PHOTOENDOCRINE MANIPULATIONS AND POULTRY PRODUCTIVITY:

EFFECT OF TIMED TRANSITION FROM LONG TO SHORT PHOTOPERIOD IN COMBINATION WITH HYPO. OR HYPERCORTICALISM IN RIR PULLETS

(Summary)

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CONCISE SUMMARY

In this era of modern scientific research, the field of poultry is at the fore-front because of its obvious economic importance. The development of artificial incubation technology has played a major role in this context. The decreased egg production has been overcome by isolation and selective breeding of genetically superior strains of poultry birds. The poultry products (egg and meat) have gained importance and constitutes the important components of human diet. Since an egg constitutes of all the necessary ingredients required for the nourishment of a developing embryo, it is considered to be a complete food. The growing demand for poultry meat has been overcome by introduction of broiler breed. Also, dual purpose breeds (for both egg and meat) were also developed and were major breeds of early part of 20^{th} century and, continues to be an important breed in small and medium sized Indian poultry farms.

The important dual-purpose breeds are Barred Plymouth rock and Rhode Island Red (RIR). The Indian RIR breed is obtained by crossing the English RIR breed with the Kalinga brown of Bhuvaneshwar. The subsequent generations have a better resistance against diseases and environmental factors and, can survive well in the hilly areas.

Though, cross breeding and selection procedures have resulted in generation of better breed of poultry birds, the many qualitative and

quantitative traits, like growth, sexual maturation, initiation and duration of egg laying, and, the number of eggs laid, are not realized to the full genetic potency. This is mainly due to the epigenetic effects of various environmental factors. Epigenetic effects of nutrition, management techniques, humidity, light and temperature have all been recognized to influence poultry productivity. Feed management and nutritional manipulations have been shown to influence poultry productivity (Dunn, *et al.,* 1990; Sandoval and Gernat, 1996). Photoperiod has also been recognized as important environmental variable in poultry breeding and rearing, from the many experimental evidences available. Hence, photoperiodic manipulations are a powerful tool in the modern day poultry management techniques.

Birds, in general, exhibit a wide spectrum of adaptive photoresponsivenes which phase the hypothalamic neurosecretions, which eventually regulate migratory fattening, moult, gonad development and other photoperiodic functions. In birds, light is perceived through photoreceptor in the hypothalamus which acts as biological transducers that convert photon energy into neural impulses, which in turn, are amplified by the endocrine system to control ovarian and testicular functions and, consequently the multitude of reproductive functions, behaviour and secondary sexual characters (Etches, 1996). Photoperiodism is the process whereby endogenous circadian and circannual rhythms of the body functions are synchronized with external daily and seasonal rhythms. A range of environmental stimuli is transmitted through the CNS to effect the liberation of neuro-hormones or releasing factors (RF) in the median eminence of the pituitary gland. These neuro-hormones are transmitted via portal blood vessel to the anterior lobe of the pituitary to release pituitary hormones, mostly gonadotropin which in turn regulate gametogenesis and synthesis and secretion of steroid hormones (Sturkie, 1986).

The effect of environmental lighting and temperature on the neuroendocrine system of poultry birds has been studied in considerable detail in western countries. It has been known to affect varied aspects of reproduction like, age of onset of lay (AFE), rate of lay, timing of lay, shell quality, egg size and feed efficiency. Absolute photoperiod is of lesser importance in domestic hen as ovarian development and sexual maturity have been known to occur at the same age regardless of the duration of the photoperiod under widely different lighting regimens (Lewis, *et. al.*, 1994). Earlier, studies have shown that exposure of laying hens to shortened photoperiod results in reduced egg production (Sykes, 1956; Hutichson and Taylor, 1957; Morris *et.al.*, 1964). Age at first egg was shown to be advanced or delayed when growing pullets were exposed to an increased or decreased photoperiod respectively (Morris, 1968). These were later related to the size and timing of change in photoperiod (Morris, 1963; Lewis *et. al.*, 1992). Sexual maturity has been shown to be delayed when pullets are reared under 6 hrs or 18 hrs of photoperiod from day one, compared to a rearing photoperiod of 10 hrs (Morris, 1967). The age related responsiveness to changes in photoperiod has been demonstrated by Morris (1968), with maximum responsiveness observed closer to sexual maturity. Also, rearing pullets under normal or long days delated sexual maturity (8 hrs light/day) (Payane, 1975; Proundfoot, 1986; Renden and Oates, 1989).

