CHAPTER 6

INFLUENCE OF HYPR./HYPOCORTICALISM IN RIR PULLETS REARED UNDER A SHORT PHOTOPERIOD (LD 6:18) ON THE COMPOSITION OF EGGS.

The egg of birds is a mature female germ cell invested with a rich store of potential energy ; in the form of yolk, synthesised and deposited starting with the metabolic activity of liver and, albumen, synthesised and deposited later by the magnum part of the oviduct. Ultimately the egg is laid, with a shelled envelope made up of $CaCo_3$ crystals and, organic molecules, to prevent desiccation and to permit embryonic development in a protected closed environment. Though the mode of formation and chemical composition of the eggs are similar in all birds, there are nevertheless some relative differences within various constituents in relation to the mode of development (Recklefs, 1977; Roca, 1984). Eggs of poultry birds, especially the domestic fowl, have been studied to a great extent in terms of their metabolite contents due to their inherent economic interest and relevance to human diet. Since the nutrient rich yolk and albumen are the outcome of the specialized metabolic activity of liver and oviduct, factors in the external environment as well as in the internal milieu of the bird are capable of influencing the metabolic activity of these organs. Some of the previous studies have identified season and diet as external factors and, age and genetic makeup as internal factors, capable

of exerting modulatory influences on the chemical composition of eggs (Cruickshank, 1941; Gutteridge and O'Neil, 1942; Everson and Souders, 1957; Patton and Palmer, 1958; Cunningham *et al.,* 1960; Edwards, 1964; Chun and Stadelman, 1965; Marion *et al.,* 1965; Hamilton 1978; Sibbald, 1979; Washburn, 1979; Sainz *et al.,* 1983; Winton, 1993; Panda, 1995; Etches, 1996). Photoperiod is an important environmental agent exerting profound effects on the physiology and activity of organisms. Though photoperiodic manipulation is an important practice and, different photoperiodic schedules have been assessed in terms of egg productivity and laying performance (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), the consequential effect of such photic manipulations on composition of eggs have not been evaluated. In this respect, previous studies on rearing of pullets under a short photoperiod have been shown to influence not only sexual maturity and laying performance (Chapter 1), but also the chemical composition of eggs (Chapter 4). Hormones, on the other hand, are powerful internal factors affecting physiology, metabolism and behaviour of animals. However, the influence of hormones, especially the metabolic hormones (thyroid hormones and adrenal corticosteroids), has not been studied in relation to egg laying or egg composition, though their effect on body growth and general metabolism in the domestic fowl has been studied (Blivaiss, 1947; Winchester and Davis, 1952; Nagra and Meyer 1963; Nagra *et al.,* 1965; Raheja *et al.,* 1971; King and King, 1973; Kallicharan and Hall, 1974; Carasia,1987; Bartov, 1982; Kuhn *et al.,* 1984;Akiba *et al.,* 1992; Hayashi *et al.,* 1994). Previous studies undertaken in this context had revealed subtle influence of mild hyper./hypocorticalism in the *pullet* stage, on laying performance (Chapter 2) as well as on the chemical composition of eggs (Chapter 5). Moreover, a combination of the two, such

as rendering the pullets hypercortic or hypocortic and, rearing them under a short photoperiod (SP, LD 6:18), induced further interactive alterations on attainment of sexual maturity and laying performance independent of the effects of SP or altered corticosterone status alone (Chapters 1 & 3). The present study involves a carry forward extension of the above observations to decipher the impact of a combinatorial schedule (Chapter 3), on the structure and composition of the eggs.

RESULTS

Physical features :

The physical measurements which are represented in table 1 show that, there was no consequential effects of HPR on the physical parameters. The egg weight and egg volume were both increased significantly under HPO. In terms of phases of lay, egg weight was persistently higher in HPO hens in all the phases, while the egg volume was high in the initial and late phases. Neither on an overall basis nor, in terms of phases of lay, was there any significant difference in yolk and albumen weight though, there were some difference in albumen weight which got nullified by reciprocal changes during the three phases (table 2 a-c).

