Status of Step-up Photoperiod and Hypothyroidism on Egg Lay, Egg Composition and Hormonal and Metabolic Responses in RIR Pullets

(CONCISE SUMMARY)

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CONCISE SUMMARY

The production of eggs has been the factor of greatest economic importance in poultry rising as far as the chicken industry is concerned. For the most part, therefore, the problem of the poultry breeder has been how to develop efficient egg-laying strains, at the same time giving due consideration to the economic importance of meat production. During the last four decades poultry science has made an all round progress on varied aspects like genetic, nutrition, disease control, management technology and marketing. The field of physiology of reproduction has witnessed the emergence of newer concepts involving the role of non-classical hormones emanating from thyroid and adrenal in modulating reproductive functions in mammals and is gaining increasing validity, in the avian species, these glands have been reported to show seasonal variations in structure and activity in relation to breeding activities which have lead to tentative suggestions of parallel or inverse thyroid gonadal axis in some birds (Thapliyal, 1980; Thapliyal and Carg, 1969; Thapliyal, 1969; Jallageus and Assenmacher, 1974; Knowlton *et al.*, 1999) and parallel or inverse adrenal gonadal axis in other birds (Ramachandran and Patel, 1986; Riddle *et al.*, 1924; Petite and Etches, 1991). The role of thyroid hormones in

reproduction of poultry birds has also been documented (Singh and Prashad, 1978) and appropriately timed 6-propyl 2-thiouracil (PTU) treatment brings about precocious puberty and abnormal spermatogenesis resulting in increased testis size and sperm production in domestic fowl (Kirby et al., 1996), while dietary PTU treatment in commercial layers affected egg production and egg shell quality (Peeble et al., 1994). Further, Knowlton et al. (1999) have also reported early adult gonadal function and sexual maturity in turkey hens.

Similar is the fate of the status of pineal function in relation to reproduction and based on the disparate results obtained; progonadal or antigonadal has been ascribed to it in the past. A definite role of pineal in reproduction is however highlighted by the many studies, which have shown the influence of photoperiodism in regulating the annual gonadal cyclicity of temperate species of birds (Follett et al., 1974; Wingfield and Farner, 1980).). However, later works on number of bird species have rigorously demonstrated that a circadian photoperiodic clock is involved in the process of induction and termination of seasonal reproduction (Kumar, 1988, 1997; Kumar and Tiwari, 1989; Kumar and Kumar, 1991, 1995).

As in seasonally breeding birds, many workers have demonstrated the effect of various photic schedules on

reproduction of domestic birds (Follett and Sharp, 1969; Ellan and Soller, 1991; Morris, 1994; Etches, 1996). Short exposure to long days provides a large stimulatory response resulting in increased plasma LH and increased egg production in layers. Long exposure to long days sets in photorefractoriness and dissipates the stimulatory effect of long days. These responses are assumed to be the sum of inhibitory and stimulatory inputs to the GnRH secreting neurons depending upon previous exposure to light (Sharp, 1993). However, most of the studies involved screening for a favourable set of photoperiod, which could result in increased egg laying in domestic fowl. Such studies have been restricted to temperate species of laying hens (ISA Brown, Shaver 288, Bab cock 300 etc, Lewis et al., 1996a, 1996b, 1996c). But reports are scant on tropical species of domestic fowl, with particularly no report of the Indian RIR on its egg laying performance. It becomes evident from above review of literature that both photoperiod manipulations (representing an exogenous change) and manipulation of thyroidal status (representing an endogenous change) in birds have potential effects on attainment of sexual maturity but there is no or vary scant (Freg and Bryan, 1998) studies showing the effect of combination of both photoperiodic and hypothyroidism. However, such studies were performed in our laboratory on RIR Pullets, involving effect of hyper or hypocorticalism under the

influence of long or short photoperiod (Dandekar et al., 1999, 2000; Devkar et al., 1998, 1999, 2001; Ramachandran et al., 1999). The results of above studies were early initiation of egg laying, effects on egg composition and related favourable changes in histomorphology of ovary and serum hormone profile. These studies involving photo-endocrine manipulations are a novel approach in enhancing the reproductive potential of poultry birds.

The egg is the single most complete food known to man, versatile and nutritious The composition of the egg in the domestic fowl is of important economic interest, as many factors that can affect their size, composition and viability. A variety of factors or combinations of same are known to have a definitive effect on the egg size and composition. A chicken egg is made up of 11% shell, 31% yolk and 58% albumen. Egg on the whole is known to have 11.5% fat, 12.9% protein, 73% water and 0.9% carbohydrates. Taylor (1960) has reported that out of all those components of egg studied, yolk is resistant to drastic change in composition and hence is called as the conservative component of a Hen's egg. In recent year much attention has been focused on the fat, fatty acid and cholesterol contents of egg. As there is no report from anywhere depicting effect of photoperiod or endocrine manipulations on egg composition

attainment of sexual maturity but there is no or very scant (Freg and Bryan, 1998) studies showing the effect of combination of both photoperiod and hypothyroidism. However, such studies were performed in our laboratory on RIR pullets, involving effect of hyper or hypo corticalism under the influence of long or short photoperiodism (Dandekar *et al., 2000*; Devkar *et al.*, 1998, 1999). The results of above studies were early initiation of egg laying, effects on egg composition and related favourable changes in histomorphology of ovary and serum hormone profile. These studies involving photo-endocrine manipulations are a novel approach in enhancing the reproductive potential of birds.

