CHAPTER 7

Influence of hyper. or hypocorticalism in RIR pullets reared under a long photoperiod (LD 18 :6) on the composition of eggs.

Introduction

The egg of birds is a large macroscopic cell, laden with a rich store of nutrients in the form of yolk and albumen, and encased within a calcarious shell to withstand desiccation and, is a product of the ovary with inputs from the liver and the oviduct. The repertoire of nutrients and the shelled boundary are; for permitting critical embryonic development in a protected environment. The mode of formation and chemical composition are more or less similar in all birds. Nevertheless, some differences in terms of relative constituents are reported between the eggs of altricial and precocial birds (Ricklefs, 1977; Roca *etal.,* 1984). More attention has been paid to the study of eggs of domestic and game birds, especially the fowl, mainly due to the biased human interest in economic and nutritional terms Though the genetic composition, primarily controls the metabolic activity

of liver, ovary and oviduct and, the physical and biochemical characters of the egg, as in case of different breed, many external factors and, even hormones of endogenous origin, are capable of affecting the relative structure and composition of eggs, by modulating the interactive expressions of genes. In this respect, the influences of age and genetic make up as internal factors and those of season and diet as external factors, on chemical composition of egg have been studied to some extent (Cruikshank, 1941; Gutteridge and O'Neil, 1942; Everson and Sounders, 1957; Patton and Palmer, 1958; Cunningham *et al.,* 1960; Edwards, 1964; Chung and Stadelman, 1965; Marion *et al.,* 1965; Sibbald, 1979; Washburn, 1979; Sainz *et al.*, 1983; Winton, 1993; Panda, 1995; Etches, 1996). Photoperiod is a powerful environmental agent capable of influencing the physiology of organisms and, as such, the usage of diverse artificial photoperiodic schedules for rearing and productivity has become a common poultry practice (Sykes, 1956, Hutchinson and Taylor, 1957; Morris *et al.*, 1964; Morris, 1968; Payne, 1975; Andrews *et al.,* 1990; Lewis *et al.,* 1992; Tucker and Charles, 1993; Lewis *et al.,* 1996a,b). Though the influence of photoperiod on egg productivity has been studied, its influence on egg composition has bot been evaluated despite the fact that photoperiod can influence physiology and metabolism of organisms by inducing neuroendocrine alterations. In this respect, some recent studies from this laboratory have revealed the effect of short photoperiod (SP) during the rearing stages, not only on attainment of sexual maturity and overall laying performance but also on the composition of eggs (Dandekar, 1998). Also, hypercorticalism (HPR) or (HPO) during the rearing stage has also been shown to have some influence on features of egg laying and, even have consequential effects on the composition of eggs (see chapters 3 and 6). Further, HPR or HPO alone, or in combination with short photoperiod, were also shown to have significant effects on laying performance as well as egg composition (Dandekar, 1998). The present study intends to study the effect of HPR or HPO along with a long

photoperiod (LP), in Indian RIR breed during the rearing stage, on the physical features and chemical composition of eggs as, LP alone was reported to have some marked effects on attainment of sexual maturity and overall laying performance (see chapter 2).

RESULTS

Overall changes in physical features :

Except for some marginal alterations such as, an increase in the egg width in HPR eggs and reduced egg height, egg volume and shell thickness in HPO eggs, no other physical measurement showed any change. There was a slightly reduced albumen weight in HPO eggs with no difference in percentage water and solid contents (Table 1).

Overall changes in biochemical parameters :

There was no significant alteration in the biochemical parameters of HPR eggs, except for a slightly reduced albumen protein and increased yolk glucid content and albumen cholesterol content. However, the HPO eggs showed increased albumen, protein, lipid and cholesterol contents together with decreased yolk protein content (Table 2)(fig. 1).

Changes during phases of lay :

Physical features : The egg weight was significantly higher in the mid phase in HPR hens, while, reduction in egg weight from mid to late phase was significantly greater in HPO eggs. The egg width was significantly higher in HPR eggs in all phases. The egg volume was significantly higher under both HPR and HPO the in initial phase. The egg volume was significantly higher in HPR eggs even in the mid phase. While, the egg volume remained constant in control eggs in the mid and late phases, it showed a significant decrease by late phase in both HPR

and HPO eggs. Maximal shell weight, (about 67% greater) was registered by the HPR eggs in the mid phase. There was a tendency for increased shell thickness in the HPR eggs with, maximum thickness recorded in the mid phase (Table 3).

Biochemical composition : The percentage solid content of albumen was significantly less in HPR eggs in the initial phase with compensatory increased contents in the mid and late phases while, the HPO eggs showed a reverse pattern. Yolk protein content was significantly lower in the HPR eggs during the late phase and, in the HPO eggs, during the initial and late phases. The albumen protein content of HPR eggs was significantly lower in the initial and mid phases, while in the HPO eggs, it was significantly greater in the mid phase. The yolk glucid contents of HPR eggs was significantly greater in the mid and late phases. The yolk glucid content of HPO eggs was significantly greater in initial and late phases. The albumen glucid content of HPR eggs was significantly lower in the mid phase and higher in the late phase. The yolk lipid content of both HPR and HPO eggs was significantly lower in the initial phase and, higher in the late phase. The albumen lipid content of HPR eggs was high in the initial phase and significantly lower in the mid phase, while that of HPO eggs was higher in both initial and mid phases, more pronouncedly in the mid phase. The yolk cholesterol content was significantly greater in HPR eggs in the initial phase. While the albumen cholesterol content of HPR eggs was significantly higher at all phases, that of HPO eggs showed a pronounced increment in the mid phase. The yolk cholesterol content tended to be high in the HPO eggs with a significantly higher content in the initial phase (Table 4)(fig. 2a,b).