Chemical composition :

The yolk water content was significantly decreased with reciprocal increase in solid content in both HPR and HPO eggs. However, there was no difference in the contents of albumen, solids or water. The data on the metabolite content of yolk and albumen are shown in table 3; fig. 1 A - D. There was no significant difference in the protein and cholesterol contents of yolk and albumen in HPR eggs. The yolk carbohydrate and albumen

Table: 1 Overall physical features of eggs laid by Control, HPR and HPO hens under SP.

	HPR	*Control*	*HPO*
Egg weight (gm)	45.06 ±0.295	45.87 ±0.898	48.21 ±0.655[a]
Egg height (mm)	5.08 ±0.060	5.46 ±0.064	5.57 ±0.061
Egg width (mm)	3.70 ±0.152	3.83 ±0.081	4.01 ±0.144
Egg Volume	39.90 ±0.692	40.30 ±0.975	42.72 ±0.617[a]
Shell weight (gms) & % of egg weight	4.78 ±0.14010.6%	5.68 ±0.13012.38%	6.03 ±0.21112.50%
Shell thickness (mm)	4.78 ±0.140	5.68 ±0.130	6.03 ±0.211
Yolk weight (gms) & % of egg weight	14.93 ±0.57133.1%	14.25 ±0.63731%	15.44 ±0.691 32%
Albumen weight (gms) & % of egg weight	25.13 ±0.52355.7%	25.76 ±0.50956.15%	26.85 ±0.64955.6%
Yolk : Albumen	0.59	0.55	0.57

Values : Mean, ±S.E, N= 12. [a]P < .05.

Table: 2a Physical features of eggs laid by control, HPR and HPO birds

Initial phase.	*HPR*	*CONTROL*	*HPO*
Egg weight (gm)	43.75 ±1.21	41.50 ±0.97	45.01 ±1.37[a]
Egg height (mm)	5.21 ±0.08	5017 ±0.03	5.45 ±0.073
Egg width (mm)	3.77 ±0.06	3.65 ±0.09	3.75 ±0.071
Egg volume	37.7 ±1.26	37.2 ±1.17	41.04 ±1.20[a]
Shell weight (gm) & % of egg weight	4.25 ±0.55 (9.94%)	5.5 ±0.50 (13.25%)	6.25 ±0.63 (13.88%)
Shell thickness (mm)	0.237 ±0.012	0.213 ±0.005	0.268 ±0.017
Yolk weight (gm) & % of egg weight	12.36 ±1.05 (28.91%)	11.25 ±0.61 (27.1%)	12.75 ±0.204 (28.33%)
Albumen weight (gm) and % of egg weight	26.5 ±0.52[a] (67.6%)	24.25 ±0.38 (58.1%)	26.58 ±0.86[a] (59%)
Yolk:Albumen	0.46	0.463	0.47

Values : Mean, ±S.E, N= 12. [a]P < .05.

Table: 2b Physical features of eggs laid by control, HPR and HPO birds

Mid phase.	*HPR*	*CONTROL*	*HPO*
Egg weight (gm)	46.2 ±0.204[c]	48.5 ±0.40	50.00 ±0.577[a]
Egg height (mm)	5.26 ±0.02	5.52 ±0.13	5.87 ±0.07
Egg width (mm)	3.02 ±0.201	3.62 ±0.27	4.57 ±0.134[b]
Egg volume	43.25 ±0.39[a]	45.00 ±0.57	45.75 ±0.841
Shell weight (gm) & % of egg weight	4.67 ±0.938 (10.09%)	5.25 ±0.82 (10.82%)	5.05 ±0.849 (10.10%)
Shell thickness (mm)	0.306 ±0.053	0.311 ±0.005	0.286 ±0.039[a]
Yolk weight (gm) & % of egg weight	15.25 ±0.406 (32.97%)	15.00 ±0.33 (30.92%)	15.11 ±0.66 (30.98%)
Albumen weight (gm) and % of egg weight	26.33 ±0.237[a] (56.92%)	28.25 ±1.02 (58.24%)	29.75 ±0.612 (59.5%)
Yolk:Albumen	0.579	0.530	0.50

