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Physiological Response and Postmolt Performance of Laying Hens Molted by Non-Feed Removal Methods

Fariborz Khajali, Saied Karimi and M.R. Akhari
Department of Animal Science, Shahrekord University, Postal Code 88186-34141, Shahrekord Iran,

Abstract: One experiment was conducted to evaluate the physiological response and postmolt performance of laying hens subjected to non-feed removal molting programs. One hundred and eighty 78-week-old Hy-line W36 laying hens were distributed among 45 groups of four birds and located in cages so that mean body weight of each cage was very similar. Three adjacent cages were considered as a replicate and 3 such replicates were assigned to each treatment. There were five treatments (molting procedures): Treatment 1 was continuous feed removal (CFR) and considered as the control. Hens on treatment 2 (T_2) fed ground corn as sole feed ingredient and dietary vitamin and macro and microelement levels were maintained as Hy-line W36 guideline specifications. Treatment 3 was similar to T_2 except that salt was removed from diet. Treatment 4 was similar to T_2 except that corn was replaced with wheat. Treatment 5 was similar to treatment 4 except that salt was removed from diet. Birds on T_2 to T_5 were fed at the rate of 50 g day^{-1}. The results indicated that hens subjected to CFR went out of production by Day 5 while those on corn or wheat diets with or without salt ceased egg production from Day 7 to Day 13. Nevertheless, postmolt egg production did not significantly differed among the treatments. Body weight loss in feed-deprived hens during molt was significantly ($p<0.05$) greater than non-feed removal treatments when measured on Day 7 and Day 12. Starvation during continuous feed removal resulted in increased heterophil to lymphocyte (H/L) ratio ($p<0.05$), hematocrit and plasma T_4 whereas decreased plasma T3 level ($p<0.05$).

Key words: Feed deprivation; laying hens; molting; non-feed removal

INTRODUCTION

Molting in avian species is defined as periodic shedding and replacement of feathers which is accompanied by involution of reproductive organs [1]. Natural molting of laying hens generally takes four months [12], which raises economic concerns as the hens continue to be fed during non-production times [11]. The molting process can be sped up by management practice called induced molting. Induced molting uniformly rests all hens and returns them to a more consistent high rate of lay for an extended period [11]. Conventional induced molting program usually involves a period of fasting for 10 to 15 days or up to 30% body weight reduction achieved [15]. Hens subjected to continuous fasting experience stress and are highly susceptible to infection by salmonella [5]. Egg industry, therefore, should seek for alternative molting programs to be replaced for continuous feed removal.

Several non-feed removal procedures were used to induce molting in hens. Feeding a high zinc diet was successfully used by Park *et al.* [13] Use of high fiber diets provided by alfalfa [10] or whole cottonseed [3] was reported to be as effective as complete feed removal program. Koelkebeck *et al.* [9] have studied the effectiveness of a corn or a wheat diet fed at free access for induction of molt and indicated that layer performance was inferior to feed removal procedure. In present study, feeding a corn or a wheat diet was limited at a rate of 50 g day^{-1} either in presence or omitting salt and physiological responses as well as postmolt performance were examined.

MATERIALS AND METHODS

One hundred and eighty 78-week old Hy-line W36 laying hens were kept in a house equipped with cages (45×50cm) and exposed to 16 h daily photoperiod. Prior to beginning the experiment, all hens were weighted and distributed among 45 cages so that 4 hens were allotted to each cage with equal mean body weight in each cage. Three adjacent cages were considered as a replicate and 3 such replicates were assigned to each treatment. There were five treatments (molting

Corresponding Author: Fariborz Khajali, Department of Animal Science, Shahrekord University, Postal Code 88186-34141, Shahrekord Iran Tel: +98 381 4424401

procedures): Treatment 1 was continuous feed removal (CFR) and considered as the control. Hens on treatment 2 (T_2) fed ground corn as sole feed ingredient and dietary vitamin and macro and microelement levels were maintained as Hy-line W36 guideline specifications. Treatment 3 was similar to T_2 except that salt was removed from diet. Treatment 4 was similar to T_2 except that corn was replaced with wheat. Treatment 5 was similar to treatment 4 except that salt was removed from diet. Birds on T_2 to T_5 were fed at the rate of 50 g day^{-1}.

The experiment was lasted 16 weeks consisted of a four-week period of molt and 12 weeks postmolt lay period. On Day 1 of molt (the initiation of feed withdrawal), the daily photoperiod was decreased to 8 h. On Day 24 and 30, the photoperiod was increased to 10 and 12 h respectively, then, increased 30 min per week until a photoperiod of 16 h was reached at peak production. Hens were fed *ad libitum* according to Hy-line W36 commercial management guide manual (2005) during postmolt period of 12 weeks.

