Trop. J. Anim. Sci. 2002 Vol. 5 No. 2: 19-26

Effect of Quantitative Feed Restriction on Pullet Development and Subsequent Egg Production

A.A. Sekoni, I.A. Adeyinka and S.O. Ogundipe

National Animal Production Research Institute, Ahmadu Bello University, Shika, Zaria, Nigeria

Target Audience: Feed miller, Poultry Producers, Research Scientists and Teachers

Abstract

The effect of quantitative feed restriction during rearing on mature body weight and subsequent egg production of pullets was investigated in two experiments. All the birds in the two experiments were fed ad libitum on 20% crude protein and 2649kcal/kg ME diet from 0-8 weeks of age. From 9 – 20 weeks, feed was denied the birds for a day after one or two days of ad lib feeding, or restricted to 75% of ad lib intake by the control birds. Results of these two studies showed that with restriction, a significant decrease in growth rate was obtained at 20 weeks and 36 weeks. However, the feed regimen imposed on the birds during the growing period did not have any significant effect on sexual maturity nor peak production levels. Hen-day and hen-housed production levels as well as cost of feed per unit weight or dozen eggs, were not significantly affected by the treatments.

These studies showed that when growing birds are restricted in quantity of feed fed, they respond with a reduction in mature weight, but the laying phase is unaffected.

Key words: Feed restriction, pullet, egg production

Description of Problems

Quantitative feed restriction involves the allocation to birds of a predetermined percentage of the feed consumed by the fully fed controls. This is either done on a daily basis or giving feed *ad libitum* on some days and no feed at all on other days.

Pullets have been restricted in feed consumption from varying ages; before 5 weeks of age (1, 2) and between 6 and 8 weeks (3, 4). Feed restriction reduces body weight, and lower body weight at the onset of sexual maturity is associated with highly increased egg production compared with *ad libitum* feeding (5), mortality is greatly reduced (6) and fertility is improved (6, 7). The extent of delay in sexual maturity depends on types of birds and on the severity of restriction (1, 4).

This study was designed to study the effect of quantitative feed restriction during the growing phase on pullet development and on subsequent egg production during the laying phase. This was done in two separate experiments.

Materials and Methods

Two experiments were conducted to evaluate the effect of quantitative feed restriction on the rate of pullet development and subsequent egg production. In the first experiment, four treatments were used. Restriction started at the 9th week and was terminated at the 20th week. The different treatments used were as follows: -

Treatment 1: Feed available *ad libitum* everyday.
2: Feed available every other day (skip a day)
3: Feed available every two days and no feed on the third day (skip a day, after every two days).
4: Feed approximately 75% of feed

consumed by treatment 1 the previous week

For the second experiment, treatment 4 was dropped as it was found to be very labour intensive and therefore involved more costs. Consequently treatments 1 to 3 were repeated to further confirm the findings of experiment 1.

Experiment 1

Six hundred day-old pullet chicks were obtained from a local hatchery and reared in 12 deep litter pens in a tropical – type open-sided poultry house providing 0.074m^2/bird. The birds were weighed in groups of 50 and allotted to each pen or replicate. Heat for brooding was supplied by kerosene-fuelled lanterns two of which were used in each pen. Three randomly selected replicates were fed one of the four treatments.

During the brooding period (0-8 weeks) feed was available *ad libitum* to all the birds but during the rearing period (9-20 weeks) different quantities of feed were available to the birds as specified by each treatment as stated below.

Treatment 1:- 20% crude protein (0-8 weeks): 16% crude protein (9-20 weeks); feed available *ad lib* from 0-20 weeks. This served as the control treatment.

Treatment 2:- 20% crude protein (0-8 weeks *ad lib* feeding): 16% crude protein (9-20 weeks); feed available *ad lib* every other day.

Treatment 3: - 20% crude protein (0-8 weeks *ad lib* feeding); 16% crude protein (9-20 weeks); feed available *ad lib* every two days followed by one day of no feed.

