한국가금학회지 제 29권 제 4호, 243~247(2002)
Korean J. Poult. Sci. Vol. 29, No. 4, 243~247(2002)

Effect of Induced Molting on the Relative Weights and Hormone Levels of Thyroid, Ovary, and Adrenal Glands in Spent Laying Hens

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산란노계에서 강제환우가 갑상선, 난소, 부신 및 호르몬 수준에 미치는 영향

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ABSTRACT : A study was conducted to investigate the effect of induced molting on the relative weight and hormone levels of thyroid, ovary, and adrenal glands in spent laying hens. Three hundred sixty 77-wk-old, Babcock White hens were divided into 36 experimental units of 10 hens each and induced to molt for seven weeks. A diet containing 16% CP and 2,800 kcal ME/kg was fed *ad libitum* from 84 to 126 weeks of age. Thirty-six birds were randomly selected for blood collection and slaughtered at pre-molt, 5% egg production, peak, and end phase of the egg production. Weights of the thyroid, ovary, adrenal glands, and plasma T3, T4, cortisol, and estradiol contents were measured at each stage. Weight of the thyroid reached its highest level at 5% egg production stage. The ovary weight was greatly reduced during molting, but started to increase after induced molting until the end of the egg production phase ($P<0.05$). Plasma T3, T4 and cortisol were found to be the highest at the start of the post-molt production stage, but reached their minimum at the end phase of egg production. Plasma estradiol was the lowest at the 5% egg production stage. The present study demonstrated that molting is a complex process that require the involvement of endocrine glands to trigger their specific hormones, which play a key role in molt induction.

(Key words : induced molting, laying hens, thyroid, ovary, hormone)

INTRODUCTION

Molting is a process that requires involution of the reproductive tract and loss of primary feathers to halt the egg production. A rejuvenation and general increase in productive performance following the molting has been reported by Lee (1982), Mehta et al. (1986) and Brake (1993). Although the effects of this rejuvenation could be found from many changes in physiological parameters, Brake and Thaxton (1979) reported that the discrete changes at the cellular level provided the driving force for the required tissue sensitivity. The ovary, adrenal gland (Payne, 1972) and thyroid (Lien and Siopes, 1989) have been found to mediate the molting, even though Payne (1972) reported no particular endocrinal hormonal changes in association with the induction of molting. Akram (1998) postulated the importance of endocrine hormones triiodothyronine (T3), thyroxin (T4), estradiol, progesterone and cortisol in induced molting. Various physiological changes should be expected in modern strains at different environmental conditions induced by molting.

Thus, this study was proposed to investigate the impact of induced molting on the physiological changes that occurred in

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endocrine glands by measuring hormonal and biochemical parameters in spent laying hens.

MATERIALS AND METHODS

Three hundred sixty Babcock white hens at the age of 77 weeks were randomly divided into 36 experimental units of 10 hens each for induced molting. The effect of molting was observed on subsequent changes in thyroid, ovary, adrenal glands during the production phase. Hens were allowed 7 days for pre-molting and followed with 7 wk molting, the hens were subjected to a 12 h light : 12 h dark cycle, and the light time was gradually increased by 30 minutes per week until it reached 16 hours according to the method of Akram(1998). A diet containing 16% CP and 2800 kcal ME/kg was fed *ad libitum* from 84 to 126 weeks of age. A total of thirty-six birds were randomly selected for slaughtering, dressing and blood collection at pre-molt, 5% egg production, peak, and end phase of egg production to investigate the relative weights of thyroid, ovary, adrenal glands and their plasma hormonal changes.

Weights of the thyroid, ovary, and adrenal glands of the slaughtered birds at each stage were recorded based on 100 g body weight. Hormonal changes were measured for tri-iodothyronine (ng/ml), thyroxin (May, 1978), cortisol (ng/ml), and estradiol (pg/ml; Kano et al., 1986) at pre-molt, 5% egg production, peak, and end phase of egg production. The data collected on thyroid, ovary, adrenal glands and their hormone levels at each production stage were subjected to statistical analysis using SAS (1996).