Values : Mean, ±S.E, N= 12. [a]P < .05, [b]P < .005, [c]P < .0005

Table: 2c Physical features of eggs laid by control, HPR and HPO birds

Late phase.	*HPR*	*CONTROL*	*HPO*
Egg weight (gm)	45.18 ±1.39	47.61 ±0.86	49.64 ±0.73[a]
Egg height (mm)	4.79 ±0.400	5.71 ±0.30	5.41 ±0.073
Egg width (mm)	4.31 ±0.79	4.23 ±0.46	4.71 ±0.39
Egg volume	36.4 ±0.60[a]	38.7 ±0.94	41.4 ±0.88[a]
Shell weight (gm) & % of egg weight	5.43 ±0.94 (12.01%)	6.31 ±0.53 (13.25%)	6.81 ±0.89 (13.71%)
Shell thickness (mm)	0.213 ±0.007	0.271 ±0.005	0.283 ±0.009
Yolk weight (gm) & % of egg weight	17.18 ±1.06 (38.02%)	16.50 ±1.51 (34.65%)	18.57 ±0.992 (37.4%)
Albumen weight (gm) and % of egg weight	22.57 ±1.26 (49.93%)	24.8 ±0.96 (52.08%)	24.26 ±1.14 (48.87%)
Yolk:Albumen	0.76	0.66	0.765

Values : Mean, ±S.E, N= 12. [a]P < .05.

Table: 3 Overall biochemical composition of eggs of control, HPR and HPO hens.

	HPR		*CONTROL*		*HPO*	
	Units expressed as mg/100mg of yolk/albumen					
	Yolk	***Alb.***	***Yolk***	***Alb.***	***Yolk***	***Alb.***
Protein	17.35 ±1.16	14.36 ±0.211	17.83 ±0.51	14.77 ±0.43	16.86 ±0.82	16.26[a] ±0.55
Glycogen	0.0379 ±0.0036	0.0226 ±0.0035	0.0496 ±0.0031	0.0249 ±0.0039	0.0500 ±0.0034	0.0321 ±0.0048
Lipid	24.82 ±1.02	0.261[a] ±0.018	25.50 ±0.30	0.390 ±0.047	21.11[c] ±0.33	0.219[b] ±0.020
Cholesterol	2.632 ±0.155	0.0231 ±0.0037	2.943 ±0.080	0.0234 ±0.001	2.521 ±0.116	0.0238 ±0.0018
Cholesterol as % of lipid	10.6	8.8	11.5	5.9	11.9	10.7
% Water content	49.18 ±0.496	87.18 ±0.131	51.15 ±0.693	86.33 ±0.592	49.91 ±0.704	86.91 ±0.236
% Solids	50.82[a] ±0.496	12.81 ±0.132	48.85 ±0.693	13.01 ±0.133	50.71[a] ±0.634	13.08 ±0.236
Absolute content in yolk/albumen (gm).						
Protein	2.59	3.85	2.54	3.80	2.60	4.36
Glycogen	0.0056	0.0050	0.0070	0.0064	0.0077	0.0086
Lipid	3.70	0.0655	3.63	0.1004	3.25	0.0588
Cholesterol	0.3929	0.0058	0.4193	0.0060	0.0588	0.3892

Values : Mean, ±S.E, N= 12. [a]$P < .05$, [b]$P < .005$.

