CHAPTER- 7

Rearing photoperiod and alterations in lipid parameters in RIR pullets

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Body fat, the most variable among the organic constituents,l serves as an energy reserve of utmost importance. Amongst the vertebrates, birds have reportedly greater ability to store lipids as energy source (Blem, 1976). The stored lipid can serve as a source of energy under different conditions like sustained stress, migration (Griminger and Gamarsh, 1972; Bartov *et al.*, 1980 a,b), incubation of eggs for long periods (Oring, 1982) and even molting (Williams *et al.*, 1977). The total amount of fat in the body of birds, which can be influenced by nutritional factors and neuro endocrine factors, varies greatly with species, sex and age of the birds. In general, apart from insulin, prolactin and corticosterone are the hormones of prime importance in the fattening process of birds (Meier, 1977).

The endocrine system plays a profound role in the dynamic adaptive metabolic homeostasis of the vertebrate body. The crucial role that the endocrine system might play in modulating the metabolic adjustments needed during ontogenetic developmental process, more specifically the neonatal period in mammals or the ex ovo phase in birds, could be very dynamic and interesting . This is very pertinent in birds as the ex ovo phase of development essentially links the endocrine independent embryonic phase with the more hormone dependent adult phase. It is inferable that during this period of transition, the organism might express differential sensitivity to various hormonal principles providing a developmental basis for effective adaptations at later stages of life cycle. Manipulation of the hormonal *milieu* during the post hatched phase of development could therefore result in metabolic alterations establishing a new homeostasis. A lipogenic influence of adrenocorticotrophin and corticosterone in adult fowls and young chicks of three weeks of age or more has been reported (Baum and Meyer, 1960; Nagra and Meyer, 1963; Bartov *et al.*, 1980 a,b; Bartov, 1982; Davison *et al.*, 1983; Buyse *et al.*, 1987). Steroids such as corticosterone and thyroid and pancreatic hormones are powerful regulators of body function and, they offer a mechanism by which sensory inputs are translated into biochemical processes throughout the body. Apparently, body resources can be relocated in response to internal and external changes.

The present study has been undertaken to see the effect of different rearing photoperiods, agents of external changes, which can induce internal changes involving hormones, on the total hepatic lipid, cholesterol, cholesterol ester and free cholesterol contents.

Results:

Hepatic total lipid:

There is a gradual increase in the hepatic total lipid content from 30-90 days in both NP and LP groups of pullets with a slightly higher level being in the 2^{nd} month. However in SP pullets, there was only a marginal increase with almost similar level through out. (Table: 7.1; Fig: 7.1)

Hepatic cholesterol fractions:

All cholesterol fractions *i.e.* total cholesterol, free cholesterol and cholesterol ester, show an increase under NP. Both LP and SP pullets also show increased total cholesterol and cholesterol ester fractions, with significantly decreased free cholesterol levels. Like in the case of total lipid, the hepatic cholesterol fraction also shows a relatively higher level in the 2^{nd} month. (Table: 7.1; Fig: 7.2 to 7.4)

Table 7.1: Hepatic total lipid and cholesterol fractions in RIR Pullets

Treatment	Total lipid			Total cholesterol			Free cholesterol			Esterified cholesterol		
	Age in Days			Age in Days			Age in Days			Age in Days		
	30	60	90	30	60	90	30	60	90	30	60	90
(NP) LD (12:12)	2.933 ±0.482	5.241 ±0.819	4.628 ±0.982	0.319 ±0.096	0.861 ±0.023	0.681 ±0.020	0.079 ±0.018	0.288 ±0.021	0.283 ±0.009	0.240 ±0.063	0.578 ±0.002	0.397 ±0.011
(SP) LD (6:18)	3.185 ±0.222	3.786 ±0.141	3.466 ±0.076	0.644[b] ±0.045	0.682[c] ±0.021	0.791[a] ±0.035	0.085 ±0.011	0.152[c] ±0.006	0.042[c] ±0.005	0.558[b] ±0.035	0.530[a] ±0.015	0.749[c] ±0.029
(LP) LD (18:6)	3.210 ±0.217	4.655 ±0.324	4.413 ±0.238	0.583[a] ±0.035	0.919 ±0.025	0.731 ±0.019	0.061 ±0.0001	0.215 ±0.034	0.065[c] ±0 011	0.522[b] ±0.035	0.703[c] ±0.005	0.660[c] ±0.007