RESULTS AND DISCUSSION

1. Thyroid, ovary, adrenal glands

The relative weights of the thyroid and ovaries of the birds showed significant differences between pre- and starting of the post-molt production stage ($P<0.05$). The highest thyroid weight was found at 5% egg production (Fig. 1), but the lowest weight at peak production phase. This result suggests that thyroid might be highly involved in molt induction. It also agreed with the reports of Brake and Thaxton (1979) that the thyroid could

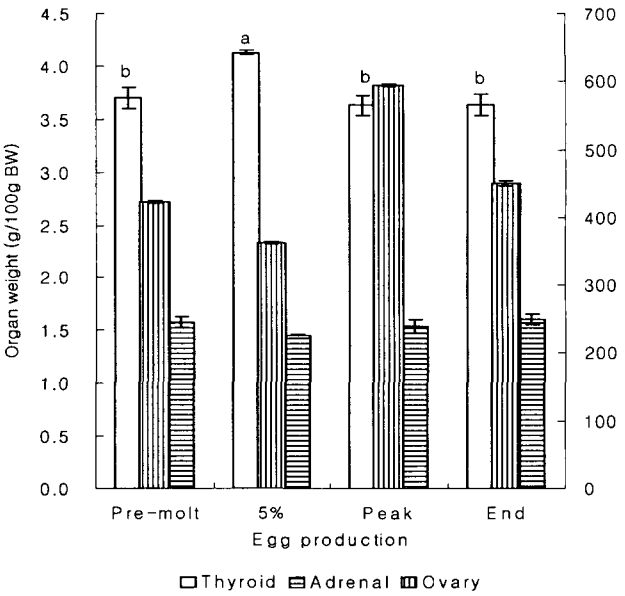

Fig. 1. Rleative weights of thyroid, ovary and adrenal glands (Mean±SE) between pre- and post-molt production stage in spent laying hens.
[a,b] Means with the different superscripts differ significantly ($P<0.05$).

be related to increases in basal metabolic rate and elevated body temperature during induced molting in hens. Ovary weight was reduced to minimal after induced molting which might have been caused by the cessation of egg production, but started to increase in size and reached maximum at peak production. Ovarian regression in the present study was explained by the findings of Brake and Thaxton (1979) who demonstrated the important role of the feed, water and light restriction. They further reported that ovarian regression was divided into two distinct phases. The mature follicles remaining at the time of water withdrawal underwent a necrotic type of atresia characterized by ruptured follicles and appeared to be resorbed. Consequently, a very rapid decrease in the weight of ovary followed by oviduct regression occurred (Brake and Thaxton, 1979). Tanabe et al.(1957) postulated that the absence of an estrogen influence was responsible for feather papilla stimulation. Therefore, the absence of a functional ovary would lead to feather loss in this experiment. This result was supported by the reports of Nalbandov (1976) which linked the effects of feed removal, cessation of lay, follicular regression and

regression of the oviduct and comb to those of hypophysectomy. Adrenal gland weight was not significantly different among production stages, even though it was the lowest at 5% egg production stage which may have been due to release of stress combating hormones after induced molting. These results corresponded to the results of Brake et al. (1979), who reported a trend towards increased total adrenal steroids by feed withdrawal and an increase in adrenal cholesterol upon the resumption of feeding.

2. T3, T4, Cortisol, Estradiol

Induced molting showed a significant effect on plasma T3, T4, cortisol, and estradiol concentrations in spent laying hens ($P<0.05$). The highest value of T3 was noted at 5% production stage, but minimum at the pre-molt stage (Fig. 2). These results corresponded to the study of Lien and Siopes (1993a, b), in which plasma T3 started to increase throughout molting and attained its highest level when molting was completed. Plasma T3 peaked at the onset of egg production and decreased rapidly until peak production, and remained low during the decline of egg production. The level of T4 was the highest at 5% production, but the lowest at the pre-molt stage. These results were similar to the report of Chotinski et al. (1990) that T3 and T4 decreased on the 3rd day and increased on the 22nd day, but decreased on the 52nd day. Plasma cortisol concentration reached its maximum at 5% egg production, but minimized at the end phase of egg production (Fig. 3). This could be explained from the findings of Latshaw (1991) who postulated the important role of adrenal corticoids in adaptive response as a factor in molting that feed restriction during molting, which increased its concentration. Because cortisol, T3 and T4 delineated the high rate of thyroido-adrenal activity during induced molt, a temporal association of thyroid and adrenal glands might be involved in induced molting. The highest values of estradiol was observed at pre-molt and peak production stage, whereas the lowest were confirmed at the 5% egg production stage (Fig. 3). Similarily, Porter et al. (1991) and Dickerman et al. (1992) reported decreased plasma estradiol concentrations due to ovarian regression during molting. Minimum plasma estradiol concentration proved to have a positive correlation with egg production (Izumi et al., 1992). Estradiol concentration was simultaneously decreased to the minimum in

