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Comparison of Four Induced Molting Methods Based on Subsequent Performance and Welfare of Single Comb White Leghorn Hens

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Abstract: A total of 400 Single Comb White Leghorn hens at 80 weeks of age were used in present study. Four treatment groups that were consisted of six replications with 10 hens per each replication were considered. In the first treatment, food and water were removed for the first 2, 4, 6 and 8 days. However, on days 3, 5, 7, 9 and on day 10 until day 28 hens were fed 45 g of food per hen (ON-OFF group). In the second and third groups, food was withdrawn for 10, 14 days, respectively and oyster shell and water were provided for *ad libitum* until day 28 (California and North Carolina treatments (CAL, NC groups)). The last group (full-food treatments (FF group)) was the hens that were non-food-deprived and were fed corn molt diet for 28 days *ad libitum*. In all treatment groups at day 29, hens were returned to a full food layer ration and received 16 h of light day^{-1}. Body weight, egg production, egg weight, relative eggshell weight, internal egg quality, egg specific gravity and mortality were determined. Differential leukocyte count and antibody response were also measured. The results demonstrated that induced molting increased egg production according to pre-molt egg production. There was not a significant difference in the rate of egg production during the peak period of post molt production for treatments. No significant differences were detected in differential leukocyte counts and antibody response against Sheep Red Blood Cell (SRBC) between treatments at pre molt and post molt of the experiment. This study indicated that diets with high corn level (FF groups) are effective and simplified nonfood removal procedure for welfare molting hens.

Key words: Induced molting programs, layer, immune responses, welfare

INTRODUCTION

Domestic hens are often force molted by a variety of procedures in order to prevent the age-related declines in egg production and eggshell quality (Bar *et al*., 2001; Breeding *et al*., 1992; Rolon *et al*., 1993). The most commonly used procedures for molting are based on Feed Withdrawal (FW) with or without light restriction (Hussein, 1996). For example, Brake (1993) recommended fasting a flock until they reached a target body weight loss. The length of fasting in this program is usually at least 10 days and unusually longer.

Animal rights activists have recently been pressing for an end to molt induction by FW. And their claim is based, among other things, on strong physiological evidence such as an increase in plasma corticosterone (Davis *et al*., 2000) and weakening of the immune response (Holt, 1992a).

These concerns have contributed to interests in alternative procedures for molt induction or in fine-tuning of rearing protocols without molt induction (Bar *et al*., 2003). It seems that the best method of induced molting should create less stress for birds in molting period and have the best performance in second of phase egg production.

The purpose of the present study was comparison of four induced molting methods on subsequent performance and less stress to birds in molting period.

MATERIALS AND METHODS

This study has been performed in the farm of the Department of Animal Science of Tehran University during autumn of 2006. Single Comb White Leghorn of the Hy-line white strain (80 weeks of age) were housed in cage layer house of commercial design with water and feed provided *ad libitum*. Hens were exposed to a 17 h daily photoperiod prior to the start of the experiment. Prior to starting the experiment, all hens were weighed and allocated to each treatment group according to equal body weights (1). Five replicate groups of 20 hens each were randomly assigned to each treatment. A total of 400 hens were randomly assigned to 4 treatments, which consisted of birds fed a corn molt diet (FF) or restricted-feeding (ON-OFF) and birds deprived of feed for 10 (CAL) or 14 days (NC).

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At the start of the experiment on day 1, feed was withdrawn from the groups designed to be deprived of feed for 10 or 14 days. The birds in other treatment were fed their respective diet. In the ON-OFF treatment, feed was removed in 1, 2, 4, 6 and 8 days after the commencement of experiment and hens fed in days 3, 5, 7, 9 with 45 g of high corn molt diet. The hens deprived of feed for 10 or 14 days were fed the corn molt diet at a rate of 45 g hen^{-1} day for the first two days following the feed withdrawal period to minimize over consumption and crop impaction. Then birds were given ad libitum access to their diet for 18 or 14 days, respectively. The last group (full-feed treatments (FF group)) were the hens that were not deprived of feed and were fed ad libitum access to the corn molt diet for 28 days and at day 29 fed 16% protein layer diet. The total length of the experiment was 14 weeks (four weeks for the molt period and 10 weeks for the post-molt lay period).