NP: Normal photoperiod; SP: Short photoperiod; LP: Long photoperiod

Values expressed as Mean ± S.E, n=6; a: $p \leq 0.05$, b: $p \leq 0.02$, c: $p \leq 0.001$

Fig. 7.1: Hepatic total lipid content in RIR pullets at different photoperiods

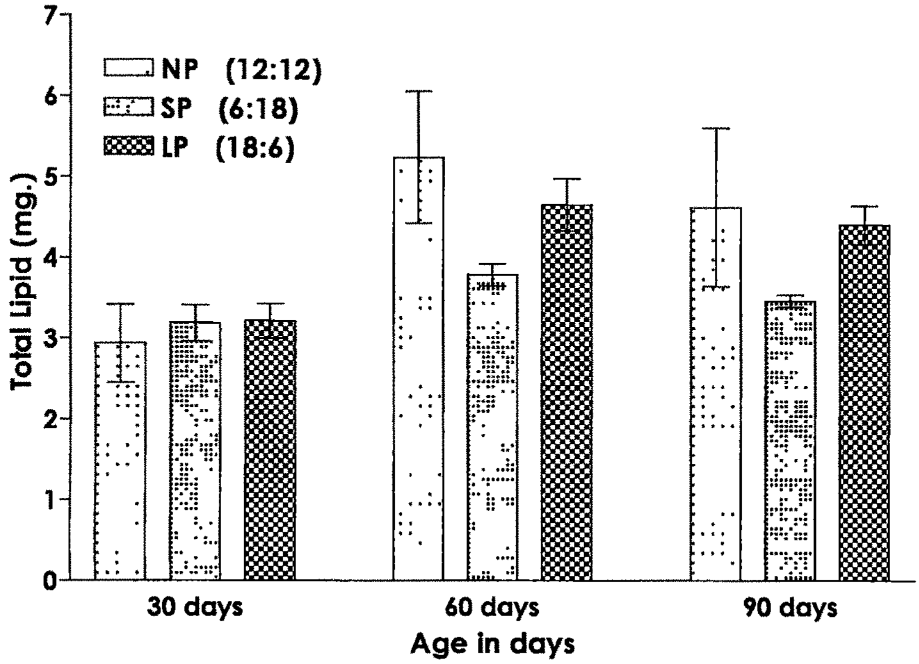
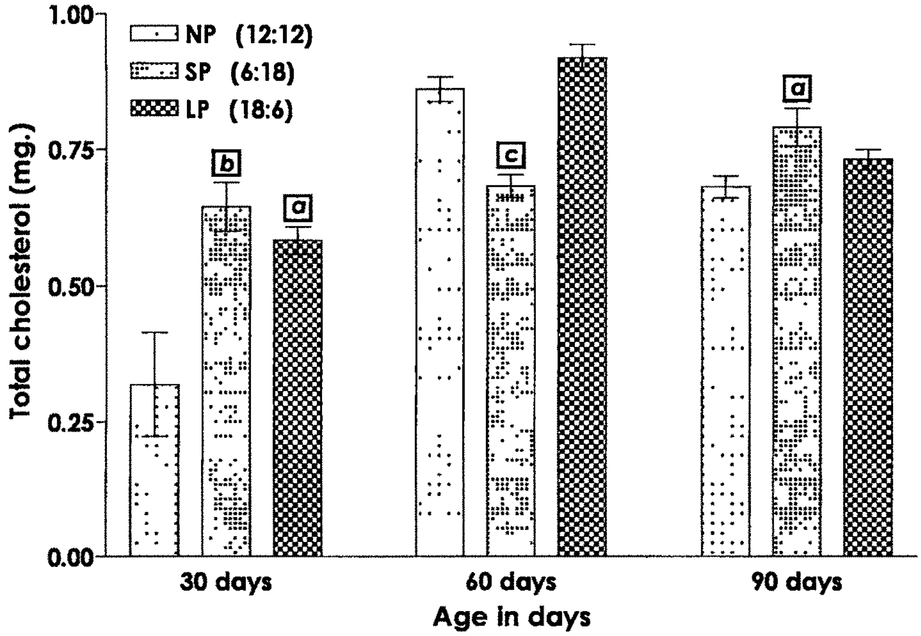