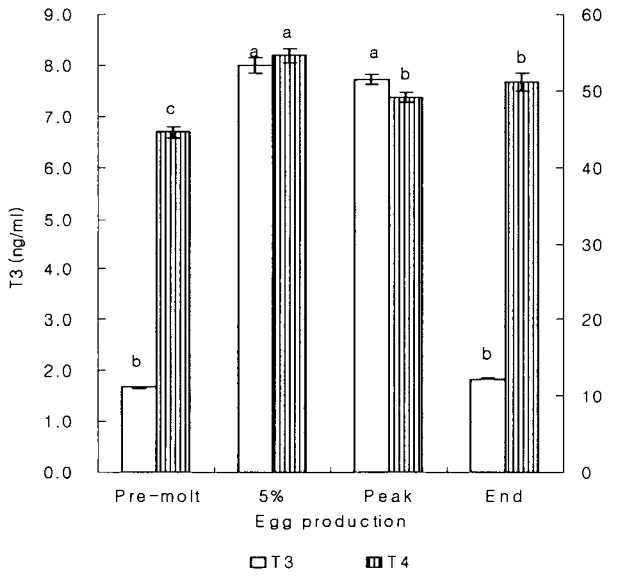

Fig. 2. The recovery of thyroid hormone(Mean±SE) between pre- and post-molt production stages in spent laying hens.

[a-c] Means with the different superscripts differ significantly ($P<0.05$).

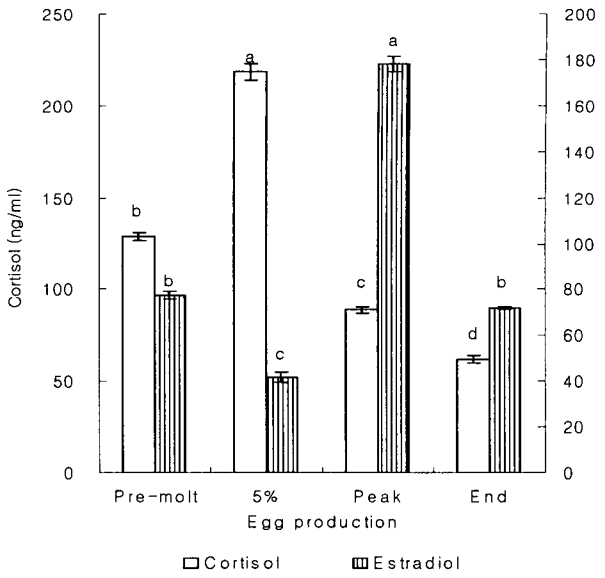

Fig. 3. Plasma hormone level changes (Mean±SE) between pre- and post-molt production stages in spent laying hens.

[a-d] Means with the different superscripts differ significantly ($P<0.05$).

the blood with ovary regression and non laying. It reached the highest level at the peak, but declined as the egg production decreased.

The present study indicated that molting is a complex process, which is accomplished by the involvement of some endocrine glands. They trigger the specific hormones, which played key roles in molt induction by inducing many changes. The manipulation of thyroid and ovarian hormones could also have a potential to expedite the molting process in spent laying hens.

적 요

본 실험은 산란노계에서 강제환우가 갑상선, 난소, 부신의 무게 및 이들 기관에서 분비되는 호르몬 수준의 변화에 미치는 영향을 구명하고자 시행하였다. 77주령 산란계 360수를 10수씩 36개의 펜에 배치하여 7주간 강제환우를 시행하였다. 사료는 단백질 수준이 16%이며 대사에너지가 2,800 kcal/kg 함유된 시판용으로 84주령부터 126주까지 급여하였다. 강제환우전, 산란율 5%, 산란피크 및 실험 종료시에 각각 36수씩 희생시켜 채혈을 하였으며, 갑상선, 난소, 부신의 무게를 측정하였고 혈청에서 T3, T4, cortisol 및 estradiol 함량을 측정하였다.

갑상선의 무게는 산란율이 5%에 도달하였을 때 제일 높게 나타났다. 난소의 무게는 강제환우 후에 현저하게 감소되었지만 그 후에 지속적으로 증대되어 실험 종료시에 극대화되었다($P<0.05$). 산란율이 5%에 도달한 시기에 혈청의 T3, T4 및 cortisol 수준은 다른 시기에 비하여 높게 나타났지만 실험 종료시에 제일 낮게 나타났다. 혈청의 estradiol은 산란율이 5%에 도달한 시기에 제일 낮았다.

본 실험에서 강제환우 과정에서 환우의 유기에 주요 역할을 하는 내분비 기관 및 이들 기관에서 분비되는 T3, T4, cortisol, estradiol 수준이 복합적으로 관련될 수 있음을 시사하였다.

(색인어 : 강제환우, 산란노계, 갑상선, 난소, 호르몬)

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