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Effect of Quantitative Feed Restriction on the Performance of Laying Hens

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Abstract

This study was undertaken to determine the effect of quantitative feed restriction on the performance of laying hens. Forty-eight laying hens which were fifty-two weeks old were assigned to four treatments which were made up of three replicates each. They were subjected to the same management conditions. The treatments consisted of the control T_1 (120g), T_2 (115g), T_3 (110g) and T_4 (105g) per hen. The experiment lasted for 8 weeks. On completion of 4^{th}, 6^{th}, 8^{th} week feeding trial, one fresh egg was collected per replicate for analysis of the external, internal and performance qualities. The result indicated that significant difference ($p<0.05$) existed in the Albumen width, Feed intake and Feed conversion ratio while there was no significant difference ($p>0.05$) among the other treatment means. T_3 showed highest number of eggs at 110g of feed per bird followed by T_2 at 115g of feed per bird. The Haugh unit of T_3 was highest with low feed cost. Therefore, it was concluded that farmers can practice quantitative feed restriction in laying hen at 110g of feed per day.

Keywords: *Laying hens, Performance Characteristics, Egg characteristics*

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Background to the Study

The term poultry generally refers to all domestic birds reared in the farm for meat, egg, feathers and also for skin in the case of ostrich. Poultry therefore includes domestic chicken, turkey, guinea fowl, duck, geese, ostrich, swam, quail, pigeon and pheasant. It is also the collective or group name for all domesticated birds (Ebenebe, 2021). Poultry farming is the act of raising domesticated birds such as chicken, turkey, ducks, and geese, for the purpose of meat, egg and feather production. Poultry birds are farmed in great numbers with chicken being the most numerous. Chickens raised for meat are called broilers while those raised for eggs are called layers. In this study, we are concentrating on laying hens.

Rearing of chicken is one of the activities which improves the livelihood of the poor due to the advantages it has in terms of the capital required and the relative ease to set up such a production system (Ogunlade & Adebayo, 2019: Ja'afa-Fura & Gabdo, 2020). Poultry is a popular industry for the small holder's farmer with tremendous contribution to Nigeria Gross Domestic Product and creation of employment opportunities (Okonkwo & Akubo, 2018, Adebayo & Adeola, 2015). Poultry production remains one of the veritable ways of achieving sustainable and rapid production of high-quality animal protein to meet the current meat shortage in Nigeria (Burden, 2015). It is well settled that there is inadequate intake of animal protein in Nigeria (Atsu, 2022). Thus, it is necessary to efficiently carry out poultry farming to improve productivity and sustain the sub-sector in Nigeria since eggs have been considered as a major food item for human consumption, providing adequate nutrition for both children and adults (Basmacioglu & Ergul 2005).

It is obvious that feeding constitutes over 70% of the overall cost of egg and broiler production (Adefolayan & Folaya 2015). For this reason, profit can be achieved by reducing the cost of feed which usually contributes more than half of the total cost of producing the birds (Etalem *et al.,* 2019). For poultry production to be meaningful and sustainable, it is very necessary to find the means of reducing the cost of feeding. An alternative feed management practice that addresses this issue becomes imperative, and one way of achieving this is by restricting the quantity of daily fed for a particular period of time thereby stimulating compensatory growth (Dunnington *et al.,* 2022).

Feed restriction in laying hen's production involves either reducing the number of hours that the hens have access to feeds or actual reduction of the number of feeds given per day. Restricted feeding according to Renema & Robinson (2014) helped in maintaining correct body weight, prevented overeating, and limit health risks and maintained high fertility for parent stock.

The restricted quantity of feed is quickly consumed; thus, the hens starve for longer period of time before another feed is offered. This results in improved performance. The major challenge that has been linked to quantitative feed restriction programme is that it is usually difficult for all the hens to have access to feed when it is available (Simeon, 2014). It has also been noted that all hens do not have uniform body weight, body weight gain, and the rate of egg production therefore varies. These aforementioned issues therefore have significant impact on the quantity of feed eaten by a particular bird even when they are of similar or the same age.

Fasuyi & Ojo (2022) reported insignificant effect of regulated feed time on egg quality traits. In contrast, other studies showed that feed deprivation had no significant effect on, egg number, hen-day production, egg weight and egg quality (Osman *et al.,* 2020). Simeon (2014) also observed that feed deprivation during the rearing period did not have any negative influence on the number of eggs produced but it delayed sexual maturity of the birds and resulted in reduced body weight of the laying hens. Several farmers had tried to reduce the cost of production of livestock through various means. Since feed cost accounts for 60-75% of the production cost, most farmers either supplement the feed with cheaper feed ingredients, non-conventional feedstuffs or use of restricted commercial feeds without considering the implication of their action on the egg quality. This research was therefore undertaken to examine the effect of restricted feeding of laying birds on the egg quality.