Discussion :

The influence of short or long photoperiod and, transient hyper. or

Table 1. Overall physical features of eggs of HPR and HPO birds under LP.

	Egg weight (gms)	Height (cm)	Width (cm)	Volume (cc)	Shell weight (gms)	Shell thickness (mm)	Yolk weight (gms)	Albumen weight (gms)
LP	51.98 ± .760	5.37 ± .099	3.92 ± .046	45.82 ± .535	5.88 ± .178	0.290 ± .011	16.20 ± .347	29.90 ± .599
HPR	53.22 ± .949	5.32 ± .066	4.20** ± .061	46.36 ± .578	6.90 ± .632	0.320 ± .017	16.30 ± .358	30.02 ± .219
HPO	51.10 ± .918	5.05* ± .107	3.95 ± .067	44.77 ± .530	6.49 ± .508	0.306 ± .006	15.99 ± .510	28.84 ± .511

Values : Mean ± se * P<.05, ** P<.005, *** P<.0005

Table 2. Physical features of eggs of HPR and HPO birds under LP, during initial, peak and late phases of lay

	Initial Phase			Peak Phase		
	Control	HPR	HPO	Control	HPR	HPO
Egg Weight (gms)	48.25 ± .69	49.7 ± 1 16	48.07 ± 0.53	54.19 ± .52	57.66* ± 1.23	55.5 ± .694
Height (cm)	4.90 ± .07	5.06 ± .143	4.53 * ±.125	5.50 ± .07	5.60 ± .120	5.31 ± .173
Width (cm)	3.70 ± .01	3.90* ± .09	3.66 ± .102	4.03 ± .06	4.40*** ± .041	3.95 ± .028
Egg Volume (cc)	43.25 ± .51	45.33* ± .94	46.31*** ± .46	46.66 ± .84	49.17** ± 1.07	45.66 ± .849
Shell weight (gms)	6.57 ± .53 (13.61%)	5.01 ± .881 (10.08%)	6.31 ± .583 (13.12%)	6.01 ± .54 (11.09%)	10.03** ± 1.10 (17.39%)	5.75 ± 1.17 (10.36%)
Shell thickness (mm)	.276 ± .007	0.281 ± .028	0.256 ± .035	0.347 ± .008	0.413*** ± .0007	0.371 ± .041
Yolk weight (gms)	14.73 ± .33 (30.52%)	15.33 ± .616 (30.52%)	15.81 ± .235 (32.88%)	17.66 ± .23 (32.58%)	18.07 ± .816 (31.33%)	18.25* ± .144 (32.88%)
Albumen weight (gms)	27.25 ± .90 (56.37%)	29.33 ± 1.31 (59.01%)	26.71 ± .436 (55.56%)	30.33 ± .23 (55.96%)	29.66 ± 1.54 (51.43%)	31.05* ± .288 (55.94%)
Yolk : albumen	0.54	0.52	0.59	0.58	0.60	0.58

Values : Mean ± se * P<.05, ** P<.005, *** P<.0005

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	Late Phase		
	Control	HPR	HPO
Egg Weight (gms)	53.51 ± .86	52.61 ± 1.02	49.75** ± .796
Height (cm)	5.71 ± .057	5.46 ± .186	5.33 ± .289
Width (cm)	4.05 ± .04	4.31 ± .139	4.23 ± .399
Egg Volume (cc)	47.5 ± 1.15	44.6* ± 1.10	42.13** ± 1.26
Shell weight (gms)	5.07 ± .52 (9.47%)	5.87 ± .542 (11.15%)	7.42** ± .498 (14.91%)
Shell thickness (mm)	0.249 ± .031	0.281 ± .009	0.293 ± .005
Yolk weight (gms)	16.50 ± .28 (30.80%)	15.55 ± .502 (29.55%)	13.93** ± .77 (27.97%)
Albumen weight (gms)	32.3 ± 1.02 (60.36%)	31.08 ± .992 (59.07%)	28.76* ± 1.31 (57.80%)
Yolk : albumen	0.51	0.50	0.48

Values : Mean ± se * P<.05, ** P<.005, *** P<.0005

Table 3. Overall composition of eggs of HPR and HPO birds under LP.

