
**EFFECT OF QUANTITATIVE FEED RESTRICTION ON THE
PERFORMANCE AND LAYING CHARACTERISTICS OF PULLETS**

*Tropical and
Subtropical
Agroecosystems*

[EFECTO DE LA RESTRICCIÓN DE ALIMENTO EN EL
COMPORTAMIENTO Y POSTURA DE AVES]

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SUMMARY

The effects of various levels of quantitative feed restriction and lengths of the restriction period on the performance, laying characteristics and economics of egg production of pullets were assessed using 147 20-week old Olympia Brown commercial pullets. The experiment lasted from 20th week of age to 50% hen day production (HDP), which was however, divided into 2 major periods: Period I (20 weeks of age to point-of-lay (POL) and Period II (POL - 50% HDP). During period I the birds were subjected to 3 treatments: *ad libitum* feeding (AF), 10% (RF₁) and 20% restriction feeding (RF₂). In period II, the AF birds were subdivided into 3 groups – one continued on *ad libitum* feeding (AFAF), the second group was switched over to 10% (AFRF₁) or 20% restriction feeding (AFRF₂). Each of RF₁ and RF₂ birds were subdivided into 2 groups, with one continuing on its original feeding regime; RF₁RF₁ and RF₂RF₂, while the second groups were returned to *ad libitum* feeding; RF₁AF and RF₂AF, respectively. During rearing (period I), weight gain, feed conversion ratio (FCR), and body weight were not significantly affected (P>0.05). At early laying period (period II) restricted feeding had significantly depressed (P<0.05) feed intake, weight of first eggs, HDP, hen house average (HHA) and significantly delayed age at first egg. Birds that were under restriction feeding laid heavier first eggs. RF₁AF birds had the best economic indices.

Keywords: feed restriction, length of restriction period, growth performance, laying characteristics.

INTRODUCTION

Increase in population in the third world countries like Nigeria has not been matched by growth in agricultural productivity especially in the area of animal production. This has led to hunger and serious malnutrition among the people (Igbedioh, 1993; Weaver, 1994; Ukachukwu *et al.*, 2002). To correct

RESUMEN

Se evaluó el efecto de varios niveles y duración de restricción de alimento sobre el comportamiento productivo, características de postura y costos de producción de huevos en aves. Se emplearon aves de 20 semanas de edad de la línea Olympia Brown. El experimento se desarrolló de la semana 20 de edad hasta alcanzar una producción de 50% día (HDP), subdividida en 2 períodos: período I comprendió de la semana 20 al rompimiento de postura (POL) y período II comprendido de de POL a 50% HDP. Durante el período I la aves fueron alimentadas *ad libitum* (AF), o con restricción del 10% (RF₁) o 20% (RF₂). Durante el período II, las aves del tratamiento AF fueron subdivididas en tres grupos para ser mantenidas en alimentación *ad libitum* (AFAF), o con restricción del 10% (AFRF₁), o 20% (AFRF₂). Las aves de los grupos RF₁ y RF₂ fueron a su vez subdivididas en dos grupos, para mantenerse en su tratamiento RF₁RF₁ y RF₂RF₂, o cambiar a una alimentación *ad libitum* RF₁AF y RF₂AF. Durante el período I ganancia de peso, conversión alimenticia y peso vivo no fueron afectados (P>0.05). Durante el período II los dos tratamientos de restricción deprimieron consumo, peso de los primeros huevos, HDP, y retrasaron la edad de inicio de postura (P<0.05). Aves en tratamiento de restricción alimenticia tuvieron primeros huevos más pesados que las aves alimentadas *ad libitum*. RF₁AF fue el tratamiento con los mejores índices económicos.

Palabras clave: restricción de alimento, duración de restricción, crecimiento, postura.

the short fall in animal protein intake of the populace, there is need to intensify livestock production which is characterized by high cost of production due to cost of finished feed that accounts for over 70% of the production cost (Adegeye and Dittoh, 1982; Ogunfowora, 1984; Oluyemi, 1984).