Fig. 7.2: Hepatic total cholesterol content in RIR pullets at different photoperiods



Control: Normal photoperiod, SP: Short photoperiod, LP: Long photoperiod
a: $p \leq 0.05$, b: $p \leq 0.02$, c: $p \leq 0.001$ of 3 animals

Fig. 7.3: Hepatic free cholesterol content inRIR pullets at different photoperiods

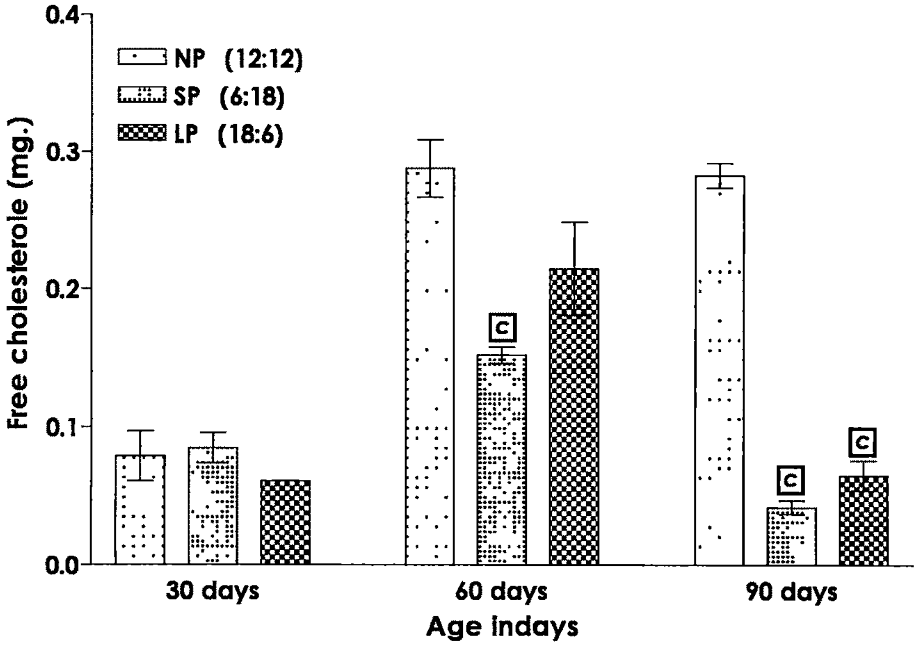
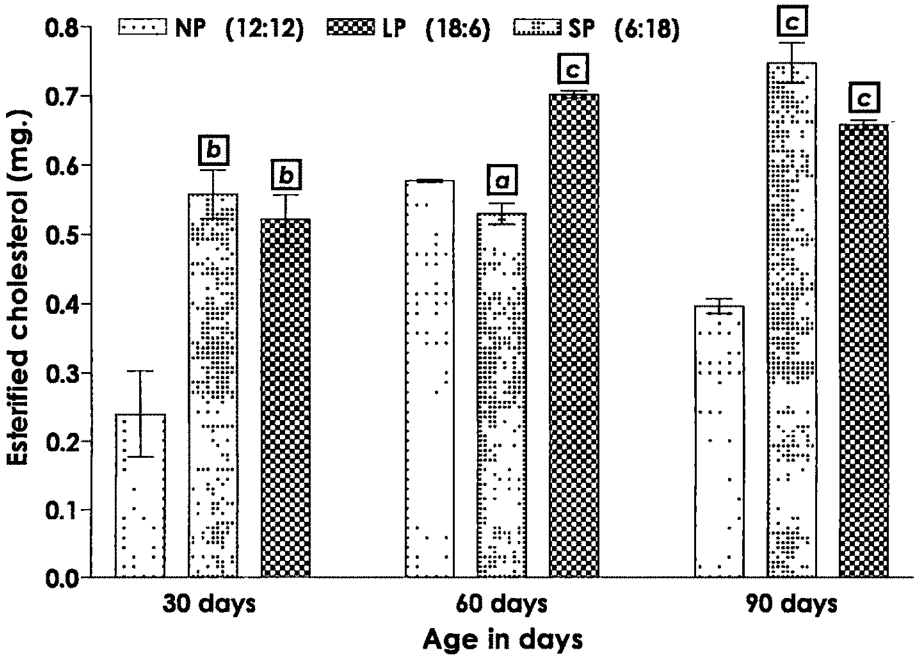