	% Water content		% Solids		Total Protein		Carbohydrates		Total Lipids		Total Cholesterol	
	yolk	ablumen	yolk	albumen	yolk	albumen	yolk	albumen	yolk	albumen	yolk	albumen
C	46.46 ± .345	86.79 ± .721	53.52 ± .519	13.17 ± .495	19.18 ± .531	16.78 ± 1.93	0.048 ± .004	.0303 ±.003	24.23 ± .607	0.179 ± .023	2.150 ± .124	0.019 ±.009
HPR	47.59 ± .612	86.45 ± .776	52.74 ± .624	13.50 ± .339	18.62 ± .833	14.89 ± .497	0.055* ± .004	.0293 ±.002	24.34 ± 2.22	0.177 ± .014	2.264 ± .214	0.038* ±.005
HPO	47.74 ± 1.42	86.91 ± 1.01	53.65 ± .490	13.20 ±.209	16.8** ±.341	18.92 ± 1.47	0.046 ± .003	.0313 ±.004	23.83 ± 1.73	0.251* ± .028	2.400 ± .213	0.038 ±.011

Values : Mean ± se * P<.05, ** P<.005, *** P<.0005

Table 4. Composition of eggs of HPR and HPO birds under LP, during initial, peak and late phases of lay.

	Initial Phase						Peak Phase					
	Control		HPR		HPO		Control		HPR		HPO	
	yolk	albumen	yolk	albumen	yolk	albumen	yolk	albumen	yolk	albumen	yolk	albumen
% water content	46.71 ± 1.63	85.23 ± .31	48.88 ± 1.03	88.12*** ± .13	49.02 ± 1.10	86.78*** ± .22	44.91 ± .97	86.04 ± .22	44.78 ± .96	85.52 ± .16	41.28 ± 1.60	86.15 ± .014
% Solids	53.29 ± 1.63	14.77 ± .31	51.12 ± 1.03	11.88*** ± .12	50.98 ± 1.10	13.22** ± .22	55.09 ± .97	13.96 ± .22	55.22 ± .96	14.48 ± .16	58.72 ± 1.66	13.85 ± .014
Total Protein	16.58 ± .88	15.91 ± .77	17.17 ± .82	13.90* ± 57	13.62* ± .70	16.68 ± .49	20.46 ± 1.31	20.06 ± .55	22.72 ± 1.01	17.35** ± .571	19.60 ± 1.42	26.08 ± 1.09
Carbo -hydrate	0.044 ± .018	0.032 ± .005	0.040 ± .005	0.037 ± .003	0.031 ± .012	0.039 ± .007	0.047 ± .010	0.023 ± .002	0.069 ± .014	0.019 ± .003	0.048 ± .016	0.014 ± .0006
Total Lipids	22.58 ± .72	0.175 ± .033	19.94 ± 1.14	0.237 ± .096	19.8*** ± .55	0.206 ± .026	23.52 ± .61	0.258 ± .051	23.72 ± 1.65	0.193 ± .049	22.94 ± .38	0.452 ± .026
Total Cholesterol	1.76 ± .18	0.016 ± .004	1.89 ± .172	0.020 ± .007	2.07 ± .126	0.017 ± .003	2.55 ± .468	0.022 ± .003	2.64 ± .276	0.064*** ± .006	2.14 ± .134	0.069 ± .007

Values : Mean ± se * P<.05, ** P<.005, *** P<.0005

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	Late Phase					
	Control		HPR		HPO	
	yolk	albumen	yolk	albumen	yolk	albumen
% water content	47.82 ± 2.04	89.1 ± .01	48.10 ± 1.46	88.10 ± .001	48.73 ± 2.13	87.81* ± .03
% Solids	52.18 ± 2.02	10.97 ± .29	51.90 ± 1.46	11.90 ± .01	51.27 ± 2.13	12.19* ± .03
Total Protein	20.51 ± .55	14.38 ± .37	16.38*** ± .57	13.43 ± 1.10	17.23** ± .58	14.02 ± .73
Carbohydrate	0.053 ± .003	0.036 ± .001	0.058 ± .001	0.031** ± .001	0.059* ± .001	0.040* ± .001
Total Lipids	29.61 ± .92	0.098 ± .008	29.36 ± .80	0.101 ± .012	30.12 ± .96	0.095 ± .006
Total Cholesterol	2.35 ± .188	0.021 ± .001	2.92 ± .091	0.030 ± .004	2.907 ± .075	0.029 ± .003

Values : Mean ± se * P<.05, ** P<.005, *** P<.0005

Table 5. Composition of eggs of HPR or HPO birds under LP, during initial, peak and late phases of lay (values expressed in terms of gms in yolk/albumen in whole egg).

	Initial Phase						Peak Phase					
	Control		HPR		HPO		Control		HPR		HPO	
	yolk	alb.	yolk	alb.	yolk	alb.	yolk	alb.	yolk	alb.	yolk	alb.
Total Protein	2.44	4.33	2.63	4.02	2.15	4.55	3.61	6.08	4.10	3.13	3.57	8.09
Carbohydrate	0.016	0.008	0.016	0.010	0.020	0.010	0.008	0.007	0.0125	0.0035	0.008	0.004
Total lipids	3.32	0.047	3.46	0.069	2.98	0.055	4.15	0.078	4.28	0.034	4.18	0.202
Total Cholesterol	0.259	0.004	0.270	0.005	0.327	0.004	0.450	0.006	0.478	0.011	0.536	0.214

	Late Phase					
	Control		HPR		HPO	
	yolk	alb.	yolk	alb.	yolk	alb.
Total Protein	3.38	4.64	2.54	4.17	2.40	4.03
Carbohydrate	0.008	0.116	0.009	0.009	0.008	0 011
Total Lipids	4.39	0.031	4.56	0.031	4.19	0.027
Total cholesterol	0.387	0.006	0.454	0.009	0.404	0.008

Values : Mean

Table 6. Overall metabolite content in eggs of HPR or HPO birds under LP, during initial, peak and late phases of lay.