Records of body weight were kept before induction of molt (Day 1), Day 12 when around 30% BW reduction occurred and Day 28 which was end of molt period. Blood samples were taken from the brachial vein of one hen per replicate (9 hens/treatment) on Day 1(before molt), Day 14 (mid-molt) and Day 28 (end of molt). Blood samples were used for determination of hematocrit and differential leukocyte counts [7]. Plasma was discarded by centrifugation at 1400g for 15min and plasma samples were used to measure T_3 and T_4 hormone concentrations by radioimmunoassay using a commercial kit (REF KT2CT, Barcelona, Spain). Records of egg production were kept daily for 12 weeks post molts and records of egg weight were kept monthly during aforementioned period.

Data were subjected to a complete randomized block design and analyzed by GLM procedure of SAS software (1997). Duncan multiple range test as well as orthogonal contrasts was used to compare treatment means.

RESULTS AND DISCUSSION

The reduction in hen-day egg production during a 28d molt period is shown in Fig. 1. The figure indicates that hens on continuous feed removal went out of production by Day 5 whereas those on corn or wheat diets either with or without salt ceased egg production from Day 7 to 13.

Orthogonal contrast showed that body weight loss was significantly differed between continuous fasting and other treatments. Table 1 depicts trend of BW loss among the molting methods. Hens of the control lost 24 and 28% of their initial body weight by Day 7 and 12, respectively, which was significantly greater than other molting methods. Birds on the control group gained higher than those on non-feed removal groups during refeeding so that they had even higher body weight on Day 28.

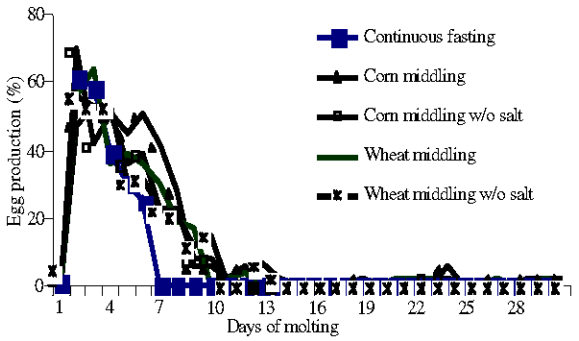

Fig. 1: Regression in egg production during molting period among molting programs

Table 1: Changes in body weight of hens measured at different times during molt period

	Body weight (g)		
Molting procedure	Day 7	Day 12	Day 28
Continuous feed removal	1232.2(24.0)^{b}	1177.0(28.0)^{c}	1365.6(15.8)^{a}
Corn diet	1491.7(8.0)^{a}	1450.3(10.6)^{a}	1324.2(18.4)^{ab}
Corn diet without salt	1467.5(9.6)^{a}	1406.4(13.3)^{ab}	1271.9(21.6)^{b}
Wheat diet	1461.9(9.9)^{a}	1416.1(12.7)^{ab}	1280.8(21.1)^{b}
Wheat diet without salt	1435.5(11.5)^{a}	1375.4(15.2)^{b}	1271.7(21.6)^{b}
SEM	20.95	18.35	18.32

Means within each column with uncommon superscript have significant difference ($p<0.05$). Data in parentheses show body weight loss as a percent of initial body weight

Table 2: Thyroid hormone concentrations of hens subjected to different molting programs at different times during molt period

	T3 (ng dL^{-1})			T4 (µg dL^{-1})		
Molting procedure	Day 7	Day 14	Day 28	Day 7	Day 14	Day 28
Continuous feed removal	290.4a	242.5	269.4	1.50	2.14	1.53
Corn diet	285.4a	210.9	326.2	1.58	1.83	1.60
Corn diet without salt	251.8ab	223.1	282.6	1.51	1.94	1.54
Wheat diet	262.4ab	255.8	277.4	1.86	2.17	1.54
Wheat diet without salt	170.9b	304.7	288.3	1.68	2.11	1.58
SEM	27.28	41.06	19.34	0.26	0.34	0.16

Means within each column with uncommon superscript have significant difference ($p<0.05$)

Table 3: Hematocrit and heterophil to lymphocyte ratio in hens subjected to different molting programs at different times during molt period

	Hematocrit			H:L (%)		
Molting procedure	Day 7	Day 14	Day 28	Day 7	Day 14	Day 28
Continuous feed removal	40.9	39.4	38.8	0.81a	0.79	0.86a
Corn diet	37.7	40.4	41.9	0.48c	0.59	0.67ab
Corn diet without salt	36.9	40.6	42.0	0.66abc	0.62	0.60bc
Wheat diet	37.4	39.3	43.9	0.72ab	0.50	0.48c
Wheat diet without salt	33.9	43.9	44.3	0.61bc	0.56	0.76ab
SEM	1.81	1.39	1.34	0.058	0.095	0.054

Means within each column with uncommon superscript have significant difference ($p<0.05$)