Fig. 7.4: Hepatic esterified cholesterol inRIR pullets at different photoperiod



Control: Normal photoperiod, SP: Short photoperiod, LP: Long photoperiod
a: $p \leq 0.05$, b: $p \leq 0.02$, c: $p \leq 0.001$ of 3 animals

Discussion:

The present study evaluating the effect of 3 different rearing photoperiods on the hepatic lipid profile has revealed a gradually increasing lipid and cholesterol contents from 30-90 days under all the 3 photoperiods. A very interesting feature is the maximal level at 60 days, followed by a decrease by 90 days which would suggest a lipogenic state between 1st and 2nd month and a lipolytic phase between 2nd and 3rd month. The period between 2nd and 3rd month seems to be a very crucial one as photoperiodic manipulations as well as inductions of hypothyroidism at this phase, has been shown to be more favorable in terms of attainment of maturity, age at first egg and egg yield (Chapter-3). Though the increasing hepatic load of lipid and cholesterol can be related with the increasing insulinogenic action during the trimester of post-hatch development, as has been inferred previously with respect to carbohydrate metabolism (Chapter-7), the relatively lesser increase in the lipid content in LP and SP pullets needs further explanations. It is likely that the lesser hepatic lipid contents seen in LP pullets relative to NP pullets could be related with the increased T_3, and T_4 levels seen in these birds between 2nd and 3rd month (Dandekar *et al.,* 2000). Still lesser hepatic lipid contents seen in SP pullets could be related with a higher melatonin level which has a hypolipedemic effect (Patel and

Ramachandran, 2000). Moreover, the circulating corticosterone titres are also lower in SP pullets (Dandekar *et al.*, 2001).

In contrast, the higher total hepatic cholesterol and cholesterol ester contents noted in the LP pullets relative to NP pullets could be considered as due to altered adrenocorticoid secretion. Liver is known to be the principal site of cholesterol synthesis and lipogenesis in birds. The levels of lipid and cholesterol in the serum are usually a reflection of their synthesis in liver and intestine and also the dietary load. The significantly lower hepatic free cholesterol contents in both SP and LP pullets with concomitantly increased total and esterified cholesterol, with the esterified fraction being quite closer to total cholesterol level, reflect the exigency of increased cholesterol biogenesis and storage. Whereas the increased hepatic cholesterol content in SP pullets is co-relatable with the hypocholesterolemic effect of melatonin, which is well envisaged in recent times, similar changes in the cholesterol seen in LP pullets is correlated with corticosterone induced (as a stress response in the 1st month) later decrease in thyroid hormones (2nd and 3rd months) and the concomitant potential insulin effect. In this context the corroborating evidences are; higher corticosterone level and lower T_3 and T_4 levels recorded in the 1st and 2nd months in LP pullets (Dandekar *et al.*, 2000), the known role of insulin as an activator of HMG' CoA- reductase activity in the liver and intestine (Mayer, 1988) and the ability of corticosterone to depress T_3 levels in chicks and the domestic fowl (Decuypere *et al.*, 1983; Buyse *et al.*, 1987b). It can be concluded from the present observations that there is a lipogenic and cholesterogenic effects in NP birds during the post hatch development, essentially 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.

Summary:

The present study has been undertaken to see the effect of different rearing photoperiods, agents of external changes, which can induce internal changes involving hormones, on the total hepatic lipid, cholesterol, cholesterol ester and free cholesterol contents. For the long photoperiod, day old pullets were reared under LD 18:6 photic schedules till 90 days of age and, for short photoperiod, day old pullets were reared under LD 6:18 photic schedules till 90 days of age under the short photoperiod. Birds were sacrificed after each treatment termination with their respective control animals, and the total hepatic lipid, cholesterol, cholesterol ester and free cholesterol contents were measured. The results are as follows; both LP and SP pullets show increased total cholesterol and cholesterol ester fractions with significantly decreased free cholesterol levels. It can be concluded from the present observations that there is a lipogenic and cholesterogenic effects in NP birds during the post hatch development essentially due to an increasing insulin action. The increased content of lipid fraction in LP and SP birds are related with altered thyroid and adreno-cortical hormones and melatonin.