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Effect of Day Length and Feed/Water Regime on Induction of Feather Moult and Subsequent Laying Performance in the Domestic Fowl

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Abstract: Investigations were carried out to ascertain the effectiveness of some conventional restriction techniques on feather moult. The techniques used to induce moult, which were imposed for 10 days, were: natural day length with feed and water *ad libitum*, natural day length with water but no feed, natural day length with no feed and no water, reduced day length with feed and water *ad libitum*, reduced day length with water but no feed, reduced day length with no feed and no water designated as T1, T2, T3, T4, T5 and T6, respectively, with T1 as the control. A total of 60 old layers aged 85 weeks were randomly assigned to each treatment in a completely randomized design, with three replicates. After the 10 days of moult induction, all the moulting hens were returned to the same conditions as the control. The results of the study revealed that shedding of feathers began 10 days from the beginning of moult induction with the feathers of the moulting birds appearing ruffled. There were no regular patterns in the shedding of wing and body feathers. Also the shedding of the two wings occurred simultaneously. The duration of shedding of wing feathers by birds in T4 was significantly ($P<0.05$) longer than for the other groups, probably because of the severity of restriction of light, feed and water for T2, T3, T5 and T6. Shedding of primary and secondary wing feathers ranged from 7 to 51 days. The T4 showed significantly ($P<0.05$) lower % egg production than T2, T3, T5, T6, after feather moulting. Also the T4 attained peak production later than the other groups following induction of feather moult.

Key words: Day length, feather moult, feeding, watering, egg production, domestic fowl

Introduction

Moulting in birds is a natural phenomenon characterized by loss and renewal of plumages (Etches, 1996). Domestic chickens bred for high productivity moult at the end of a long intensive egg laying period (North, 1972). Moulting is of two types, namely natural and artificially induced. Himeno and Tanabe (1957) reported that natural moult was due to senile deterioration of the structure of feather follicles maintaining the old feathers coupled with the decrease in ovarian activity.

Moulting occurs when plasma concentrations of the sex steroids and gonadotrophins are low. The postnuptial moult in non-domesticated birds is associated with a decrease in plasma levels of oestrogen and increase in levels of triiodothyronine and thyroxine (Etches, 1996). Etches (1996) also indicated that postnuptial moulting and induced-moulting have many physiological changes in common, although, the events that initiate feather renewal may be different. High levels of plasma thyroxine and triiodothyronine in moulting hens serve as stimulants to activate feather papillae for the formation of new feathers (Himeno and Tanabe, 1957; Etches, 1996). Rose (1997) suggested that low levels of progesterone in the plasma of moulting hens stimulate the feather follicles to start feather regeneration. On the other hand, Brake and Thaxton (1979 b) indicated that feather loss was induced as a result of the absence of functional ovary during a moult period. In the absence of a functional ovary, the levels of oestrogen secreted will not be enough to maintain growth of old feathers.

Harms (1983) observed that constant exposure of birds to day length of 12 to 14 hours during forced-moult (reduction in feed and water notwithstanding) prolonged the time of feather moult. Kekeocha (1984) reported that it took about 4 months (16 weeks) for a hen to renew its feathers under natural moulting while it took about 8 to 10 weeks under forced-moult. Thus good layers moult faster than poor layers which lose their feathers very slowly.

Techniques used in forced-moult programmes include feed and water restriction, mineral induced and hormonal induced moulting techniques. In the conventional restriction techniques, various combinations of feed, light and water withdrawals have been used to induce moult in laying hens. Hembree *et al*. (1980) induced a moult by total withdrawal of feed, water and light for 10 days. Brake and Thaxton (1979 a) withdrew water for 2 days coupled with fasting and restriction of light to 6 hours a day for 10 days. Oliver (1995) removed water for 3 days, withdrew feed for 7 days and reduced light to 11 hours per day for 49 days. McCormick and Cunningham (1987) found that fasting of birds for 4 or 10 days produced similar results during post-moult production.

For mineral induced moult, high dietary levels of zinc were successfully used to induce moult in laying hens (Shippee *et al.*, 1979; Cantor and Johnson, 1984). McCormick and Cunningham (1987) reported that high levels of dietary zinc caused cessation of egg laying in Single Comb White Leghorn (SCWL) hens by reducing feed consumption. Diets low in sodium and calcium have been used to induce moult in SCWL hens (Begin and Johnson, 1976; Naber *et al.,* 1980; Ross and Herrick, 1981). Tilbrook *et al.* (1992) observed that moulting was induced in laying hens using hormonal agonist without inducing weight loss in the moulting birds.