On day 1(the initiation of feed withdrawal or feeding molt diets), the daily photoperiod was decreased to 10 h, on day 24 photoperiod was increased to 12 h, then increased 30 min per week for the next four weeks and finally hens exposed to a 16 h daily photoperiod.

Performance data were collected for 14 weeks following the initiation of feeding the molt diets or feed withdrawal. Egg production and mortality were recorded daily. Egg weight and egg specific gravity (using the flotation method with NaCl solutions varying in specific gravity from 1.056 to 1.096 in 0.004 increments), were measured on all eggs produced on 2 consecutive days each week for egg weight and weeks 9, 14 for egg specific gravity (Berry and Brake, 1991). Feed consumption was measured weekly for the entire experiment and feed conversion ratio was calculated for weeks 4 to 14.

Body weights of hens deprived of feed for 14 days were measured on day 14; all hens were weighed on day 10 and 28.

General physiological stress was determined by counting differential blood leukocytes and calculating the heterophil: lymphocyte ratio (H:L) (Davis *et al*., 2000; Holt, 1992b). Blood samples were obtained from the wing vein from two hens per replication on initial of experiment and at the end of feed withdrawal for withdrawal treatments (10 and 14) and at the end of molting period (day 28). Antibody against SRBC was measured using the method designed by Trout *et al*. (1996). Briefly, birds were injected, intravenously, with 0.2 mL of 9% SRBC and 1 week later, birds were bled and the sera were inactivated at 56°C for 30 min. Antibody production was measured by an agglutination test using the microtiter technique (Alodan and Mashaly, 1999).

Statistical analysis: Data were analyzed to see if there exist any differences between treatment groups ON-OFF, CAL, NC, FF) using SAS® GLM procedure (SAS, 1985). Means were compared using Duncan's multiple range tests. Level of significance used in all results was ($p<0.05$).

RESULTS AND DISCUSSION

Hens that were deprived of feed for 10 or 14 days went out of production on day 6 and (ON-OFF) treatment by day 5.75 and hens that were fed the corn molt diet (FF) treatment ceased egg production by day 8 of the experiment and remained out of production until day 31. Day 32 was the first day of egg production (Table 1). However, the ON-OFF, CAL, NC hens ceased egg production on day 6 and remained out of production until day 27, 40 and 42, respectively. The hens subjected to NC and CAL methods lost 30.10 and 27.61 of their initial body weight by day 14 and day 10 of the experiment, respectively. This was significantly greater than the loss in hens in the ON-OFF (14.77) and FF (11.08) groups.

Hens reached 50% hen-day post molt egg production by days 24, 30, 28, 26 for ON-OFF, CAL, NC, FF, respectively. This was 2 to 4 weeks following the return to full-feed later ration. The effect of ON-OFF, CAL-10, NC, FF treatments on egg production are shown in Table 2. Hens in all treatment groups reached peak production approximately 6 to 8 weeks following the return to full-feed layer ration. Hen-day egg productions during the peak week were 75.00, 76.45, 80.02 and 82.73% of ON-OFF, CAL, NC, FF groups, respectively (Table 3). There was no significant difference in the rate of egg production during the peak week of post molt production for treatment groups. The effect of ON-OFF, CAL, NC and FF treatments on egg weight at the peak of post molt production are shown in Table 4. The results indicated

Table 1: The effect of different induced molting programs on different production time parameters

Treatments	Days to cessation	Days to production after molt	Days to 50 (%) production	Days to peak of production
ON-OFF	5.75^{b}	9.00^{b}	24.500	57.75
CAL	6.00^{b}	12.25^{a}	29.750	59.50
NC	6.25^{b}	14.00^{a}	28.000	61.25
FF	8.00^{a}	04.00^{c}	26.250	66.50
SEM	0.3632	0.8398	01.874	00.50

CAL: California method, NC: North Carolina, FF: Full Fed, SEM: Standard error of the mean, a-c: Different superscripts within a column differ significantly ($p<0.05$)

Table 2: The effect of different induced molting programs on two weeks period of post molt on percentage of egg production