Studies on photoperiodic manipulations in domestic hen have been carried out mostly on breeds in temperate countries, but, none on breeds of tropical countries under tropical conditions. The photoperiodic schedules followed in the government poultry farms in India are the ones borrowed from the western countries. Also the AFE and egg laying performance of tropical Vs temperate species of domestic fowl has been shown to differ under an identical photoperiod implying a possible strain difference (Dandekar, 1998). Hence, it was thought pertinent to assess the egg laying performance under a long photoperiod of LD 18:6 for first three months post-hatch, and then shifted to LD 12:12 (NLD) (amounting to a step-down photic schedule). Also, the adult hens towards the end of their first egg laying cycle (72 weeks of age) were subjected to a similar photoperiod (LD 18:6) for 1 month and shifted to NLD thereafter, to study the subsequent effect on its second cycle of egg laying.

Based on the recent reports on the effects of adrenal corticoids on mammalian reproduction (Kalimi *et .al.*, 1983; Limonta *et. al.*, 1988; Palmero *et. al.*, 1988) it was thought pertinent to assess the effect of induced hypo. or hypercorticalism alone or in combination with a step-down photoperiod, on the egg laying performance of RIR hens.

The entire investigation was divided into three phases. In the first phase, day old RIR pullets were reared under LD 12:12 (NLD) throughout or long photoperiod (LD 18:6; LP) and/or subjected to hypercorticalism (HPR) or hypocorticalism (HPO) for the first trimester of post hatch development.

The LP birds showed overall decreased egg output by 8% as compared to NLD birds, but the per hen per day yield and the between egg interval were better by 7%. Also, the LP hens laid lesser number of small eggs (<40 gms). Overall, the LP hens showed an improved rate of lay in their first egg laying cycle. In contrast, the LP hens in heir second cycle, showed an overall poor egg laying performance.

The HPR and HPO pullets reared under NLD showed no significant difference in the initiation, termination and total period of egg laying. But the adult birds (72 weeks of age) subjected to the same treatment for 30 days, showed an improved egg laying in HPR hens (15% more eggs) and poorer performance in HPO hens (22% less eggs) than the NLD hens. These results depict effects of altered corticosterone levels on egg laying.

The HPR and HPO pullets reared under LP for the first trimester post-hatch, showed certain favourable alterations in the egg laying pattern. Whereas, the HPR hens had a longer egg laying cycle with more number of eggs than LP, the HPO hens had a shorter egg laying cycle with no major difference in the number of eggs laid. Thus the LP+HPO condition seems to be economically more feasible in terms of lesser maintenance cost. The adult hens (72 weeks) towards the end of their egg laying were also subjected to the same experimental schedule. It was observed that, both HPR and HPO hens exhibited poor egg laying compared to LP hens.

In the second phase of investigation, the eggs of hens subjected to the above mentioned experimental manipulations in the pullet stage were analysed to assess changes in physical properties and biochemical composition. The LP hens laid heavier eggs than NLD hens. This increase can be attributed to the recorded higher weights of yolk and albumen. The total protein and total cholesterol contents were significantly increased while, the carbohydrate and total lipid contents were decreased in both yolk and albumen of LP eggs. A comparison of calorific value shows significantly greater energy content (13.4%) in LP eggs implying an improved nutritional status of LP eggs.

The eggs of HPR and HPO birds under NLD recorded an increment in lipid and cholesterol contents of yolk and protein content of albumen.