The most commonly used moult induction procedure is the restriction technique. The use of minerals and hormones in inducing moult may give rise to additional public health problems to humans due to the side effects of the residual amount of minerals and hormone agonists in eggs of treated flocks. Thus, despite the advantages of the mineral and hormone induced moulting techniques with regards to animal welfare, the conventional restriction procedures still remain the most practical, popular and economic methods within the egg industry (Hussein, 1996). However, conventional restriction currently used to induced moult and recycle old laying flocks differ in the physiological stress they impose on birds.

The objective of this study, therefore, was to evaluate the effects of the different conventional restriction techniques of moult induction on feather moult with a view to determining the one that achieves the fastest feather moult and the effects of feather moult on egg production.

Materials and Methods

Location of the experiment: The experiment was conducted at the poultry unit of Research Farm of Michael Okpara University of Agriculture Umudike in Abia State, Nigeria.

Experimental Design and Procedure: The experimental design was a factorial arrangement in a completely randomized design with two photoperiods and three feeding patterns. The photoperiods were: natural day length, characteristic of tropical environment (12 to 13 hour light period) and reduced day length of 8 hours of light per day (from 0800 to1600 hour); from 1600 hour to dusk, and from dawn to 0800 hour. Black polythene sheets were used to procure artificial darkness. The feeding patterns were: layer's mash and water supplied *ad libitum,* no feed but water supplied *ad libitum* and no feed and no water. The combination of these factors resulted in the following treatments;

natural day length with feed and water *ad libitum*, natural day length with water but no feed, natural day length with no feed and no water, reduced day length with feed and water *ad libitum*, reduced day length with water but no feed, reduced day length with no feed and no water. These were designated as T1, T2, T3, T4, T5 and T6, respectively. Thus T1 is the control.

A total of 360 Isa Brown commercial layers aged 85 weeks were used for the study. Each treatment combination was replicated three times with 20 birds per replicate giving a total of 60 birds per treatment combination. The period of moult induction lasted for 10 days after which the birds were returned to natural conditions as the control group. The mean temperature and relative humidity of the pens covered with black polythene sheets were 27.0^{o}C and 68.7%, respectively. On the other hand, the average temperature and relative humidity of the pens left under natural conditions were 25.7^{o}C and 70%, respectively during the 10-day moult period.

Determination of feather moult: Three birds were sampled from each replicate to study the pattern of feather moult from the different parts of the body. The pattern, rate of shedding and re-growth of primary and secondary wing feathers were also determined by taking record of the day each feather was shed, starting from the day of moult induction.

Egg production records: Percent hen-day production was recorded prior to moult induction, during moulting and post-moult.

Statistical analysis: The data generated were analyzed using analysis of variance (ANOVA). Significant means were separated using Duncan's Multiple Range Test (Duncan, 1955). All statistical analyses were done in accordance with the methods of Steel and Torrie (1980).

Results

The effect of day length on the shedding of feathers: The effect of day length on the shedding of primary and secondary feathers is presented in Table 1 and 2, respectively. Days of shedding primary feathers were significantly ($P<0.05$) shorter under reduced day length than natural day length. Like the primary feathers, reduced day length also significantly decreased ($P<0.05$) the time of shedding of majority of the secondary feathers. Wing feathers sprouted between 4 to 7 days from the time of drop and took approximately 60 to 70 days to re-grow to full size.

Effect of feeding patterns on shedding of feathers: Effect of feeding patterns on the days of shedding of primary and secondary feathers is shown in Table 3 and 4, respectively. There were no significant ($P>0.05$) differences among feeding patterns on the days of shedding of primary feathers. With the exception of secondary feathers 1 and 2 there were also no significant ($P>0.05$) differences on the days of shedding

Table 1: Effect of day length on days of shedding of primary feathers

Primary feather No.	Natural day length (12-13 hr light)	Reduced day length (8 hr light)
1	15.67 ± 4.16^b	6.33 ± 2.17^a
2	18.00 ± 4.60^b	11.44 ± 3.85^a
3	20.44 ± 5.01^b	9.44 ± 2.91^a
4	23.67 ± 5.08^b	13.33 ± 3.75^a
5	31.33 ± 4.79^b	14.11±4.42^a
6	35.56 ± 5.37^b	20.78 ± 5.74^a
7	42.56 ± 4.78^b	24.00 ± 8.32^a
8	26.89 ± 5.48^b	16.89 ± 6.35^a
9	34.89 ± 4.63^b	15.44 ± 6.04^a
10	31.44 ± 5.61^b	9.22 ± 3.61^a

a, b Means in a row with different superscripts are significantly different (P < 0.05)