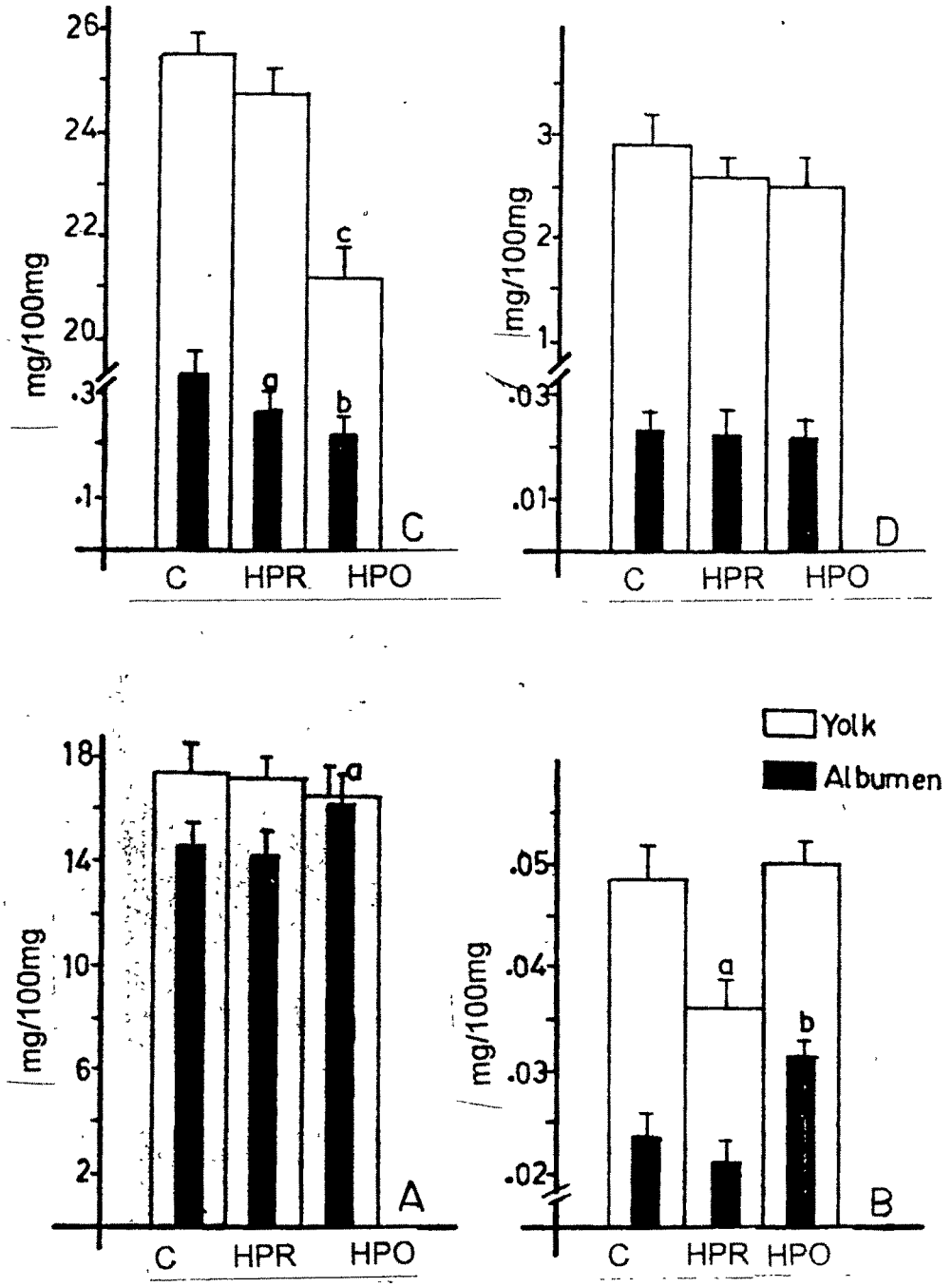

Fig. 1 (A - D) Figure showing biochemical composition of eggs laid by Control (C), Hypercorticalic (HPR) and Hypocorticalic (HPO) hens. **A.** Protein **B.** Glycogen **C.** Lipid and **D.** Cholesterol. Values : Mean, ±S.E, N= 12 **$^{a}P < .05$, $^{b}P < .005$, $^{c}P < .0005$.**

Table: 4a Biochemical features of eggs laid by Control, HPR and HPO hens.

Initial Phase	*HPR*		*CONTROL*		*HPO*	
	Yolk	*Albumen*	*Yolk*	*Albumen*	*Yolk*	*Albumen*
Units expressed as mg/100mg of yolk/albumen						
% Water content	49.11 ±0.38[a]	86.58 ±0.17	51.11 ±0.82	86.56 ±0.07	48.45 ±0.39[a]	85.88 ±0.39
% Solids	50.89 ±0.38	13.42 ±0.17	48.9 ±0.82	12.44 ±0.07	51.55 ±0.39[a]	14.12 ±0.39[c]
Protein	22.7 ±0.66[c]	14.75 ±0.59[a]	16.42 ±0.43	16.79 ±0.43	20.89 ±0.51[c]	14.70 ±0.23[a]
Glycogen	0.021±0.001[a]	0.005 ±0.002	0.034 ±0.002	0.006 ±0.43	0.038 ±0.001[a]	0.008 ±0.003
Lipid	28.08 ±1.39	0.264 ±0.036[c]	26.5 ±1.2	0.533 ±0.111	22.64 ±0.92[a]	0.222 ±0.033[c]
Cholesterol	2.81 ±0.22	0.040 ±0.004[a]	2.90 ±0.11	0.018 ±0.003	3.00 ±0.15	0.015 ±0.004
Absolute contents in gm						
Protein	2.80	3.9	1.84	4.40	2.66	3.90
Glycogen	0.002	0.0014	0.003	0.0017	0.004	0.0022
Lipid	3.47	0.070	2.98	0.139	2.88	0.058
Cholesterol	0.347	0.0108	0.326	0.0047	0.382	0.0040