Treatments	(0-2) week	(2-4) week	(4-6) week	(6-8) week	(8-10) week
ON-OFF	14.640[ab]	35.15	62.10	75.00	66.93
CAL	06.830[b]	28.51	58.06	76.45	66.49
NC	06.050[b]	26.95	61.13	80.02	72.04
FF	21.870[a]	34.18	59.20	82.73	75.30
SEM	01.258	02.04	03.21	02.72	02.738

CAL: California method, NC: North Carolina, FF: Full Fed, SEM: Standard error of the mean, a-c: Different superscripts within a column differ significantly ($p<0.05$)

Table 3: The effect of different induced molting programs on two weeks period of post molt on feed consumption (g/hen/day)

Treatments	Pre-molt	(0-2) week	(2-4) week	(4-6) week	(6-8) week	(8-10) week
ON-OFF	101.80	84.750	76.250	87.50[a]	94.50	94.50
CAL	099.75	80.500	76.500	88.00[a]	96.00	98.00
NC	101.25	81.250	79.000	86.75[a]	92.75	97.25
FF	100.00	80.750	76.750	83.25[b]	93.75	94.50
SEM	01.09	01.152	01.507	01.671	01.177	02.273

CAL: California method, NC: North Carolina, FF: Full Fed, SEM: Standard error of the mean, a-c: Different superscripts within a column differ significantly ($p<0.05$)

Table 4: The effect of different induced molting programs on two weeks period of post molt on egg weight (g)

Treatments	Pre-molt	(0-2) week	(2-4) week	(4-6) week	(6-8) week	(8-10) week
ON-OFF	65.850	62.960	66.790	63.830	65.270	63.710
CAL	65.530	62.310	64.360	64.050	63.750	63.810
NC	66.190	61.860	64.280	64.280	63.990	66.630
FF	66.550	61.900	65.440	64.770	64.250	65.020
SEM	1.067	1.435	0.899	1.444	0.914	0.989

CAL: California method, NC: North Carolina, FF: Full Fed, SEM: Standard error of the mean, a-c: Different superscripts within a column differ significantly ($p<0.05$)

that were fed the corn molt diet (FF) treatment have less feed conversation ratio, in comparison with other groups. However, nonsignificant difference was found between treatments in this term. The effect of ON-OFF, CAL, NC and FF treatments on egg weight at the peak of post molt production are shown in Table 5. No significant differences were found in egg weight between treatments. Also, there was not significant differences in egg specific gravity and internal egg quality (Haugh unit) in pre-molt, 50% and peak of hen-day egg production (Table 6, 7), although Haugh unit was increased with molt in all treatments. The effect of different induced molting programs on the differential leukocytes count and heterophil: lymphocyte ratio at different time of the experiment is shown in Table 8. There was no significant difference on antibody production against SRBC among treatments at the beginning of the experiment and end of withdrawal period molt of the experiment.

In the present research, the rate of egg production was significantly improved by molting treatments when compared to pre molt production. This result could be due to body weight loss as reported by Brake (1993), who indicated that the higher body weight loss, create the higher post molt production (Anderson *et al*., 2002; Biggs *et al*., 2003; Brake, 1993; Kogut *et al*., 1999). Another possible reason for improved egg production is the length of cessation period. In the present study, although hens of the NC group lost more body weight than hens of the CAL group, both group laid eggs at the

Table 5: The effect of different induced molting programs on two weeks period of post molt on feed conversion ratio

Treatments	(0-2) week	(2-4) week	(4-6) week	(6-8) week	(8-10) week
ON-OFF	11.19[b]	3.41	2.20	2.18	2.19
CAL	22.63[a]	4.13	2.48	2.10	2.27
NC	27.92[a]	4.73	2.21	2.07	2.11
FF	6.13[b]	3.70	2.26	2.09	1.93
SEM	0.1436	0.6430	0.2849	0.1036	0.1039

CAL: California method, NC: North Carolina, FF: Full Fed, SEM: Standard error of the mean, a-c: Different superscripts within a column differ significantly ($p<0.05$)

Table 6: The effect of different induced molting programs on two weeks period of post molt on egg specific gravity (g cm^{-3})