Day-old pullets of domestic fowl (*Gallus gallus domesticus*) of Indian RIR (Rhode Island Red) breed were used for the study. Day-old pullets were housed in cages (5×10×8 ft) under deep litter system for 90 days. Thereafter, they were shifted to a 3 tyre laying cages. Both cages were placed in a dark room and photoschedule was controlled by fluorescent tube-light, regulated by automated timer and the light intensity was maintained at 250 lx and checked regularly by lux-meter.

Few RIR pullets were subjected to photoperiodic (Step-Up photoperiod), some are subjected to Hypothyroidism (HPOT) induced by mixing anti-thyroid substance Methimazole (MMI) (Sigma Chemical Co., USA) in the diet. And others are subjected

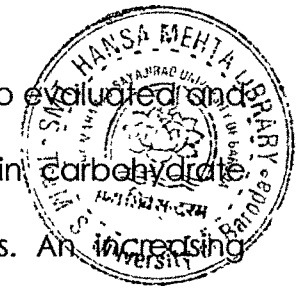
to both Step-Up photo schedule and Hypothyroidism (HPOT). Controls of respective treatments are maintained under normal light dark conditions (LD 12:12), to assess age at first egg, number of eggs laid in month after initiation of lay, the changes in the physical features and biochemical composition of eggs, the changes in organ growth, serum hormone profiles and histomorphometry of ovary. Further in the other set of study RIR pullets were subjected to short photoperiod (SP) 6:18, and Long photoperiod (LP) 18:6 and maintained till 90 days of age and were sacrificed at 30, 60 and 90 days of age respective controls were maintained under normal photoperiod (12:12). The changes carbohydrate metabolism of muscle and liver, lipid metabolism of liver and ascorbic acid level in liver and ovary were assessed.

Age at first egg was 116.48 day in Step-up photoperiod birds and 158 days in NLD birds, which showed significant early initiation of egg lay of SUP birds (42 days) than the NLD birds. The protein content of yolk and albumen of first day eggs were significantly lower in the SUP eggs. The HPOT + NLD, rendered groups II to IV showed significant early initiation of lay, by 13, 17, 23 and 42 days respectively. Further the whole egg calorific value of 1st day as well as 30th day eggs of all HPOT rendered experimental groups was significantly lower than the corresponding control egg. All the hypothyroid groups i.e. 30-60 days, 45-75 days and 60-90

days groups, showed a significant increase in the ovarian weight both on an absolute and relative weight basis Except for the 15-45 day group. The progesterone level was found to be significantly higher in hypothyroid groups of hens with a maximally increase being seen in 15 to 45 days hypothyroid hen. The experimental groups of hens rendered hyperthyroidic prior to Step-Up photoperiod (8:16-16:8-12:12) laid the first egg at 144, 126,123 and 111 days respectively. This has resulted in a delay 28, 10, and 7 days respectively for hypothyroidic groups 1-3 and an enhancement by 5 days in group IV hypothyroid hens. The same groups of chicks also showed a steady increase though with a significantly reduced weights during and in the post-hypothyroid periods on a comparative basis moreover the total follicular count and the number of follicles are significantly higher in the experimental groups, more pronounced in the 45-75 and 60-90 days hypothyroid groups. The blood glucose level in 30 day old pullets was found to be significantly higher under long photoperiod (LP: 18:6) and significantly lower under short photoperiod (SP: 6:18) compared to normal photoperiod (NP: 12:12). Hepatic phosphorylase activity was noted from 30-90 days in all the groups of birds with a significantly lower level in SP and LP compared to NP. Further, both LP and SP pullets also show increased total cholesterol and cholesterol ester fractions with significantly decreased free cholesterol levels. The hepatic

protein content of SP birds is significantly lower than that of NP birds at all ages, Hepatic, renal and adrenal AA content showed significant increment at 90days with a decrement at 60 days in NP pullets, significantly decreased level of AA was observed at 60 days in adrenals and significantly decreased ovarian AA content at 60 and 90 days in SP pullets.

Overall the present study suggests that the RIR pullets are definitely photosensitive and can be manipulated for reproductive efficiency and egg laying performance. Step-Up photoperiod has a significant effect on the age at first egg, egg weight and calorific value. Further the present study has also indicated the favourable influence of appropriately timed hypothyroidism on age at first egg, egg production and biochemical composition and nutritive value of eggs. It is also evident that the HPOT has a dominating influence over short photoperiod, and a combination of HPOT+ SuP could effect the biochemical composition of eggs and lead to the yield of low calorie eggs. Results also suggest a favorable influence of hypothyroidism on activation of hypothalamo-hypophyseal axis as well as ovarian development with consequent early attainment of sexual maturity and initiation of egg lay possibly due to interaction between gonadotropin hormones and physiological hypersecretion of thyroid hormones subsequent to withdrawal of Methimazole from the diet. The effect of rearing



photoperiod on carbohydrate metabolism is also evaluated and has provided some evidence for alterations in carbohydrate metabolism due to different lighting regimens. An increasing insulin action during the first three months of chick development with consequent glycogenic effect and the interactions of melatonin and corticosterone as additive or antagonistic resistant as insulin mediated homeostatic changes. However it is also evident from the present observations that there is a lipogenic and cholesterogenic effects in NP birds during the post hatch development essential due to an increasing insulin action. A long photoperiod potentiates the insulin action by higher corticosterone levels. And in the case of short photoperiod there is a melatonin induced reduced body lipid load and hypocholesterolemia marked by increased tissue deposition.