Materials and Methods

Experimental Birds

A total of 48 ISA Brown pullets of about 52 weeks of age were bought from a reputable farm in Owerri. They were transported to the experimental site early in the morning and in a cage. Birds were stabilized before the commencement of the feed restriction programme. Thereafter the birds were distributed into the cages. The 48 birds were randomly assigned to four Treatments (T_1 - T_4) with 12 birds each and each Treatment replicated 3 times in a completely randomized design. The initial weights of the birds were recorded. Routine management practices and good hygienic conditions were maintained all through the experimental period. Adequate number of feeders and drinkers were provided for the birds so as to achieve equal access to feed and water among each replicate.

Experimental Diet

Formulated Layers Mash containing 2694.99 kcal ME/kg, 17.26% crude protein (cp), 4.23% Crude Fibre (CF) was gotten from a reliable source. The composition of the feed is given in Table 1. The different experimental groups were offered the same diet but at various quantities.

Table 1 : Ingredient Composition *of* the Experimental Laying Hen Diet Layer Mash

Ingredients	Percentage (%)	Kg
Whole Maize	54	54
Soya Bean Meal	5	5
Groundnut Cake	8	8
Wheat offal	10.5	10.5
Palm Kernel Cake	10.2	10.2
Fish Meal	4	4
Bone Meal/Oyster Shell	7.5	7.5
Common Salt	0.3	0.3
L-Lysine	0.15	0.15
DL-Methionine	0.10	0.10
Premix (Layers)	0.25	0.25
Total	**100**	**100**
CP%		**17.26**
ME (Kcal/Kg)		**2694.99**
CF%		**4.23**

The feed quantity served as the Treatments such that T_1 (the control, 120g), T_2 (115g), T_3 (110g) and T_4 (105g). The duration of the experiment was 8 weeks. All the birds had unrestricted access to water. On the 4th, 6^{lh} and 8th week respectively, one egg was collected per replicate to study the external and internal characteristics of the eggs.

Performance Characteristics

i. **Initial Body Weight:** The initial weight of the Birds was taken before starting of the experiment using Hanna top loading weighing balance.

ii. **Daily Feed Intake:** This was determined by subtracting the amount of feed given and the leftover from the quantity of feed fed to the individual in a replicate per day or subtracting the leftover feed from the supplied feed.

iii. **Feed Conversion Ratio:** This was computed by dividing the average daily feed intake in (kg) with the average egg weight gain (kg).

Feed Conversion Ratio = Feed intake/weight Gain.
Hen Day Egg production is calculated thus: total no of Eggs laid/day divided by Number of Birds alive multiply by 100.

Final body weights of the birds were taken at the end of the experiment using electronic digital scale.

Feed Cost/Kg was calculated by summing the cost of the feed ingredients on the formulation and dividing it by 100kg.

Feed Cost/kg of Egg was calculated thus:
Feed Cost/Kg of Egg = FCR x Feed Cost/Kg.

Egg Characteristics
The Egg weight was measured using electronic digital scale while the length and width of the eggs were obtained by measuring the point and rear axis, and spheral side with a Vernier Caliper. The eggs were carefully broken and emptied into a flat plate. Albumen and Yolk length and width were measured using Mathematical set divider and tracing it on a ruler. Albumen and Yolk Height were measured using the pointed end of Vernier Caliper.

Shell Thickness was measured using Micrometer Screw Gauge. White Membrane of the shell were first removed and measurement were taken from the pointed end, rear and the middle part. The average of these three parts, gives the shell thickness.

Egg Shell Weight was measured by egg shell being carefully washed, thin white membrane removed and air-dried for 24 hours and weighed.

Egg shape index was computed by dividing Egg width with Egg length multiply by 100.
Egg surface Area was computed by multiplying egg length by egg width i.e (Egg Length x Egg Width).

Egg shape index= Mean Egg Width -Mean Egg Length x 100
Mean percentage shell= Mean egg shell weight- Mean Egg weight x 100
The Haugh Unit is a measure of egg protein quality based on the height of the egg white (albumen). The height, correlated with the weight, determines the Haugh Unit or Haugh Rating. The higher the number of the eggs the better the quality of the egg.

The Haugh Unit was calculated by using a mathematical expression.
Haugh Unit (HU) - 100log ($H+7,5-1,7W^{0.37}$) Where H - Albumen height in cm, W = egg weight in g.