Table 2: Effect of day length on days of shedding of secondary feathers

Secondary feathers number	Natural day length (12 - 13 hr light)	Reduced day length (8 hr light)
1	29.44±6.96^b	8.00±2.12^a
2	29.00±7.64^b	15.33±6.58^a
3	25.00±6.62	17.56±6.31
4	28.77±6.20^b	13.22±4.90^a
5	28.89±6.60^b	12.33±3.72^a
6	33.11±6.56^b	14.56±3.86^a
7	24.56±5.25^b	14.00±4.37^a
8	27.11±6.06^b	12.33±5.15^a
9	24.00±6.48	19.89±6.67
10	23.56±6.79^b	13.11±4.73^a
11	16.56±4.24	13.67±4.44
12	16.33±3.87	9.11±3.37
13	13.33±3.82	6.33±1.75
14	15.67±4.62	8.22±3.13
15	16.56±4.38^b	4.77±1.27^a
16	15.11±4.77^b	5.33±1.47^a

a, b Means in a row with different superscripts are significantly different (P<0.05)

of secondary feathers among the different feeding patterns (Table 4).

Effect of interaction between day length and feeding pattern on shedding of feathers: Tables 5 and 6 give the effects of interaction between day length and feeding pattern on days of shedding of primary and secondary feathers, respectively. The birds under the control technique showed no loss of body feathers, primary and secondary wing feathers. There was a significantly (P<0.05) prolonged period of shedding of primary and secondary feathers in the forced-moult group that was placed under reduced day length with feed and water supplied *ad libitum* (T4) than the other forced-moult groups (T2, T3, T5 and T6). In the case of the forced-moult groups (placed under natural day length with water, natural day length without feed and water, reduced day length with water and reduced day length without feed and water that is: T2, T3, T5 and T6, respectively, shedding of the primary and secondary wing feathers started at approximately 10 days from the commencement of moult-induction and continued till about 45 to 50 days. However, under the different techniques, the birds showed a partial shedding of body feathers with no regular pattern. Also there was no regular sequence in the shedding of primary and secondary feathers in the various forced-moult techniques.

Egg production: Prior to moult induction, the average hen-day egg production of the all hens range from 50.07 to 52.32%. During moult induction period, T2, T3, T5 and T6 stopped laying. In the T4 egg production rate decreased and they laid at the rate of about 18% and later increased gradually after moulting. After moulting, the T2, T3, T5 and T6 attained peak ranging between 71 to 79% faster (2 months following resumption of lay) than T4. The T4 had a peak of about 70.8% and thereafter egg production declined rapidly. In the other groups egg production rate was above 60% for a period of 6 to 8 months following peak. The hen-day % production of the T4 (40.78%) was significantly lower than those of T2 (54.48%), T3 (50.42%), T5 (59.79%) and T6 (63.34%) at 9 months after moult induction.

Discussion

The moulting processes became evident from day 7 to 10 of moult induction, when the feathers of the moulting birds appeared ruffled, and their feathers started dropping. The reports of Rose (1997) that shedding of feathers starts approximately 15 days from the beginning of moulting is contrary to the observations of the present study. In this study, feather moult started at about 10 days after light, feed and water restrictions. The shedding of feathers coincided with the time of ovarian regression and involution as shown by the ovary when birds were incised. This confirmed the reports of Himeno and Tanabe (1957) and Odunsi *et al.* (2002) who associated feather moult with decrease in ovarian activities. There was no regular pattern observed in the shedding of body feathers, thus contrasting the regular patterns of shedding of body feathers reported by North (1972) and Austic and Nesheim (1990). Similarly, the patterns of shedding the primary and secondary wing feathers in the different treatments were irregular and deviated from the forms reported by Austic and Nesheim (1990).