Table 4: Postmolt performance of laying hens subjected to different molting programs

Molting procedure	HDEP (%) Wk 5-17	Peak egg production (%)	Mean egg mass wk5-17 (g/b)	Egg mass at peak (g/b)
Continuous feed removal	61.3	74.8a	3966.7	5320.0
Corn diet	57.1	62.4b	3787.0	4718.0
Corn diet without salt	59.7	69.3ab	3976.0	5236.0
Wheat diet	63.0	75.0a	4081.0	5439.0
Wheat diet without salt	60.7	70.2a	3894.3	5096.0
SEM	3.27	3.45	296.5	392.4

Means within each column with uncommon superscript have significant difference ($p<0.05$)

Starvation during molting significantly decreased plasma T_3 level with concomitant elevation of plasma T_4 level (compare the means on Day 7). Refeeding restored the changes in plasma T_3 and T_4 concentrations (compare the means on Day 14 and 28) (Table 2).

Hematocrit value was numerically higher in birds subjected to fasting method compared to non-fasting groups when measured on Day 7 indicating that fasting elevated this variable. Nevertheless, the difference with respect to this variable was not significant (Table 3). The situation was restored during refeeding (compare hematocrit on Day 14 and Day 28).

Feed deprivation during molt significantly ($p<0.05$) enhanced H/L ratio (Table 3). The elevated ratio of H/L was maintained significant until the end of molt (Day 28).

Table 4 depicts results pertaining hen-day egg production and egg mass during postmolt period. The highest egg production rate and egg mass at month of peak or during 12wk period postmolt were attained by hens fed wheat as a sole source of feed ingredient during molt period. Hens on corn diet had significantly ($p<0.05$) lower egg production at peak in comparison with other groups. They had the lowest egg production during entire postmolt period.

Birds subjected to continuous fasting ceased egg production much earlier than those on non-feed removal programs. This observation was definitely expected as hens on the control received no nutrient to maintain egg production.

Body weight of hens experienced continuous fasting was much drastically lost when compared to that of hens on non-fed removal programs. After 7 days in molt, hens of the control lost 24% of their initial body weight whereas BW loss did not exceed 11.5% in non-feed removal programs at the same time. Birds on the control group gained higher than those on non-feed removal groups during refeeding so that they had even higher body weight on Day 28. Khajali *et al.* [8] demonstrated that ovary and oviduct had highest regressions during feed deprivation due to loss of gonadotropin support.

Feed deprivation during molting led to decreased plasma T_3 concentration and increased plasma T_4

concentration. Refeeding restored normal plasma T_3 and T_4 levels (Table 2). This is consistent with previous reports [4, 14]. The decrease in plasma T_3 level in feed deprived hens is likely to be the result of a shift in the balance between deiodination of T_4 by hepatic deiodinase enzyme type I (D1) and T_3 degradation by hepatic deiodinase enzyme Type III (D3) [4]. Decuypere *et al.* [4] reported increased hepatic deiodinase III mRNA levels at the first day of starvation which was dropped after refeeding.

Starvation during molting resulted in elevated hematocrit and refeeding caused it to return to the level similar to that of before molting. There are reports suggesting that starvation during molting increases packed cell volume [6]. Molting causes a remarkable regression in ovary and oviduct weight [8] which is associated with the loss of estrogenic activity. According to Keshavarz and Quimby [6], the loss of estrogenic activity could result is increased erythropoiesis and accounts for enhanced hematocrit.

Heterophil to Lymphocyte ratio is commonly used as an indicator of stress [16]. Under stress conditions the ratio is tended to increase [2]. Davis *et al.* [2] showed that H/L ratio was significantly higher during a forced molt compared to other times of year. As depicted in Table 3, fasting resulted in higher rate of H/L (compare the treatments on Day 7) and elevated ratio of H/L was maintained significant until the end of molt (Day 28). This finding shows that fasting during molting is a vigorous stress to the birds and emphasizes seeking for alternative molting practices for this conventional procedure.

Postmolt egg production and egg mass were of important results. The highest egg production rate and egg mass at month of peak or during 12 wk period of postmolt were attained by hens fed wheat as a sole source of feed ingredient during molt period. In the other hand, hens fed corn diet had the lowest egg production at peak and entire postmolt period. Wheat has higher amount of crude protein and better balance of amino acids relative to corn. Consequently, feeding corn might have depleted body protein reserves and resulted in decreased egg production in postmolt.

CONCLUSIONS

Feed deprivation during molting is associated with increased plasma T_4, H/L ratio, and hematocrit, while plasma T_3 is reduced. The findings of the present study indicates that feeding a wheat diet at limited amount can be resulted in postmolt performance comparable to the continuous feed deprivation with beneficial effects to alleviating the stress as measured through decreased H/L ratio.

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