	Yolk			albumen			Whole egg		
	Control	HPR	HPO	Control	HPR	HPO	Control	HPR	HPO
Water content	7.50	7.70	7.60	25.95	25.91	25.03	33.47	33.61	32.63
Total Lipids	3.92	3.96	3.83	0.053	0.053	0.072	3.97	4.01	3.90
Total non-lipid dry	4.82	5.13	4.56	3.90	4.07	3.73	8.72	9.20	8.46
Water Index	1.55	1.50	1.66	6.65	6.36	6.71	3.83	3.65	3.85
Lipid Index	0.813	0.771	0.839	0.013	0.013	0.019	0.455	0.436	0.461
Calorific value (edible egg)	---	---	---	---	---	---	68.98	66.41	67.70
Calorific value (per 100gm egg)	---	---	---	---	---	---	149.60	143.30	151.01

Values : Mean

Fig. 1. Overall contents of protein, carbohydrates, lipids and cholesterol of HPR and HPO eggs under LP.

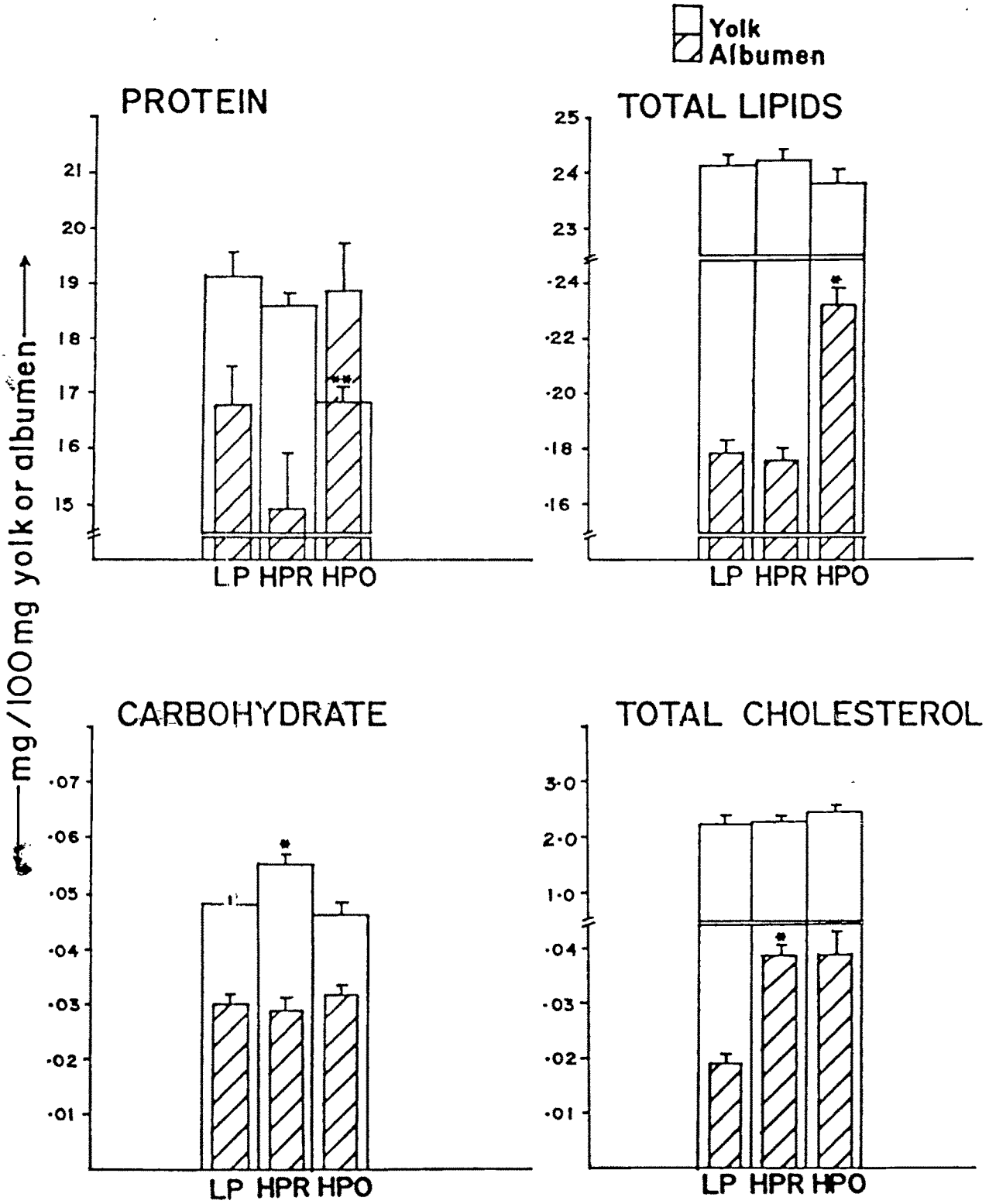


Fig. 2a. Contents of total protein and carbohydrates of HPR and HPO eggs under LP.