The moulting of the two wings as well as the body plumages occurred simultaneously. This corroborates the findings of Spearman (1971) who reported that,

Table 3: Effect of feeding pattern on days of shedding of primary feathers

Primary feather number	Feed and water *ad libitum*	No feed, Water *ad libitum*	No feed, no water
1	15.16±7.38	7.83±1.05	10.00 ±2.18
2	17.50±8.20	12.33±4.01	14.33±2.60
3	19.88±9.08	10.67±0.95	14.33±2.60
4	21.33±9.78	16.17±3.16	18.00±1.81
5	24.50± 10.97	21.67±3.41	22.00±3.69
6	34.38± 5.26	24.83±5.26	24.83±3.70
7	25.83± 11.74	29.50±9.08	33.50±3.65
8	23.83±10.80	22.17±6.46	19.67±4.86
9	24.67± 11.11	24.33±5.66	26.50±631
10	25.30± 11.34	21.16±5.33	14.50±3.45

Table 4: Effect of feeding pattern on days of shedding of secondary feathers

Secondary feather (No.)	Feed and water *ad libitum*	No feed, water *ad libitum*	No feed, no water
1	28.33 ± 12.76^{b}	14.83 ± 12.76^{a}	13.00 ± 1.75^{a}
2	29.17 ± 13.29^{b}	23.67 ± 8.18^{ab}	23.67 ± 8.18^{ab}
3	24.25± 11.55	24.83±7.45	14.50±2.51
4	25.17± 11.70	22.50±5.72	15.33±2.53
5	25.83± 11.60	17.16±5.00	18.83±3.29
6	24.83± 11.12	21.00 ±6.03	21.17±3.62
7	19.17± 9.63	17.00±3.79	21.67±4.94
8	24.50± 10.97	15.83±4.88	18.83±5.70
9	24.67± 11.04	20.00±6.54	21.17±6.56
10	19.50± 9.60	21.83±7.67	13.67±4.76
11	16.67± 7.50	14.83±4.52	13.83±3.79
12	15.83± 7.09	11.33+3.78	11.00+1.86
13	13.33± 6.61	7.67±0.80	8.50±1.26
14	15.50±7.91	12.33±3.74	8.00±1.03
15	16.67±7.60	8.00± 1.24	7.33±0.67
16	15.76±8.01	6.67±0.21	8.33±0.88

a, b Means in a row with different superscripts are significant different ($P < 0.05$)

Table 5: Effect of interaction between day length and feeding pattern on days of shedding of primary feathers

Primary Feather (no.)	Treatment groups*				
	T2	T3	T4	T5	T6
	days				
1	8.33 ± 1.86^{a}	10.67 ± 4.67^{a}	30.33 ± 6.49^{b}	9.33 ± 1.20^{a}	7.33 ± 1.33^{a}
2	17.00 ± 5.13^{b}	17.33 ± 7.31^{b}	35.00 ± 5.51^{c}	7.33 ± 1.33^{a}	11.67 ± 0.67^{ab}
3	12.00 ± 1.15^{a}	16.33 ± 5.33^{a}	39.67 ± 4.33^{b}	9.33 ± 1.20^{a}	12.33 ± 1.20^{a}
4	21.00 ± 4.58^{a}	19.00 ± 3.61^{a}	42.67 ± 4.84^{b}	11.33 ± 2.33^{a}	17.00 ± 1.53^{a}
5	24.33 ± 5.17^{a}	18.00 ± 6.93^{a}	49.00 ± 1.00^{b}	19.00 ± 4.93^{a}	26.00 ± 2.00^{a}
6	28.33 ± 4.41^{ab}	34.00 ± 6.66^{b}	49.67 ± 3.93^{c}	21.33 ± 0.33^{a}	35.67 ± 4.84^{b}
7	27.67 ± 16.48^{a}	44.33 ± 7.62^{b}	51.67 ± 4.63^{b}	31.33 ± 11.72^{a}	44.67 ± 2.91^{b}
8	30.00 ± 11.55^{b}	20.67 ± 10.73^{ab}	47.67 ± 3.93^{c}	14.33 ± 3.76^{a}	18.67 ± 1.33^{a}
9	21.67 ± 10.20^{a}	24.67 ± 12.35^{a}	49.33 ± 2.91^{b}	27.00 ± 7.00^{a}	28.33 ± 6.57^{a}
10	18.33 ± 8.33^{ab}	9.33 ± 1.67^{a}	50.67 ± 1.20^{c}	24.00 ± 8.02^{b}	19.67 ± 5.49^{b}

a-c Means in rows with different superscripts are significantly different ($P<0.05$).