The eggs of HPR birds under LP showed increased glucid content in yolk and cholesterol content in albumen, and marginal reduction in the albumen protein content. The HPO eggs showed increased lipid and cholesterol contents, whereas the protein content decreased in yolk and increased in the albumen. The calorific value of HPR and HPO eggs was similar to that of LP. These results indicate that NLD or LP alone, or in combination with functional alterations of adrenocortical activity during the pullet stage have a definite influence on egg composition of eggs by inducing subtle changes in the metabolic features of liver and oviduct.

The third phase of investigation involved the study of photoperiod or adrenocortical manipulations alone, or in combination, to assess their consequential effects on the body weight and, absolute and relative weights of thyroid, adrenal ovary, oviduct, liver and lymphoid organs (thymus, bursa and spleen) and, their growth rates and growth indices. The serum hormone levels of T_3, T_4, progesterone and corticosterone were measured and histology of thyroid, adrenal, ovary and oviduct was carried out. The pullets were sacrificed at 30, 60 and 90 days.

The weights of thyroid and ovary showed a significant increment in LP chicks, whereas the weights of liver and lymphoid organs were identical to that of NLD chicks. The weights of adrenal and oviduct were significantly lower. In general, the serum levels of T_3, T_4,corticosterone and progesterone tended to show a gradual decrement with age in NLD chicks. but the LP chicks showed a differential change marked by higher T_3 and T_4 levels throughout and, increased corticosterone and decreased progesterone levels at 30 and 60 days. Long photoperiod seems to have an initial depressive, but later stimulatory effect on growth of thyroid, whereas adrenal showed reciprocal set of changes. The histometric data indicates a stimulatory effect of light, indicated by increased number of follicles and decreased degree of follicular atresia.

The absolute and relative weights of thyroid, adrenal, ovary oviduct, liver and lymphoid organs (spleen, thymus and bursa) were, in general higher in HPR and HPO chicks, as compared to the NLD chicks. The relative weight and growth indices of liver and lymphoid organs were higher in HPR and lower in HPO chicks. The serum levels of T_3, T_4 and progesterone showed relatively lower levels of hormones in HPR chicks as compared to NLD chicks. The histoarchitecture of thyroid of HPR and HPO chicks, showed increased and moderate colloid retention respectively, with reduced follicular cell height. The adrenal showed prominent cortical cords and a mixture of active and inactive cells in HPR and HPO chicks, with HPO chicks showing relatively more secretory exhaustion. The histometry of ovarian follicles of HPO chicks showed a retarded rate of transition into higher sized follicular hierarchy. These results suggest some negative influence of HPR on ovarian functions, and further, a possible relationship of adrenal steroids and ovarian functions during growing phases in RIR pullets.

The body weights of HPR and HPO chicks were similar to LP chicks at 90 days. The organ weights and growth kinetic ratios of thyroid, adrenal and ovary were significantly greater in HPR chicks compared to LP chicks at 90 days, whereas the weights of oviduct was significantly less. The weights of adrenal, ovary and oviduct of HPO chicks were significantly greater at 90 days. The absolute and relative weights of liver and lymphoid organs (thymus, bursa and spleen) showed a significant increment in HPO chicks as compared to LP control chicks, while the weights of spleen and bursa showed a significant increment in HPR chicks. The serum corticosterone levels showed progressive decrease from 30-90 days in all the three groups of chicks. The serum T_3 concentration decreased in LP control and increased in HPR and HPO chicks from 30-60 days with no significant difference recorded at 90 days. The T_4 concentration decreased in LP control chicks and increased in HPR and HPO chicks from 30-90 days. The changes in serum progesterone levels were non-significant, except for a significant decrement in HPR chicks at 60 days. The histometric data of the ovarian follicles reveals a slow progression of follicular development followed by augmented development in the third month in HPO chicks than the control chicks. The HPR chicks showed higher percentage of big and large follicles than HPO, but lower than the control. Overall, the present study tends to indicate differential effects of superimposed HPR or HPO over LP on the hypothalamo-hypophyseal axis on intraovarian functions.