Analysis
Data collected on production performance and laying characteristics were subjected to analysis of variance (ANOVA) in a complete randomized design - CRD. Mead and Currow, 1983). Significant means was compared by Duncan's multiple Range test (Duncan, 1995) as packaged in the SPSS Computer package (SPSSINC, 2001).

Results and Discussion
Performance Characteristics of Laying Hens

Table 2: Performance Characteristics of Laying Hens Placed on Feed Restriction

Parameters	T_1	T_2	T_3	T_4	SEM
Initial Weight (g)	1.59	1.58	1.60	1.45	0.05
Final Weight (g)	1.55	1.56	1.58	1.44	0.08
Feed Intake (g)	105.94^{a}	96.45^{b}	93.51^{b}	92.49^{b}	2.71^{b}
Feed Conversion Ratio	1.85^{a}	1.64^{b}	1.52^{b}	1.55^{b}	0.05
Hen Day Egg Production (%)	79.89	66.43	68.33	60.78	2.04
Feed Cost /Kg (N)	232.14	211.34	204.90	202.66	0.00
Feed Cost /Kg of Egg (N)	429.46	346.60	311.45	314.12	0.00

SEM ± Standard Error of Mean
abcd: means on the same horizontal row with varying superscripts differ significantly ($p<0.05$),

The initial weight of the experimental birds had no significant difference ($p>0.05$) among treatment means. This implies that all the experimental birds started in similar plane of performance. The final weight of the experimental birds also had no significant difference ($p>0.05$) among treatment means. Therefore, feed restriction did not affect the performance of birds in terms of body weight change. Feed intake of the birds showed significant difference ($p<0.05$) among the treatment means with T4 recording the least feed intake. Feed conversion ratio also showed significant difference ($p<0.05$) among the treatment means. The FCR value for T3 was low compared to T_4, T_2 and the control and this could probably be as a result of efficient feed utilization and laying ability.

McDonald *et al* (2018) stated that an increase in the quantity of feed consumed by an animal generally causes an increase in the rate of passage of digesta. The feed is then exposed to the action of digestive enzymes for a shorter period of time and digestibility and feed utilization are reduced.

The hen-day egg production had no significant difference (p>.0.05) among treatment means. T_3 gave highest number of eggs followed by T_2, with feed restriction of 110g and 115g respectively the hen-day egg production of the treatment means is the same (similar).

Feed cost/kg of eggs produced were lower for T_3, and T_4 than it was for the birds on the control diet corresponding perhaps to their high hen-day egg production. It also showed that feed cost/kg of egg which is a function of FCR and feed cost/kg was also affected by the poor FCR of control diet. Birds with lower FCR values (T_3, T_4 and T_2) produced cheaper eggs in comparison with birds with high FCR value (T1). It is suggestive that laying birds can tolerate restricted feeding for optimum production and economic efficiency. All through the duration of this study, no mortality was recorded and this suggests that feed restriction can be tolerated by laying hens.

External Egg Characteristics of Laying Hens placed on Feed Restriction

Table 3: External Egg Characteristics of Laying hens placed on Feed Restriction

Parameters	T_1	T_2	T_3	T_4	SEM
Mean Egg Weight (g)	57.50	59.00	61.17	59.07	2.72
Mean Egg Length (cm)	5.22	5.34	5.42	5.32	0.01
Mean Egg Width (cm)	4.02	4.03	4.23	4.08	0.08
Mean Egg Surface Area (cm^2)	21.01	21.55	22.91	21.71	0.69
Mean Egg Shape Index	77.22	75.39	78.06	76.81	1.18
Mean Egg Shell Weight (g)	4.23	4.35	5.12	4.58	0.23
Mean Egg Shell Percentage (%)	8.72	9.22	9.16	8.20	0.18
Mean Egg Shell Thickness (mm)	0.33	0.34	0.34	0.36	0.01

SEM ± Standard error or Mean

There was no significant difference among the treatment means ($p>0.05$)

The results of the external egg characteristics evaluated in this study showed no significant differences ($p>0.05$) between treatment means for all the parameters measured. This is suggestive that restricted feeding did not affect the external characteristics of the egg produced.

The higher mean egg weight, mean egg length, mean egg width and mean egg surface area from T_3 T_2 and T_4 implied that restricted feeding could be of advantage to the farmer. This finding is similar to the report by Renema & Robinson (2014) who stated that restricted feeding of laying chickens helped in maintaining correct body weight, prevented aver eating, limited health risks, reduces cost as well as making the hens starve for a longer period of time before their next feeding resulting to better performance. Light and feed restrictions are the most important factors to control the body weight before laying period, preventing fatness and regulating the sexual maturity age (Gous *et al.,* 2020; Rossi and Loerch, 2013; Leeson *et al.,* 2015).