An average Nigerian consumes an average of 15g of animal protein per day as against 54g per capita per day in America and Europe. This is grossly inadequate and poses a threat of serious malnutrition (Jennings, 1974; FAO, 1986; FAO, 1989). Current high cost of poultry products makes it impossible for an average man in the country to consume adequate quantity of animal protein. The price increases are a reflection of corresponding high cost of feeds.

High cost of feed results in low production and short supply of poultry products. The poultry enterprise in Nigeria has suffered a decline since mid 1980's. The cost of raising pullets to point-of-lay (POL) is on the high side due to the exorbitant cost of feed. As a result great percentage of commercial poultry farmers and feed millers are fast folding up their businesses. The surviving ones incur high production costs as a consequence of high cost of feed and feed raw materials. Current efforts have been on the development of technologies and practices that can enhance, promote and sustain the industry by forcing down the cost of production and thus increase poultry production. Feed restriction is a management technique in poultry production involving the quantitative adjustment of the ration offered to the birds (Monsi and Ayodele, 1990). It is aimed at achieving greater production efficiency without inflicting severe adverse effect on the birds' nutritional requirements. 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, hence the investigation into feed restriction.

Information on feed restriction of layers in a laying year in Nigeria is limited, though much work has been reported on restricted feeding in broilers both in the temperate and tropical regions (Ibe, 1990; Ibe and Nwachukwu, 1990). Feed, according to Sanni and Ogundipe (2003), constitutes a major cost input in egg production enterprise. The concern of egg producers is to cover the cost of raising pullets from day-old to point-of-lay (POL) from the proceeds of egg produced. Any savings in feed consumption will usually increase the profit margin. In order to reduce the cost of production, Sanni and Ogundipe (2003) suggested that Nigerian egg producing farmers should pay particular attention to the major cost components by seeking a way of maximizing effectiveness of feed utilization. Oluyemi and Robert (1979) had observed that egg producers break even on feed cost when the flock produces at above 44 per cent hen day production (HDP). Thus restricted feeding becomes necessary to force down the cost of production and allow farmers to break even on feed cost at a lower percent.

This study was, therefore, designed to determine what effect different levels of quantitative feed restriction and duration of restriction period would have on the production performance and economics of egg production of pullets.

MATERIALS AND METHODS

Location, experimental birds and general management

An experiment, which lasted for 10 weeks, was carried out in the Poultry Unit of the Research and Training Farm of the Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. One hundred and forty-seven Olympia Brown commercial pullets at 20th week of age were reared in floor pens littered with wood shavings. Initial body weights of birds were taken and they were fed a commercial grower's ration from 20th week till point-of-lay. The grower's diet contained (as labeled) 2500 Kcal ME/kg, 16% crude protein, 3.30% fat, 7.20% crude fibre, 1% calcium and 0.4% available phosphorus. Commercial layer's diet (2500 Kcal ME/kg, 16.50% crude protein, 3.30% fat, 6.70% crude fibre, 3.5% calcium and 0.45% available phosphorus), was introduced from point-of-lay till the termination of the experiment. All birds had unrestricted access to water. Standard litter management practice was strictly adhered to. Birds were dewormed using Piperazine[®] and antibiotic (Keproceryl)[®] administered in drinking water to ensure good health.

Experimental Procedure and Design

The experiment was divided into 2 major periods. Period I was from 20 weeks of age to point-of-lay (20th week – POL) during which birds were randomly assigned into three treatment groups viz; *Ad libitum* feeding (AF), 10% Restriction feeding (RF₁), or 20% Restriction feeding (RF₂). Sixty-three pullets were allocated to the AF treatment which was replicated into 3 at 21 birds per replicate. Each of RF₁ and RF₂ treatments had 42 birds and replicated into 3 at 14 birds per replicate. Period II was from point-of-lay (POL) to age at 50% hen day production (HDP). At this point, the first group (AF) was further divided into 3 treatments of (1) *ad lib* continuing on *ad lib* (AFAF), (2) *ad lib* reverted to 10% restriction feeding (AFRF₁) and (3) *ad lib* reverted to 20% restriction feeding (AFRF₂). The second group RF₁ was further divided into 2 treatments (1) 10% restriction feeding continuing on 10% restriction feeding (RF₁RF₁), (2) 10% restriction feeding reverted to *ad lib* feeding (RF₁AF). The third group RF₂ was also further divided into 2 treatment groups, viz: (1) 20% restriction feeding continuing on 20% restriction feeding (RF₂RF₂) and (2) 20% restriction feeding reverted to