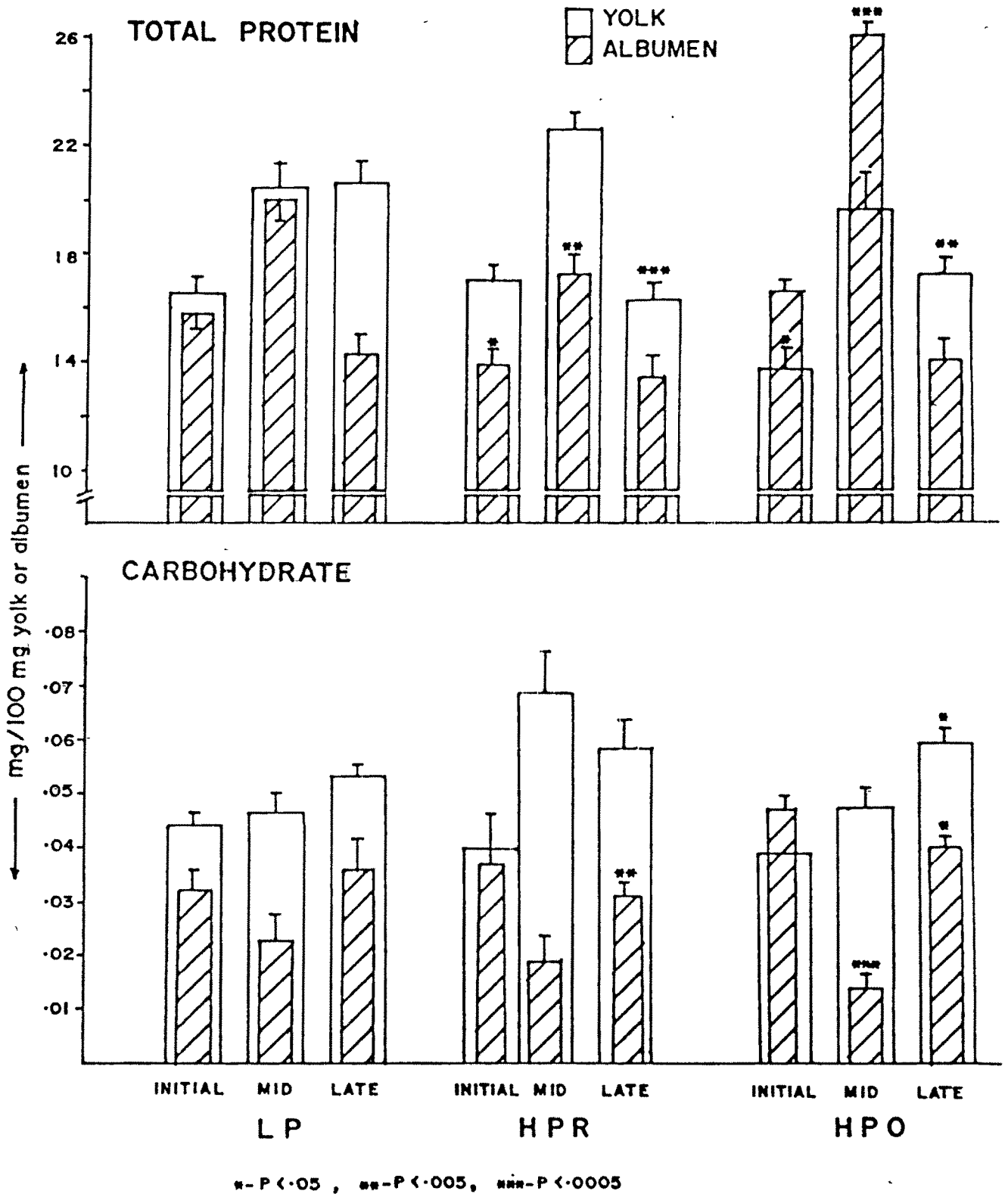


Fig. 2b. Contents of total lipids and cholesterol of HPR and HPO eggs under LP.

