51^{bc}	0.48±0.01^{ab}	0.13±0.00	1.80±0.01	77.35±0.22^{d}
29	59.84±0.39^{a}	55.91±0.15^{b}	43.76±0.13	42.13±0.95	18.17±0.11	5.90±0.05^{abc}	0.34±0.01	83.25±0.68^{a}	58.84±0.56^{ab}	0.50±0.01^{a}	0.12±0.00	1.82±0.01	78.32±0.21^{bc}

ab = means in the same column with different superscripts are significantly (P<0.05) different

* = (P<0.05)

ns = not significant

Table 3: Correlation Coefficients (r) Between External Egg Quality Traits

	Egg weight	Egg length	Egg width	Shape index	Shell weight	Shell thickness
Egg weight	1.00					
Egg length	0.696**	1.00				
Egg width	0.818**	0.472**	1.00			
Shape index	0.176**	-0.457**	0.573**	1.00		
Shell weight	0.049ns	0.006ns	0.043ns	0.037ns	1.00	
Shell thickness	0.235**	0.031ns	0.196**	0.196	0.077**	1.00

** = (P<0.01)
* = (P<0.05)
ns = not significant

Age at first egg had significant (P<0.05) effects on egg weight, egg length, shell weight, albumin length, Haugh unit, yolk index and shape index. The age at first egg increase as the egg weight increased having higher values at the egg of 27, 28 and 29 weeks. Similar report was reported by Ahmed and Islam (2). Yolk index also increased as the age increased and was higher at week 29. This shows that the higher the age at first egg the higher the yolk. It is also in line with Ahmed and Islam (2) and Asuquo et al. (4).

Correlation coefficients (r) between external egg quality traits

Table 3 showed correlation between external egg quality traits. The results revealed high, positive and significant (P<0.01) relationship between egg weight and egg length, (0.818) as well as egg width (0.696). It was also low positive and significant (P<0.01) with shell thickness (0.235) and shape index (0.176). It was however low, positive and non-significant with shell weight (0.049). The positive correlation showed that the increase in egg weight led to increase in egg length, egg width, shell thickness and shell weight. Similar report was reported by Asuquo et al., (4) who reported correlated values varying between 0.02 - 0.84.

Positive relationship indicates that selection for egg length, egg width and egg shell will lead to improvement of the correlated traits because phenotype is the proximate indication of the genotype. There was a moderate, negative significant (P<0.01) relationship between egg length and shape index. This suggested egg of round shape. This agrees with the results of Asuquo et al., (4) who reported negative value between egg length and shape index (-0.245).

Correlation coefficient between internal egg quality traits

The results of the correlation between internal egg quality results are presented in Table 4. The correlation analysis revealed high, positive and significant (P<0.01) relationship between albumin length and albumin width (0.868). which implies that selection for high albumin length will lead to increase in albumin width, thus the breeder wants to improve the albumin length, albumin width will also be improved. This work is in line with that of Charles and Tucker (8) who found that the effect of light intensity on egg production result in increased egg weight. Correlation coefficients is moderate, negative and significant (P<0.01) with albumin index (-0.751), low, negative and significant with yolk depth (-0.212), yolk index (=0.162) and Haugh unit (-0.312). It is as well low, positive and non-significant with yolk length (0.047). The correlation also revealed high, positive and significant (P<0.01) relationship between albumin depth and yolk length (0.99). This show that the increase in albumin depth will lead to the increase in yolk length. Applegate et al. (3) reported higher yolk length with increase in albumin depth which is similar to that reported in this study.

Table 4: Correlation Coefficients (r) Between Internal Egg Quality Traits

	Albumin length	Albumin width	Albumin depth	Albumin index	Yolk length	Yolk width	Yolk depth	Yolk index	Haug h unit
Albumin length	1.00								
Albumin width	0.868**	1.00							
Albumin depth	-0.596**	-0.500**	1.00						
Albumin index	-0.751**	-0.766**	0.923**	1.00					
Yolk length	0.047ns	0.99**	-0.024**	-0.057*	1.00				
Yolk width	0.069*	0.115**	-0.018**	-0.063*	0.025ns	1.00			
Yolk depth	-0.217**	-0.153**	0.421**	0.573**	0.361**	0.019ns	1.00		
Yolk index	-0.162**	-0.168**	0.179**	0.193**	-0.046*	-0.286**	0.404**	1.00	
Haugh unit	-0.312**	-0.472**	0.180**	0.328**	-0.075**	-0.076**	-0.129**	0.18ns	1.00

** = (P<0.01)
* = (P<0.05)
ns = not significant

Table 5: Correlation Coefficients (R) Between External and Internal Egg Quality Traits

	Albumin length	Albumin width	Albumin depth	Albumin index	Yolk length	Yolk width	Yolk depth	Yolk index	Haugh unit
Egg weight	0.113**	0.319**	0.148**	-0.029ns	0.068*	0.075**	0.261**	0.032ns	-0.924**
Egg length	0.119**	0.169**	0.107**	-0.002ns	0.038*	0.050ns	0.205**	-0.022ns	-0.645**
Egg width	0.080**	0.309**	0.135**	0.033ns	0.069*	0.235**	0.240**	-0.002ns	-0.755**
Shape index	-0.031ns	0.154**	0.039ns	-0.03ns	0.035ns	0.190**	0.052ns	-0.023ns	-0.162**
Shell weight	0.019ns	0.035ns	-0.008ns	0.025ns	0.008ns	0.003ns	0.002ns	-0.008ns	-0.046ns
Shell thickness	-0.312**	-0.472**	0.180**	0.328**	-0.075**	-0.076**	-0.129**	-0.046**	-0.304**

** = (P<0.01)
* = (P<0.05)
ns = not significant

Correlation coefficient between external and internal egg quality traits

The results in Table 5 revealed low, positive and significant (P<0.01) relationship between albumin length and egg weight, egg length and egg width. That is, increase in albumin length led to increase in egg weight, egg length and egg width. Asuquo et al. (4) reported high egg weight with increase in albumin length and some other internal quality traits. The correlation also revealed low, negative and significant (P<0.01) relationship with shell thickness (-0.312) and it is low, positive and not significant with shell weight. The positive and significant relation of egg weight and albumin indicates that albumin is the bulk of egg weight as reported by Ahmed et al., (1). Result for albumin length further suggests that selection for increase egg size will result in concomitant increase in egg weight.

Conclusion and Applications

1. The results of this study showed that weight and age at first egg of greater than 1.60kg and 25 weeks respectively had higher number of eggs and quality traits.
2. Therefore, it can be concluded that, weight and age at first egg of greater than 1.60kg and 25 weeks respectively are good for production and quality traits in the study area.
3. Producers in the study area should expect better performance at >1.60 Kg and 25 weeks of age.

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