The result obtained was however contrary to that of Osman *et al.* (2020) and Fasuyi & Ojo (2022) who separately reported that feed withdrawal did not affect egg number, hen-egg production, egg weight and egg equality. Also, Ejaloch *et al.,* (2021) found no significant differences in egg weight as a result of starvation of feeding regime. The highest mean egg shape index obtained in eggs from T_3 could be attributed to the dietary regime where the birds fed the T_3 diet had the biggest feed deprivation.

The mean egg shell weight and mean egg shell thickness for T_3 and T_4 are higher compared to T_2 and the control diet. This implies that T_3 and T_4 have good egg shell quality and uniformity compared toT_2 and the control diet. This result tallied with the findings of Yoruk *et al.* (2017), who reported that providing satisfactory dietary minerals and vitamins was important for good eggs shell quality. Kabir & Mohammed (2018) had reported that reduction in egg shell quality will depress hatchability and result in weakening of the embryo Means on the in fertilized eggs

Internal Egg Characteristics of Laying Hens

Table 4: Internal Egg Characteristics of Laying Hen placed on Feed Restriction

Parameters	T_1	T_2	T_3	T_4	SEM
Mean Albumen Height (cm)	0.70	0.74	0.83	0.75	0.05
Mean Albumen Length (cm)	7.51	7.88	7.75	7.42	0.20
Mean Albumen Width (cm)	6.22^{b}	6.84^{a}	6.59^{ac}	6.49^{bc}	0.10
Mean Yolk Height (cm)	1.54	1.68	1.57	1.63	0.10
Mean Yolk Length (cm)	4.51	4.44	4.49	4.37	0.10
Haugh Unit	84.32	85.53	90.15	86.15	3.16

SEM± Standard Error of Mean

Mean on the same horizontal row with varying superscripts differ significantly ($p<0.05$)

The results of the internal egg characteristics evaluated in this study showed no significant differences ($p>0.05$) among the treatment means for all the parameters measured except mean, albumen width.

The mean albumen width values for $T_?$, T_2, T_3 and T_4 are the same statistically ($p>0.05$) among each other but T, and T_2 differed significantly ($p<0.05$) among treatment means. The mean albumen width values did not follow any particular trend as T_3returned comparable value with the control and T_4while T_2 had the highest value. The differences may be related to the storage time and temperature of the eggs (Samli *et al.,* 2015).

The Haugh Unit values for the treatment means were not different significantly ($p>0.05$). The Haugh unit is used to measure the firmness of the albumen and its values and should not be below 70 (Oluyemi & Roberts 2017). Therefore, the Haugh Unit range values of 84.32-90.15 obtained in this study suggested that restricted feeding maintain the albumen and its value. Haugh unit is used to predict the quality of eggs and it can be stated that the eggs obtained from all the treatments have higher Haugh Unit and were good for human consumption. The Haugh Unit of 54.88 was reported by Akinola & Ibe (2014) for fresh brown eggs and termed as good eggs while eggs with HU of less than 40 (Garba *et al.,* 2019) and HU of 30and less termed low quality (USDA, 2000) had been classified as inferior eggs that are not good for consumption.

Summary

Feed restriction does not affect the performance of laying birds in terms of body weight change, since there was no significance difference (P>0 05) among the treatment means of the initial and final weight of the birds. There was significance difference ($P<0.05$) among the treatment means for feed intake with T_4 recording the least feed intake. Feed conversion ratio also showed significance difference ($P<0.05$) among the treatment means with T-t having the lowest value compare to T_4 and T_2. There was no significant difference ($P>0.05$) among the treatment means for Hen Day Egg production. T_3 gave highest no of eggs with feed restriction of 110g of feed aside T_b Feed cost was lower for T_4 and T_3 unlike in control treatment. The results for the external egg characteristics evaluated in this study showed no significance difference ($P>0.05$) between treatment means for all the parameters measured. The results of the internal egg characteristics evaluated in this study showed no significant difference ($P>0.05$) among the treatment means for all the parameters measured except mean Albumen width. The Haugh unit values for the treatment means were not difference significantly ($P>0.05$).

Conclusion

For poultry production to be meaningful and sustainable, it is very necessary to find the means of reducing the cost of feeding. The Study showed that quantitative feed restriction on laying birds for up to 110g of feed per day may be beneficial to the farmers as all the external characteristics of egg were not affected instead the quality of the fresh egg (Hu) was increased in the treated groups, cost of egg production reduced and health risk limited. So, farmers could practice quantitative restricted feeding especially with 110g of feed per day

Recommendation

Quantitative feed restriction could be beneficial to farmers and they are hereby encouraged to adopt 110g of feed restriction per day.

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