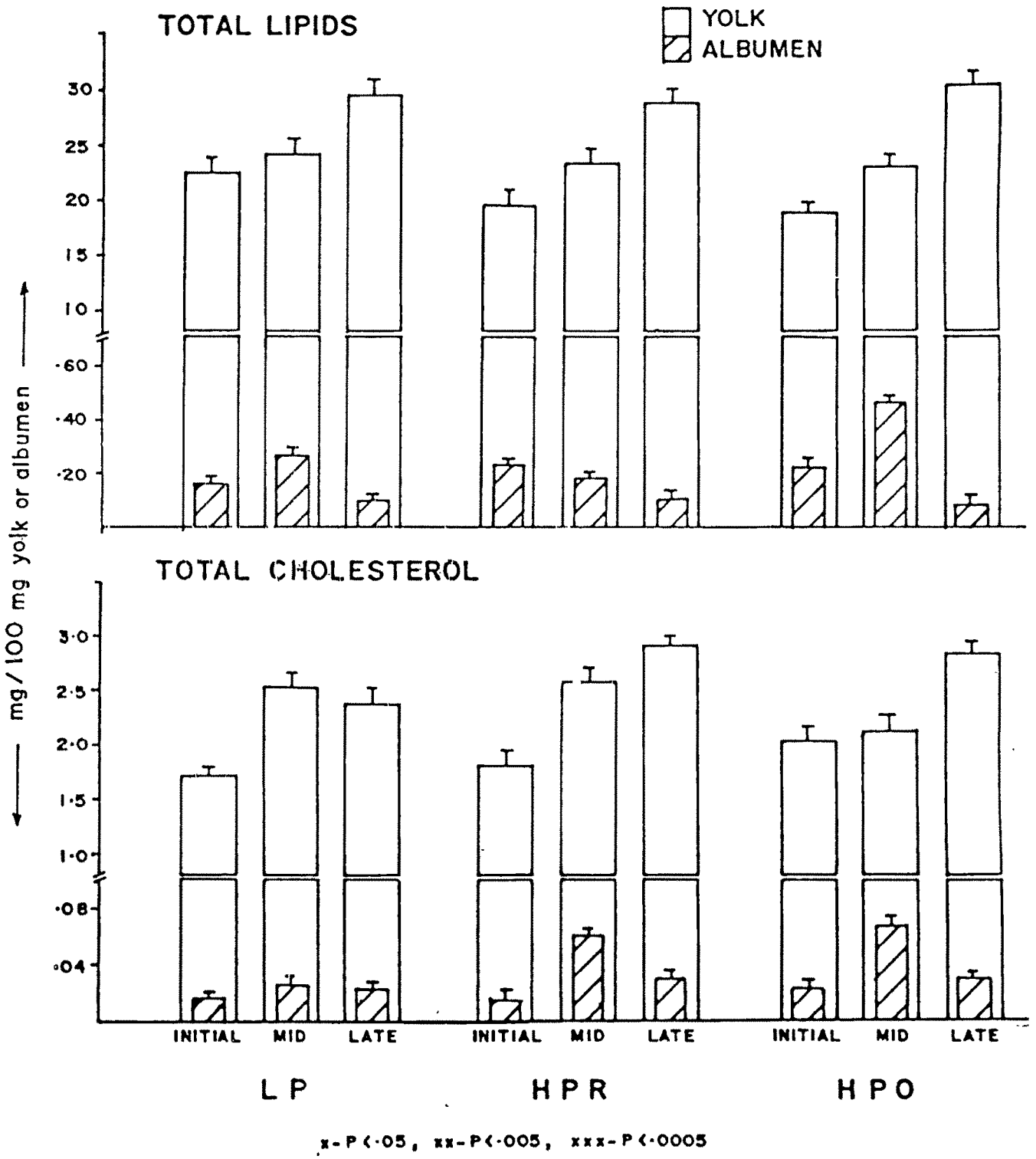
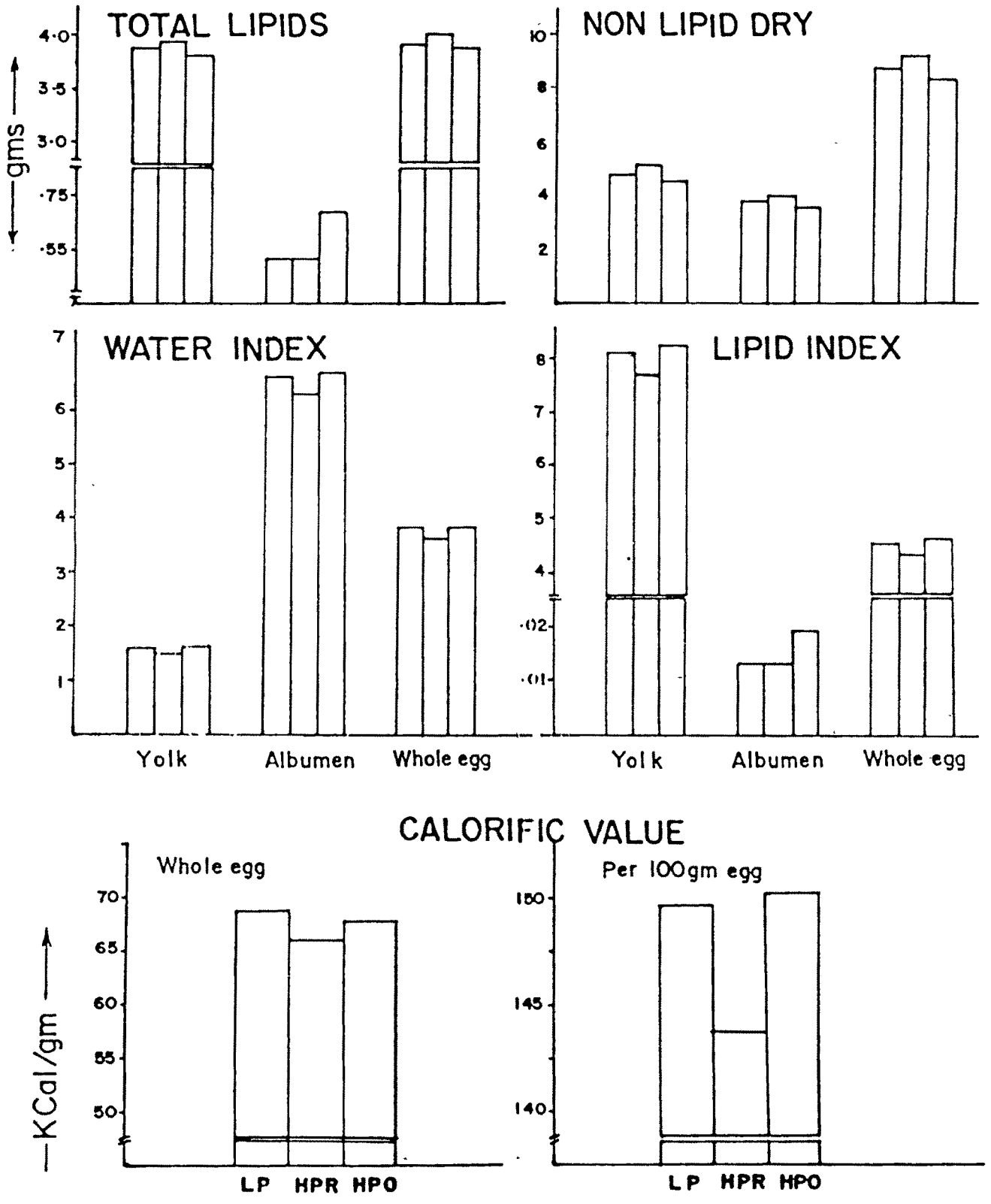