Treatment 4:- 20% crude protein (0-8 weeks *ad lib* feeding); 16% crude protein (9-20 weeks); approximately 75% of feed consumed by treatment 1 the previous week was made available.

The composition of different diets fed during the experiment is shown in Table 1. Feed was provided as specified by the treatments and water was provided *ad libitum*. Conventional brooding and rearing procedures were adopted throughout the brooding, growing and developing periods. The growth rate, feed intake and feed efficiency of the birds were monitored every 28-day period.

At 20 weeks of age, 40 pullets from each replicate were randomly selected and transferred from the growing house into two-tier laying battery cages in a tropical type laying house. The cages measured 30 x 35.5 x 41.5cm and housed 2 birds per cell. The birds were left in the same treatment groups as in the growing phase. A common layer diet shown in Table 2 was offered to all replicates from 20 weeks. Daily egg production and monthly feed intake records were kept on treatment groups. Also monitored were days to first egg (i.e. the average number of days for birds in each replicate to their first eggs) and 50% egg production (the average ages of birds for the three replicates when they first attain 50% production level for three consecutive days). Also body weight changes at 36 weeks and egg weight (average weight of all eggs laid for 3 consecutive days every week) were determined.

Experiment 2

This experiment was carried out to confirm the results of the first experiment and treatment 4 was dropped as it was found to be very labour intensive and therefore involved more costs for weekly feed weighing.

One hundred and eighty day-old chicks were allocated to three replicate treatments of twenty birds each and were subjected to the following treatments

Treatment 1: (Control):- 20% crude protein (0-8 weeks): 16% crude protein (9-20 weeks); feed available *ad lib* from 0-20 weeks.

Treatment 2: 20% crude protein (0-8 weeks *ad lib* feeding): 16% crude protein (9-20 weeks); feed available *ad lib* every other day.

Treatment 3: - 20% crude protein (0-8 weeks *ad lib* feeding); 16% crude protein (9-20 weeks); feed available *ad lib* every two days followed by one day of no feed.

The diet in Table I was fed as listed above. Birds were managed under conventional brooding and rearing procedures as in experiment 1.
At 20 weeks of age, 15 pullets from each replicate were randomly selected and transferred to battery cages and fed a common laying diet (Table 2) for 16 additional weeks. The birds were not randomised among treatments but made to retain their original treatment groups.

Analysis of data

Data obtained from both experiments were summarised and subjected to analysis of variance (8) and Duncan's Multiple Range Test (8) was used to separate means when statistical significance was indicated for treatments.

Results and Discussion

Experiment 1

The results obtained in this experiment are summarised in Tables 3, 4 and 5. During the first phase of the growing period (i.e. 0-8 weeks), there were no significant differences in all the parameters measured. This was expected as there was no restriction and all treatments were fed *ad libitum*. In the second phase of the growing period, (i.e. 9-20 weeks), treatment 1 (control) consumed significantly more feed than the feed restricted groups. The most restricted group (treatment 2) consumed about 30% less feed than the control birds, which is a substantial saving in terms of feed cost per kg weight gained. The treatment did not significantly affect the efficiency of feed utilization, which ranged between 5.65 for the control group and 5.30 for treatment 4. The control group gained significantly more weight than treatments 2 and 3 and had comparable weight with treatment 4. Mortality was highest ($P<0.05$) with the treatment 2, which was mainly due to pecking.

The results for the overall rearing period (i.e. 0-20 weeks) showed a significant saving in feed as the restricted group consumed significantly less feed than the control group of birds. Treatment 2 consumed significantly (approximately 24%) less feed than the control birds to bring them to 20 weeks. This is a substantial feed saving when compared to the control birds that were fed *ad libitum*.

Feed efficiency and feed cost per kilogram gain did not differ significantly among treatments. Control birds were significantly heavier than the restricted groups.