ad lib feeding (RF₂AF). In each case, birds were pooled and rerandomised on treatment basis to their resulting new treatments at 21 birds per treatment and each treatment was replicated into three with 7 birds per replicate. In both periods, birds in each replicate were housed in a separate pen. Each day the previous day's intake of the *ad libitum* fed birds was determined. The values to be given to the 10% and 20% restriction feeding groups were calculated as 90% and 80% of the *ad libitum* value.

The experimental design used in both periods was the completely randomized design. Parameters of interest included, initial and final body weights, feed intake, feed conversion ratio (FCR), age at first egg, average weight of first egg, average weight of bird at first egg, average hen day production (HDP), average age of bird at 50% HDP, average weight of bird at 50% HDP, hen house average (HHA); as well as economics of egg production as influenced by the feeding regimens.

Data Analysis

Data collected on production performance and laying characteristics were subjected to analysis of variance (ANOVA) in a complete randomized design (Mead and Currow, 1983). Significant means were compared by Duncan's multiple range test (Duncan, 1955) as packaged in the SPSS computer package (SPSSINC, 2001).

RESULT AND DISCUSSION

Period I: 20th week to Point-of-lay

Table 1 shows the results of Period 1 (20th week – Point-of-lay, POL). Only average daily feed intake was significantly ($P < 0.05$) affected by the feeding regimens. Pullets fed *ad libitum* had the highest feed intake (123.3g) followed by those on 10% restriction feeding (RF₁, 113.4g), while those on RF₂ (20% restriction feeding) had the least intake (102.8g). Final body weight, average daily weight gain and feed

conversion ratio (FCR) were not significantly ($P > 0.05$) affected.

The feed intake appeared to be a simple reflection of the quantities of feed made available to the various groups of birds based on the percentage restriction imposed on each group. This is in agreement with Ezieshi *et al.* (2003) who reported that feed restriction in pullets depressed feed intake. It can also be inferred that these levels of restriction, which had, however, lasted for only about four weeks, did not have any significant depression on the growth performance of the pullets, perhaps, due to improved feed utilization. This agrees with the observation of Walter and Aitken (1961), Donaldson and Miller (1962) and Macleod and Jewitt (1979), that feed restriction improves feed utilization. This appears to be true in this case since the restriction levels did not significantly depress feed conversion ratio, which is an index of feed utilization.

Period II: Point-of-lay (POL) to 50% hen day production (HDP)

The performance characteristics, some sexual maturity indices, and economics of egg production of the pullets under Period II (POL – 50% HDP) are presented in Table 2. There were significant differences ($P < 0.05$) among treatment means in average daily feed intake, age of birds at first egg, average weight of first egg, average hen day production (HDP), average weight of bird at 50% HDP, and hen house average (HHA) as well as all the economic parameters considered.

Transferring birds from *ad lib* feeding to restriction feeding significantly ($P < 0.05$) depressed their feed intake (AFAF, 115.9g versus AFRF₁, 109g and AFRF₂, 104g), whereas the transfer of the birds from any of the restriction feeding levels to *ad lib* feeding resulted in significant ($P < 0.05$) increases in their feed intake (RF₁ FR₁), 111g vs RF₁ AF, 119g and RF₂RF₂, 109g vs RF₂AF, 114g).

Table 1: Performance characteristics of birds (20th weeks – Point-of-lay, POL)

Parameters	AF	RF ₁	RF ₂	SEM
Initial body weight(g)	1143	1145	1146	12.67 ^{ns}
Final body weight (g)	1486	1478	1474	19.67 ^{ns}
Average feed intake (g)	123.3 ^a	113.4 ^b	102.8 ^c	1.99*
Average daily weight gain	12.25	11.89	11.71	0.89 ^{ns}
Feed conversion ratio(FCR)	10.06	9.54	8.78	1.99 ^{ns}

* Means on the same row followed by different superscripts are significantly different from each other at $(P < 0.05)$.

ns – Non significant; SEM - Standard error of means.