Fig. 3. Contents of lipid, non-lipid dry matter, water & lipid indices and calorific value of HPR and HPO eggs under LP.



hypocorticalism alone or in combination with short photoperiod, in the pullet stage of Indian RIR breed, on egg composition was reported (Dandekar, 1998; chapters 5,6) apart from the effects on laying performance (Dandekar, 1998; chapters 2,3,4). The present study in this line, is a further attempt, to evaluate the effect of HPR or HPO in relation to long photoperiod. The differential effects manifested in HPR and HPO conditions are being discussed separately for clarity and convenience.

Changes in eggs under HPR :

The overall mean values of none of the physical measurements showed any significant difference in HPR eggs, except for an increased egg width and a tendency for increase in egg weight and volume, shell weight and shell thickness. However, it is evident that, HPR has a tendancy to increase egg weight which, taken with a similar effect of LP compared to NLD, signifies a cumulative effect of LP and HPR on egg weight (see chapter 4). The shell thickness which was reduced due to LP, was nullified by HPR, indicating resistant action of HPR on LP induced reduction in shell thickness. The increase in egg width was prominently seen in the mid and late phases. Though, the overall mean egg weight was not statistically significant, in terms of phases of lay, it was significantly higher in the mid phase. Considering that, the egg weight of HPR eggs was not less than that of the controls in the initial and late phases, apparently, 33% of the eggs laid by HPR hens are significantly heavier. This aspect was also well reflected in egg volume, with a greater egg volume in the mid phase. Similarly, the shell weight and thickness of HPR eggs, was also greater in the mid phase. It is apparent from this, that the increase in the various physical parameters from the initial to late phase is proportionately greater with the LP+HPR combination. Hypercorticalism had no significant effect on the yolk and albumen content or, the percentage solids and water contents of yolk and albumen, either on an

overall basis or even in terms of various phases of lay. The protein load of albumen is significantly lower in the HPR eggs and, this was clearly manifested in the initial and mid phases. Previous studies had revealed significantly increased protein load in the albumen due to only HPR, or, exposure to a long photoperiod (see chapters 5,6). The present observation in this context, signifies a negation of the favourable influence of LP or HPR, in a combination status. Unlike the albumen protein content, the albumen glucid content is not influenced by a combination of LP and HPR as, the presently recorded albumen glucid content is the same as recorded for under LP or HPR alone (see chapters 5,6). Apparently, the favourable influence on albumen glucid content is the same under HPR or LP alone, or even under a combination of the two. The glucid content of yolk recorded in the control LP and LP+HPR eggs, is significantly less than that recorded for NLD and NLD+HPR eggs. Clearly, HPR alone has no effect on yolk glucid content while, LP has a significant lowering effect and, this effect of LP persists even under a combination of LP and HPR though there is a slight decrement. Both LP and HPR have a positive influence on yolk lipids and negative a influence on albumen lipid content (see chapters 5,6) and, the present observation on yolk and albumen lipid contents suggest, neither a cumulative nor a nullifying influence under a combination of the two. The same is applicable to yolk cholesterol content also, as LP or HPR and, a combination of the two have same effect. However, the albumen cholesterol content is significantly increased in HPR eggs, similar to that observed in NLD eggs. Since both LP and HPR had the same effect of decreasing the albumen cholesterol content to the same degree, the presently observed increased albumen cholesterol content, is indicative of a nullifying influence of these two factors, when present together. Moreover, HPR along with LP, also significantly increased the proportion of cholesterol in the albumen lipid; overall suggesting a quantitative and qualitative alteration in the lipoprotein metabolism of the oviduct. The water and lipid indices, representing the ratio of water and