The results obtained in the laying phase are summarised in Table 4. The use of quantitative feed restriction during the growing phase significantly ($P<0.05$) affected the weight of the birds at 20 weeks (i.e. point of lay). The control birds were about 20% heavier than the lightest group (treatment 2 birds). The type of restriction given to the birds during growth did not significantly affect the age of the birds at first egg, 50% and peak production. However, there was a significant decrease in the weight of the birds both at 20 weeks and at the end of the experiment. Although the feed consumption of the birds from 20 weeks to 5%, 50% and at the end of the experiment did not show significant differences, it was evident in Table 5 that when restriction was terminated at 20 weeks, the restricted birds consumed slightly more feed than the control birds. The differences in consumption gradually became narrower by the end of the experiment. Quantitative feed restriction did not have any significant effect on hen-day egg production, hen-housed egg production, feed consumption and efficiency of feed for egg production as shown in Table 4.

Experiment 2

The results obtained in this experiment are summarised in Tables 6, 7 and 8 and were similar to those of experiment 1. The only difference is in the mortality which was reduced in this study apparently because the birds were debeaked early.

Table 1. Percentage composition of chick and grower diets for experiments

Ingredients	Chick mash, %	Grower mash, %
Maize	52.50	58.30
Groundnut cake	28.40	15.60
Wheat Bran	15.70	23.70
Vitamin/mineral Premix[a]	0.15	0.15
Common salt	0.25	0.25
Bone meal	3.00	3.00
Total	100.00	100.00
Calculated Nutrient Composition		
Crude Protein (%)	20.00	16.00
Metabolizable Energy, Kcal/kg	2645.00	2647.00
Crude fibre (%)	5.72	5.92
Calcium (%)	0.95	0.65
Available Phosphorus (%)	0.55	0.43
Lysine (%)	0.85	0.61
Methionine+Cystine%	0.63	0.54

[a] Zoodry VM 201 Premix used supplied the following per kg of ration
Vitamin A (stabilized) 10,0051U; Vitamin D_3 (stabilized) 2,250 LU; Vitamin E (stabilized) 5.01 LU; Vitamin K (stabilized) 2.01mg; Vitamin B_2 4.50mg; Vitamin B_6 3.0mg; Nicotinic acid 22.005mg; Calcium D-Pantothenate 6.0mg; Vitamin B_{12} 0.0 12mg; Choline chloride 200.10mg; D.O.T. (3,5-dinitro-orthotoluamide) 100.05; Manganese 80.01mg; Iron 50.01mg; Zinc 40.005 mg; Copper 2.4mg; Iodine 1.401 mg; Cobalt 0.201 mg; Selenium 0.051mg.

Table 2. Percentage composition of layers diet fed in experiments 1 and 2

Ingredients	Chick mash, %
Maize	50.00
Soyabean meal	15.50
Wheat Bran	24.50
Bone meal	2.25
Oyster shell	7.10
Common salt	0.25
Premix[b]	0.20
DL - Methionine	0.20
Total	100.00
Calculated Nutrient Composition	
Crude Protein (%)	16.08
Metabolizable Energy, Kcal/kg	2407.00
Crude fibre (%)	4.39
Calcium (%)	3.42
Available Phosphorus (%)	0.45
Lysine (%)	0.92
Methionine+Cystine%	0.73

[b]Zoodry VM 301 Premix used supplied the following per kg of ration
Vitamin A (stabilized) 10,0051U; Vitamin D_3 (stabilized) 2,010 LU; Vitamin E (stabilized) 10.005 LU; Vitamin K (stabilized) 2.01mg; Vitamin B_2 4.50mg; Vitamin B_6 3.0mg; Nicotinic acid 25.005mg; Calcium D-Pantothenate 8.01mg; Vitamin B_{12} 0.012mg; Vitamin C 20.01mg; Choline chloride 200.10mg; Manganese 100.005 mg; Iron 50.01mg; Zinc 40.005 mg; Copper 2.4mg; Iodine 1.401 mg; Cobalt 0.20 1 mg; Selenium 0.05 1mg.