AF – *Ad libitum*; RF₁ – 10% restriction; RF₂ – 20% restriction

Overall, birds transferred from 10% restriction feeding to *ad lib* feeding (RF₁AF) had the highest (P<0.05) feed intake followed by those that started and continued on *ad lib* feeding (AFAF) while those that were transferred from *ad lib* feeding to 20% restriction feeding (AFRF₂) had the lowest (P<0.05) feed intake. As in period I, the feed intakes appear to be a reflection of the quantities of feed made available to the various groups based on their corresponding feeding regimens.

Birds on treatments AFAF and those moved to AFRF₁ and AFRF₂ were the earliest (P<0.05) to start laying eggs at the age of 165 days of age. Birds in RF₁RF₁ and RF₂RF₂ were the last (P<0.05) to start laying eggs at ages of 183 and 180 days respectively. Their transferred counterparts (RF₁AF and RF₂AF) started earlier (P<0.05) than them at the ages of 173 and 176 days respectively. The plane of nutrition may have played a role here. The feeding regimens determined the amount of nutrient available to the groups for production. The groups that had full access to feed appear to have had more nutrients reserved for production purposes. Hence they came into lay before their restricted counterparts. A significant delay in age at first egg is in agreement with the work of Akinokun *et al* (1984), who reported that feed restriction had a significant influence on age at sexual maturity.

The groups AFAF, AFRF₁, and AFRF₂ had the same age at first egg. This is because they were all under the same plane of nutrition in period I. So they had similar nutrient reserve for production and, perhaps, were at similar stage of egg development at the point the birds were redistributed.

RF₂RF₂ and RF₁RF₁ laid the heaviest (P<0.05) first egg (47.35g and 44.77g), followed by those of AFRF₂ (39.53g) and RF₁AF (38.64g), while AFRF₁ (33.16g), AFAF (34.43g) and RF₂RF₂ (35.58g) laid the lightest (P<0.05) first eggs. It was observed that the groups that were earliest to come into lay had the lightest first eggs while those that were the last to start laying eggs had the heaviest first eggs. This is in agreement with Gowe *et al* (1960) and Blair (1972) who had earlier reported that feed restriction in pullets reduced body weight, delayed sexual maturity and increased egg size. Bruggeman *et al* (1988) had also reported delay in sexual maturity due to restriction.

On hen day production (HDP), birds in AFAF and RF₁AF had the highest (P<0.05) HDP (2.86 and 2.71), while RF₂AF (2.28), AFRF₁ (2.17) and AFRF₂ (2.27) had similar HDP which were lower (P<0.05) than those of RF₁AF and AFAF but higher (P<0.05) than those of RF₁RF₁ (1.91) and RF₂RF₂ (1.92). Also, birds in RF₁AF had the highest (P<0.05) hen house average (18.95) followed by AFAF (17.19) and RF₂AF (15.95).

Table 2: Production performance, some sexual maturity indices and economics of egg production of pullets (POL – 29th week of age)

Parameters	AFAF	AFRF ₁	AFRF ₂	RF ₁ RF ₁	RF ₁ AF	RF ₂ RF ₂	RF ₂ AF	SEM
Initial body weight (g)	1473	1479	1480	1475	1474	1480	1472	17.39
Final body weight (g)	1667	1548	1524	1578	1572	1555	1586	15.15 ^{ns}
Av.daily feed intake (g)	116 ^a	109 ^b	104 ^c	111 ^b	119 ^a	109 ^b	114 ^a	0.11*
Age at first egg (d)	165 ^c	165 ^c	165 ^c	183 ^a	173 ^b	180 ^a	176 ^b	1.05*
Av. weight of 1 st egg (g)	34.4 ^c	33.2 ^c	39.5 ^b	44.8 ^a	38.6 ^{bc}	47.4 ^a	35.6 ^c	1.06*
Av. weight of bird at 1 st egg (g)	1546	1499	1530	1583	1542	1440	1617	18.82 ^{ns}
Av. hen day production (HDP)	2.86 ^a	2.17 ^b	2.27 ^b	1.91 ^c	2.71 ^a	1.92 ^c	2.28 ^b	0.07*
Av. age of bird at 50% HDP (d)	191	193	194	190	186	190	184	1.15 ^{ns}
Av. weight of bird at 50% HDP (g)	1718 ^a	1683 ^a	1673 ^a	1673 ^a	1666 ^b	1585 ^c	1650 ^b	20.96*
Hen house average (HHA)	17.2 ^{ab}	13.0 ^c	13.6 ^c	13.4 ^c	19.0 ^a	13.5 ^c	16.0 ^b	0.52*
Kg feed/dozen egg	2.83 ^c	3.53 ^b	3.19 ^{bc}	4.06 ^a	3.09 ^c	4.00 ^a	3.43 ^b	0.13*
Cost of feed/ dozen egg (₦)	113.2 ^c	131.2 ^b	127.6 ^{bc}	162.4 ^a	123.6 ^{bc}	160.0 ^a	137.2 ^a	1.84*
Gross margin from a dozen egg (₦)	66.8 ^a	48.8 ^{ab}	52.4 ^{ab}	17.6 ^c	56.4 ^a	20.0 ^c	42.8 ^b	1.04*