Values : Mean, ±S.E, N= 12. [a]P < .05, [c]P < .0005.

Table 4b Biochemical features of eggs laid by Control, HPR and HPO hens.

Mid Phase	HPR		CONTROL		HPO	
	Yolk	Albumen	Yolk	Albumen	Yolk	Albumen
Units expressed as mg/100mg of yolk/albumen						
% Water content	47.11 ±1.49	87.29 ±0.204	48.23 ±2.49	86.43 ±0.75	46.98 ±1.33	87.88 ± 0.172
% Solids	52.89 ±1.49	12.71 ±0.204	51.77 ±2.49	13.57 ±0.75	53.02 ±1.33	12.12 ±0.17
Protein	12.99 ±0.264[b]	14.91 ±0.277	16.73 ±0.90	13.15 ±0.91	15.04 ±0.57	18.98 ±0.911[b]
Glycogen	0.052 ±0.001[b]	0.031 ±0.003	0.0602 ±0.001	0.0288 ±0.003	0.0604 ±0.002	0.0478±0.003[b]
Lipid	26.53 ±0.92	0.180 ±0.003[c]	25.97 ±1.13	0.473 ±0.023	19.88 ±0.27[b]	0.132 ±0.003[c]
Cholesterol	3.18 ±0.085	0.009 ±0.002[c]	3.06 ±0.10	0.023 ±0.004	2.55 ±0.011[a]	0.0261 ±0.002
Absolute contents in gm						
Protein	1.98	3.92	2.50	3.71	2.25	5.64
Glycogen	0.007	0.0082	0.009	0.0081	0.0099	0.0142
Lipid	4.04	0.047	3.89	0.133	2.98	0.039
Cholesterol	0.475	0.002	0.459	0.006	0.382	0.007

Table :4c Biochemical features of eggs laid by Control, HPR and HPO hens.

Late Phase	HPR		CONTROL		HPO	
	Yolk	Albumen	Yolk	Albumen	Yolk	Albumen
Units expressed as mg/100mg of yolk/albumen						
% Water content	51.32 ±0.86	87.69 ±0.11	54.11 ±0.90	88.01 ±0.10	52.72 ±1.09	86.98 ±0.33[b]
% Solids	48.68 ±0.86[a]	12.32 ±0.11[a]	45.89 ±1.29	11.94 ±0.10	47.28 ±1.09	13.02 ±0.33[a]
Protein	16.38 ±0.518[a]	13.43 ±1.10	20.36 ±0.55	14.38 ±0.37	14.67 ±0.318[a]	15.10 ±0.374
Glycogen	0.040 ±0.001[c]	0.031 ±0.002[b]	0.054 ±0.001	0.039 ±0.001	0.045 ±0.002[b]	0.040 ±0.001
Lipid	19.86 ±1.99[b]	0.339 ±0.042[c]	24.05 ±1.76	0.164 ±0.034	20.81 ±0.99[b]	0.302 ±0.017[c]
Cholesterol	1.90 ±0.107	0.019 ±0.003[a]	2.86 ±0.046	0.028 ±0.005	2.012 ±0.131	0.030 ±0.004
Absolute contents in gm						
Protein	2.81	4.09	3.35	4.02	2.72	4.49
Glycogen	0.0069	0.009	0.0087	0.011	0.0084	0.011
Lipid	3.41	0.103	3.96	0.046	3.86	0.089
Cholesterol	0.326	0.0058	0.472	0.0080	0.375	0.0089