lipids, to the non-lipid dry material, are inferred to show correspondence with, the water and lipid indices of newly hatched chicks, as the non-lipid component is considered to be the most conservative fraction, used primarily for synthesis and thereby assimilated by the embryo, while, the water and lipid contents of the eggs decrease during *in ovo* development, due to evaporation and metabolism during respiration respectively (Ricklefs, 1977). Whereas, there was no significant difference in the water index of HPR eggs, the lipid index tended to be lower, due to mainly increase an in the non-lipid fraction and, decrease in the lipid fraction. The decreased lipid index of HPR eggs, is a reversal of the changes induced by LP, as the lipid index of HPR eggs of present study is similar to that of NLD eggs (see chapter 6). In contrast to the present observation, HPR status under NLD had a very significant influence in increasing the lipid index, more pronouncedly even than LP, mainly due to a decrease in non-lipid matter and increase in the lipid matter (see chapter 5). Apparently, this influence of HPR, is photoperiod specific, as it occurred under NLD but not under LP. Moreover, a combined status of LP and HPR, has a nullifying influence on LP induced changes as well. The calorific value of the HPR eggs also showed a decrease towards the value obtained for NLD eggs. Previous works have clearly shown that, both LP and HPR have positive influence on calorific value of eggs, with the increase being of a greater magnitude under HPR. Conceivably, a combination of both LP and HPR, tends to nullify the independent effects of each, resulting in no net change in calorific value of eggs (Table 6) (fig. 3).

Changes in eggs under HPO :

In terms of overall lay, the mean values of various measurements of eggs were not significantly different under HPO except, for egg weight, which was lesser in all phases of lay. A comparison of the physical measurements during phases of lay, shows a significant reduction in

weight of late phase HPO eggs and, a reverse set of change in egg volume, in the form of temporal reduction in egg weight in HPO eggs as against increase in egg weight in control eggs. The shell weight of HPO eggs appears to be greater in the late phase, which was nullified by an insignificant increase in the initial and late phases. Evidently, HPO has a nullifying effect on LP induced decrement in egg width and shell thickness and increase in egg volume. An increment in shell weight was observed in LP+HPO eggs, with no significant changes in the weights of yolk, albumen and percentage contents of water and solids. However, there is a marked tendency for reduction in yolk and albumen weights of HPO eggs in the late phase. The protein content of HPO eggs was significantly lower in the yolk and greater in the albumen and these differences were mainly due to the significant changes in the initial and mid phases, in the case of the former and, in the mid phase in the latter. Apparently, the metabolic activities of liver and oviduct are sufficiently altered by HPO, to reduce the protein content of yolk and, increase the same in albumen respectively. The effect of HPO in reducing yolk protein content seems to be a generalised one, independent of photoperiodic conditions, as HPO nullified the increase in protein content of yolk induced by LP and, decreased the protein content of NLD eggs further (see chapter 6). However, the effect of HPO in increasing the albumen protein content seems to be cumulative as, both HPO and LP had elevating influence on albumen protein content (Table 5)(fig. 2a) and, the presently recorded protein content of albumen is significantly more than that obtained under LP or HPO alone.

Both the lipid and cholesterol contents of albumen in HPO eggs were significantly increased by 40% and 95% respectively. These increments are, suggestive of the obviating influence of HPO on LP induced decrement as reported earlier (see chapter 6). Relating these alterations in albumen lipid and cholesterol contents with those seen in HPO eggs the in NLD condition (chapter 6), it becomes obvious that HPO *per se* has no influence on albumen lipid content but, it has a negating

influence on LP induced decrements. As against the influence on lipid content, HPO had a similar reducing effect as LP, on albumen cholesterol content. Presumably, both LP and HPO can independently reduce the albumen cholesterol content. However, a combination of LP and HPO tends to nullify the independent effects of each, resulting in no alteration in the albumen cholesterol content. A combination of LP and HPO increased the cholesterol to lipid ratio in the albumen, thereby attesting to a quantitative and qualitative influence on the lipoprotein metabolism of the oviduct. The water and lipid indices, as well as the calorific value of the HPO eggs, were similar to those of the LP eggs (fig. 3). It can be concluded from the present observations that, HPR or HPO in combination with a long photoperiod has certain effects on the metabolite load of the eggs, and that, corticosteroid photoperiod interactions in the growing phase, have potential effects on the biochemical composition of the eggs by, subtly altering the metabolic homeostasis of liver and oviduct.