abcdef - Means on the same row followed by different superscripts are significantly different from each other at *(P < 0.05)

ns - Non significant.

SEM – Standard error of means.

Price/dozen egg (₦) 180

HHA for birds in RF₁RF₁ (13.39), RF₂RF₂ (13.45), AFRF₁ (13.00) and AFRF₂ (13.62) were the lowest (P<0.05). The highest HHA and HDP values observed in RF₁AF agree with the suggestion of Hocking *et al.* (1993) that feed restriction should continue until the onset of lay. Gowe *et al.* (1960) and Blair (1972) also observed increased intensity of egg production once the delay in sexual maturity has been overcome. This is however, not true for RF₁RF₁ and RF₂RF₂, as the prolonged duration of restriction constituted a stress rather than a positive measure. Mench (2002) has reported that broiler breeder pullets showed evidence of physiological stress as well as an increased abnormal behaviour due to restriction. Average weight of birds at 50% HDP for AFAF (1718g), AFRF₁ (1603g), RF₂RF₂ (1673g) and RF₁RF₁ (1673g) were similar but heavier (P<0.05) than those of RF₁AF (1666g), RF₂AF (1650g) which were also similar. RF₂RF₂ (1585g) had the lowest value.

There were significant (P<0.05) differences in the quantity of feed required to produce unit number of eggs (kg feed/dozen egg) among the different feeding regimens, with the RF₁RF₁ and RF₂RF₂ having the largest values. Their transferred counterparts (RF₁AF and RF₂AF) had smaller (P<0.05) values. The value for RF₂AF was however, smaller (P<0.05) than that of RF₁AF but similar (P<0.05) to those of AFRF₁ and AFRF₂. The value for the control AFAF was the smallest (P<0.05) but similar to those of RF₁AF and RF₂RF₂. Cost of feed per dozen egg (₦) followed similar trend as above. The RF₁AF had gross margin that was similar to those of both the control (AFAF) and the transfers from control (AFRF₁ and AFRF₂), but was however higher (P<0.05) than that of RF₂AF. The gross margin of RF₁RF₁ and RF₂RF₂ were the lowest (P<0.05) but similar to each other. RF₁AF, AFRF₁ and AFRF₂ had similar gross margins to the control (AFAF). RF₁RF and AFRF₂ compare favourably with control in both kg feed and cost of feed per dozen egg produced. This suggests a superiority of the RF₁AF group in the utilization of feed for production purpose at minimum cost. This is supported by the high gross margin (₦) of the same RF₁AF which is similar to that of the control.

CONCLUSION

During the late growing stage (20th week to point-of-lay, POL) feed restriction depressed average feed intake of birds, but had no depressive effect on other growth parameters. During the early laying period (POL – 50% HDP) feed restriction significantly depressed average feed intake of pullets, weight of first egg, hen day production (HDP), hen house average (HHA) and gross margin of a dozen eggs produced. From this study, it can be concluded that subjecting 20 week old pullets to 10% quantitative

feed restriction up to point-of-lay and restoring them to *ad libitum* feeding appears to be most desirable practice to be adopted by farmers involved in commercial egg production.

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