* T2 =Natural day length with water *ad lib*

T3 = Natural day length without feed and water

T4 = Reduced day length (8 hours of light) with feed and water *ad lib*

T5 = Reduced day length (8 hours of light) with water *ad lib*

T6 = Reduced day length (8 hours of light) without feed and water

Note: Shedding of feathers was not observed in the control (T1) group

Table 6: Effect of interaction between day length and feeding pattern on days of shedding of secondary feathers

Secondary feather number	Treatment groups *				
	T2	T3	T4	T5	T6
	days				
1	12.67±1.20^{a}	11.33±2.03^{a}	56.67± 3.33^{b}	17.00±2.00^{a}	14.67±2.91^{a}
2	34.67±14.15^{b}	11.33±2.67^{a}	58.32±5.70^{c}	12.67±3.71^{a}	16.00±250^{a}
3	36.00±11.93^{b}	16.67±3.18^{a}	49.00± 8.14^{c}	13.67±3.18^{a}	12.33±4.10^{a}
4	22.67±11.61^{a}	17.00±3.79^{a}	50.33±7.13^{b}	22.33±5.36^{a}	13.67±3.84^{a}
5	13.00±2.00^{a}	24.00±4.16^{b}	51.67±2.40^{c}	21.33±10^{ab}	13.67±3.18^{a}
6	18.33±1.20^{a}	25.33± 2.40^{a}	49.67±1.45^{b}	23.67±13.17^{a}	17.00±6.51^{a}
7	23.00±5.77^{b}	19.00±6.66^{ab}	38.33±8.41^{c}	11.00±1.53^{a}	24.33±8.41^{b}
8	16.67±9.67^{a}	20.33±10.33^{a}	49.00± 1.00^{b}	15.00±5.00^{a}	17.33±7.31^{a}
9	33.00±8.50^{b}	26.67±12.44^{b}	49.33±0.67^{c}	9.33±1.76^{a}	13.33±3.84^{a}
10	19.00±9.17^{b}	20.33±7.42^{b}	39.00±9.00^{c}	8.33±0.88^{a}	23.33±15.38^{b}
11	19.00±6.66^{b}	22.00±7.09^{b}	33.33±1.86^{c}	8.67±0.88^{a}	7.67±0.67^{a}
12	14.67±7.69^{a}	12.67±3.76^{a}	31.67± 0.88^{b}	8.00±1.15^{a}	9.33±0.67^{a}
13	8.67±1.33^{a}	10.33±2.03^{a}	26.67± 6.36^{b}	6.67±0.67^{a}	6.67±0.67^{a}
14	15.33±7.42^{b}	9.33±1.76^{ab}	31.00±8.50^{c}	9.33±2.40^{ab}	6.67±0.67^{a}
15	7.00±0.58^{a}	7.33±1.33^{a}	33.33±3.33^{b}	9.00±2.52^{a}	7.33±0.67^{a}
16	6.67±0.33^{a}	9.33±1.67^{a}	31.33±8.67^{b}	6.67±0.33^{a}	7.33±0.33^{a}

a-c Means in a row with different superscripts are significantly different ($P<0.05$).
*T2 = natural day length with water *ad lib*
T3 = natural day length without feed and water
T4 = reduced day length (8 hours of light) with feed and water *ad lib*
T5 = reduced day length (8 hours of light) with water *ad lib*
T6 = reduced day length (8 hours of light) (8 hours of light) without feed and water
Note: Shedding of feathers was not observed in the control (T1) group

although primary and secondary feathers did not follow the same patterns of moult, the shedding of feathers occurred synchronously. The significant decrease in the number of days of shedding majority of primary and secondary feathers under light restrictions confirm the reports of Harms (1983) who observed similar results. The non-significance of the different feeding patterns on shedding of most of the primary and secondary feathers suggests that feed and water restrictions alone are not enough to induce feather moult. The significant differences recorded in the number of days of shedding of wing feathers in the different treatments indicate the severity of the effects of withdrawal of light, feed and water and that this gave rise to faster shedding of the feathers. However, there are other physiological mechanisms involving a complex interaction between the hypothalmo-hypophyseal-gonadal-adrenal-thyroid-axis (Brake and Thaxton, 1979a; Etches, 1996), which contributed to feather moult and to moulting in general. This study revealed that egg laying commenced before feather moult and feather renewal were completed. This is consistent with the findings of Rose (1997) who observed that feather loss and egg production during moulting are not mutually exclusive.

Egg production: The differences observed in the period of reaching peak production could be attributed to the differences in the time of shedding of feathers between the T4 and the other forced moult groups. The T4 that took longer time in shedding their feathers was delayed in the attainment of peak and exhibited lower rate of lay. This suggests that the faster the shedding of feathers the higher the egg production after moulting. The significantly high percent hen-day production of T6 at 9 months after moulting indicated the vital roles played by the incorporation of light, water and feed restrictions in induction of feather moult.

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