Treatments	Pre-molt	50 (%) production	Peak of production
ON-OFF	1.0762	1.0790	1.0815
CAL	1.0763	1.0792	1.0830
NC	1.0762	1.0790	1.0820
FF	1.0760	1.0785	1.0810
SEM	0.00074	0.00075	0.00102

CAL: California method, NC: North Carolina FF: Full Fed, SEM: Standard error of the mean, a-c: Different superscripts within a column differ significantly ($p<0.05$)

Table 7: The effect of different induced molting programs on two weeks period of post molt on egg internal quality (Hough unit)

Treatments	Pre-molt	50 (%) production	Peak of production
ON-OFF	69.42	82.81[a]	74.15
CAL	70.09	80.64[ab]	74.42
NC	67.63	83.38[a]	79.45
FF	70.95	76.76[b]	75.82
SEM	02.348	01.812	02.379

CAL: California method, NC: North Carolina FF: Full Fed, SEM: Standard error of the mean, a-c: Different superscripts within a column differ significantly ($p<0.05$)

Table 8: The effect of different induced molting programs on immune parameters

Parameters	ON-OFF	CAL	NC	FF	SEM
Pre-molt period					
Lymphocyte (%)	52.370	51.250	56.250	53.000	2.7510
Monocyte (%)	2.375	2.500	2.500	02.500	0.2068
Heterophil (%)	42.750	38.500	38.875	40.875	3.0370
Eosinophil (%)	2.125	1.750	2.000	2.000	0.1566
H/L	0.8625	0.7332	0.6968	0.7867	0.0987
SRBC*	4.2750	4.750	5.625	5.125	0.5860
Post-molt period					
Lymphocyte (%)	52.750	52.50	56.00	52.50	2.7520
Monocyte (%)	2.375	2.50	2.500	2.500	0.1997
Heterophil (%)	42.200	37.00	38.8750	40.00	2.7420
Eosinophil (%)	2.125	1.750	2.1250	2.00	0.1509
H/L	0.8651	0.7225	0.6940	0.7641	0.0949
SRBC*	4.250	8.3750	8.875	7.875	0.9415

CAL: California method, NC: North Carolina, FF: Full Fed, SEM: Standard error of the mean, a-c: Different superscripts within a row differ significantly ($p<0.05$) by Duncan's test, *: Values are $\log_2$ of reciprocal dilution of antibody titer

same rate during the peak of post molt production. This result could be due to the fact that hens in NC group stayed out of production for a longer period than hens in CAL group, as previously reported by Buhr and Cunningham (1994). These authors suggested that the longer egg cessation period, the better the post molt production. In the present study egg weight at the post molt production were not different significantly. This finding is in agreement with those who found that different induced molting programs did not significantly affect egg weight (Berry, 2003; Berry and Brake, 1991; Christmas *et al*., 1985; Garlich, 1995; Said *et al*., 1984). Although we found that induced molting increased internal egg quality and shell quality in all groups, but no significant difference were found between treatments in this terms. The heterophil: Lymphocyte ratios, which are used to measure the level of stressful conditions, showed no significant differences (Holt, 1992a, b; Koelkebeck *et al*., 1992). Present result showed that the different induced molting programs did not adversely affect antibody production against SRBC. These results are in agreement with the findings of Holt (1992b), who found that molting in laying hens had no effect on antibody production. Furthermore, throughout the present study, mortality for all molting groups was within the expected range, which suggests that excessive stress did not occur to influence either the immune response or heterophil: lymphocyte ratio. Because present study, simultaneously, compared the influence of different molting programs, it allowed us to determine the optimum procedure to be followed. Present results indicated that induced molting with FF method increased egg production, egg weight, feed conversion ratio, internal egg quality and shell quality, in comparison with other groups. However, no significant difference was found between treatments in these terms. In addition, other studies demonstrate that induced molting with FW increased the birds level of stress (Holt, 1992b). Therefore, we think that one of the factors for selecting the best molting program is that of less of stress to birds. Hence, in this study we opted the FF group in support of the best method because the hens were not deprived of feed, were fed *ad libitum* corn molt diet for 28 days and had the best performance with less stress. Finally, considering the animal welfare and right as well as simplicity of use, it could be concluded that FF program was the simple and best method for molting.

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