Table 3: Effect of quantitative feed restriction on growth performance of replacement pullets in Experiment 1

Treatment	Feed intake (g/bird)	Feed efficiency (g feed/g gain)	Weight gain (g/bird)	Feed/kg gain (N)	Mortality(%)
0-8 Weeks					
1	1219.50	3.79	322.67	2.24	1.00
2	1179.57	3.45	342.80	2.03	1.00
3	1164.40	3.71	313.47	2.19	1.00
4	1156.07	3.61	321.07	0.13	1.33
SEM[3]	17.63	0.01	10.49	0.06	0.11
9-20 Weeks					
1	4926.33a	5.65	881.47a	3.08	3.00b
2	3470.07b	5.33	653.48b	2.93	11.00a
3	3848.37b	5.62	688.73b	3.06	3.6Th
4	3805.73b	5.3	717.43ab	2.92	2.67b
SEM[3]	123.65	0.3	51.72	0.16	0.52

[1]Means obtained from 150 birds in three replicates of 50 birds each.
[2]Means within each column with different letters are significantly different (P<0.05)
[3]SEM = Standard error of the means

Table 4. Effect of quantitative feed restriction on various laying performance traits evaluated in experiment I

	Treatments[1]				SEM[2]
Parameters	1	2	3	4	
Hen-day Production (%)	61.72	56.74	55.17	56.98	2.75
Hen-housed Production (%)	60.6	55.2	54.06	56.02	3.15
Days to first egg	170	175	174	173	3.58
Days to 50% production	188	192	193	191	4.43
Days to peak production	227	233	230	233	4.04
Feed consumption to 50% production (kg/bird)	12.14	11.48	11.54	10.91	0.57
Cumulative feed consumption (0-36 weeks) (kg/bird)	19.88	18.61	18.73	18.21	0.99
Feed conversion (kg feed/doz eggs)	2.51	2.87	2 83	2.52	0.75
Feed conversion (kg feed/kg eggs)	1.65	1 85	1 79	1.6	0.11
Percentage at peak production	84.9	82 8	84 90	83.9	1.72
Egg weight, (g)	53.5	52.67	52	52.98	4.36
Weights of birds at 20 weeks (kg)	1.24a	1.03b	1.04b	1.07b	0.05
Weights of birds at 36 weeks (kg)	1.74a	1.54b	1.55b	1.58b	0.04
Laying house mortality, (%)	0.69	0.69	0.72	0	0.61

[1]Means within rows with different letters are significantly different (P<0.05)
[2]SEM = Standard error of the means

Table 5: Feed consumption of quantitatively restricted laying chickens for experiment 11.2

Treatment	Feed consumption			
	0-20 weeks (kg/bird)	20 weeks – 5% production (kg/bird)	20 weeks – 50% production (kg/bird)	20 – 36weeks production (kg/bird)
0-8 Weeks				
1	6.15a	4.19	5.99	13.73
2	4.65b	5.18	6.83	13.96
3	5.01b	4.89	6.53	13.77
4	4.96b	4.63	5.95	13.25
SEM[3]	0.12	0.55	0.61	0.98

Table 6: Effect of quantitative feed restriction on growth performance of replacement pullets in Experiment 2

Treatment	Feed intake (g/bird)	Feed efficiency (g feed/g gain)	Weight gain (glbird)	Feed/kg gain (N)	Mortality (%)
0-8 Weeks					
1	1110.60	3.37	330.94	1.98	0.00
2	1177.57	3.28	359.00	1.94	0.00
3	1175.17	3.18	371.06	1.87	0.00
SEM[3]	17.63	0.09	16.07	0.05	0.00
9-20 Weeks					
1	4869.13a	5.60	869.73a	3.09	2.78
2	3708.67b	6.49	57167b	3.58	0.00
3	4268.33ab	6.04	706.67b	3.34	1.11
SEM[3]	132.93	0.18	29.85	0.11	1.01
0-20 Weeks					
1	5979.70a	4.98	1200.68a	5.07	2.78
2	4886.23b	5.25	93067b	5.52	0.00
3	5443.5ab	5.05	107772b	5.21	1.11
SEM[3]	145.01	0.11	39.75	0.14	0.93

[1]Means obtained from 60 birds in three replicates of 20 birds each.
[2]Means within each column with different letters are significantly different *(P<0.05)*
[3]SEM = Standard error of the means

Table 7. Effect of quantitative feed restriction on various laying performance traits evaluated in experiment 2

	Treatments[1]			
Parameter	1	2	3	SEM[2]
Hen-day Production (%)	63.18	62.84	66.06	4.15
Hen-housed Production (%)	61.29	60.71	62.05	5.52
Days to first egg	160	167	164	3.51
Days to 50% production	183	190	183	3.4
Days to peak production	192b	205a	197b	3.14
Feed consumption to 50% production(kg/bird)	10.44	9.92	10	0.38
Cumulative feed consumption (0-36 weeks) (kg/bird)	14.06	13.86	14.21	0.25
Feed conversion (kg feed/doz eggs)	3.1	3.38	3.12	0.37
Feed conversion (kg feed/kg eggs)	2.07	2.2	2.04	0.15
Percentage at peak production	76	76	82.5	3.38
Egg weight (g)	54.45	53	55.01	1.45
Weights of birds at 20 weeks (kg)	1. 24a	0.97b	1.12	0.04
Weights of birds at 36 weeks (kg)	1.74a	159b	160b	0.02
Laying house mortality, %	6.51	8.33	13.33	2.38

[1]Means within rows with different letters are significantly different *(P<0.05)* [2]SEM = [2]Standard error of the means

Table 8: Feed consumption of quantitatively restricted laying chickens for experiment 21,2

	Feed consumption			
Treatment	0-20 weeks (kg/bird)	20 weeks - 5% production (kg/bird)	20 weeks - 50% production (kg/bird)	20 -36weeks production (kg/bird)
0-8 Weeks				
1	5.98a	1.89	4.46	8.08
2	4.87b	2.67	5.05	8.99
3	5.44ab	2.86	4.56	8.77
SEM[3]	0.15	0.53	0.57	0.72

'Means obtained from 60 birds in three replicates of 20 birds each.
[2]Means within each column with different letters are significantly different (P<0.05)
[3]SEM = Standard error of the means

Conclusion

1. There is a significant saving in feed as restricted group consumed significantly less feed than birds fed *ad libitum*.
2. The type of restriction given the birds during growth did not significantly affect the age of birds at first egg, 50% and peak production.
3. Quantitative feed restriction did not have any significant effect on hen-day egg production, hen-housed egg production, feed consumption and the efficiency of feed for egg production.

References

1. M'bugua, P.N. and D.L. Cunningham 1983. Effects of feed restriction on production performance of replacement pullets. Poultry Science 63:1255-1261.
2. Lee, P.J.W., A.L. Gulliver, and T.S. Morris, 1971. Review article. Quantitative analysis of the literature considering the restricted feeding of growing pullets. British Poultry Science 12:413-437.
3. Hocking, P.M. Waddington, D. Walker, M.A. and Gilbert A.B. (1989). Control of the development of the ovarian follicular hierarchy in broiler breeder pullets by food restriction during rearing. British Poultry Science, 30:161-174.
4. Hocking P.M (1993). Welfare of broiler breeder and layer females subjected to food and water control during rearing: Quantifying the degree of restriction. British Poultry Science 34:54-64.
5. Whitehead, C.C., Herron, K.M. and Waddington, D. (1987). Reproductive performance of dwarf broilers breeders given different allowances of food during the rearing and breeding periods and two lighting patterns. British Poultry Science, 28:415-427.
6. Hocking, P.M.; Bernard, R.; and Robertson, G.W. (2002). Effects of low dietary protein and different allocations of food during rearing and restricted feeding after peak rate of lay on egg production fertility and hatchability in female broiler breeders. British Poultry Science 43:94-103.
7. Hocking, P.M. (1990b). Relationship between body weight, fertility and dietary protein in naturally mated broiler breeder males. British Poultry Science 31:743-757.
8. Steel, R.G.D. and Torrie, J.H. 1980. Principles and procedures of Statistics. McGraw-Hill Book Co. Inc. New York, Toronto, London.