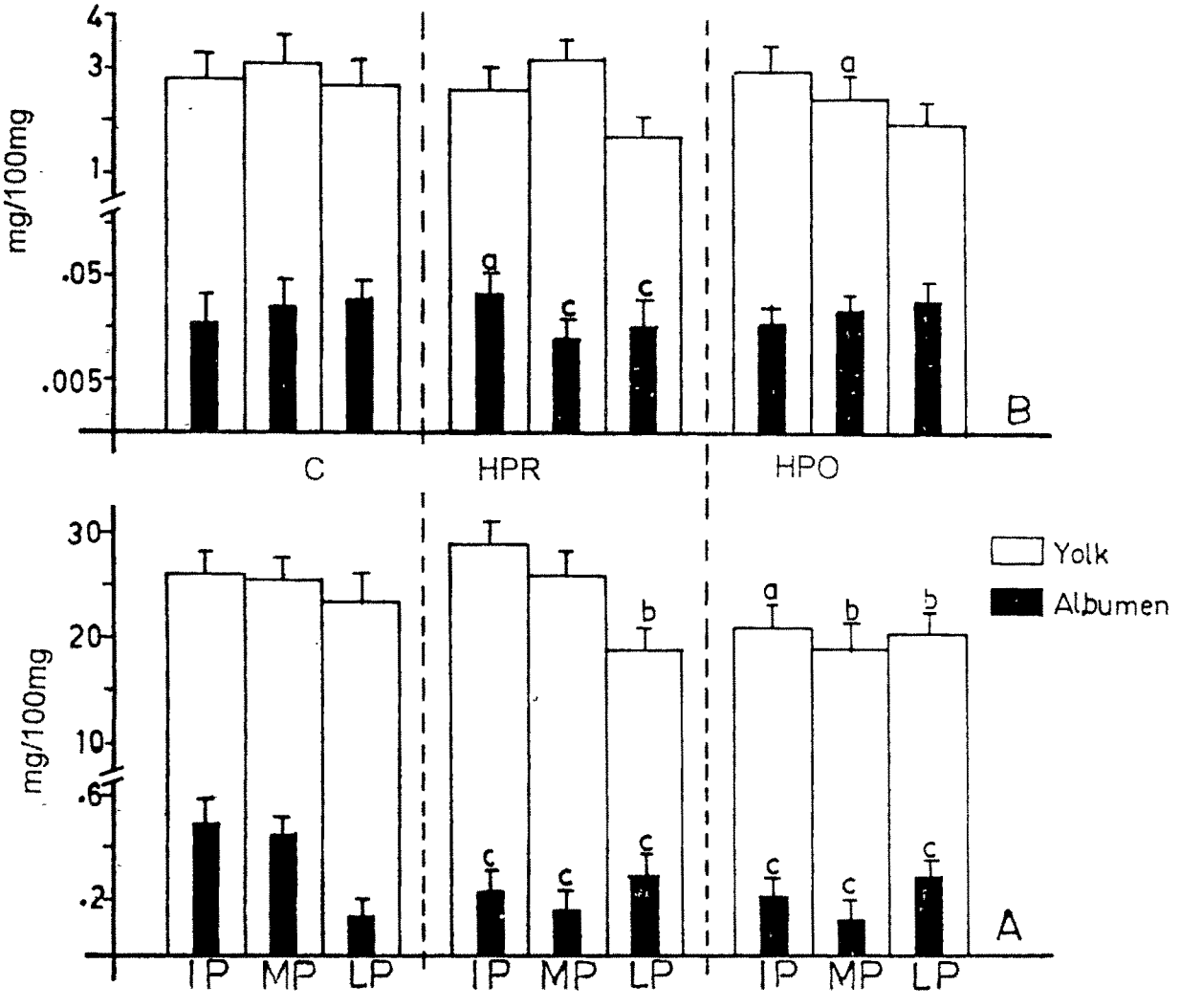

Fig. 2. Changes in egg composition from initial to late phase in Control (C), Hypercorticalic (HPR) and Hypocorticalic (HPO) hens **A.** Protein **B.** Glycogen. IP - Initial Phase, MP - Mid Phase, LP - Late Phase. Values : Mean, ±S.E, N= 12 **$^{a}P < .05$, $^{b}P < .005$, $^{c}P < .0005$.**

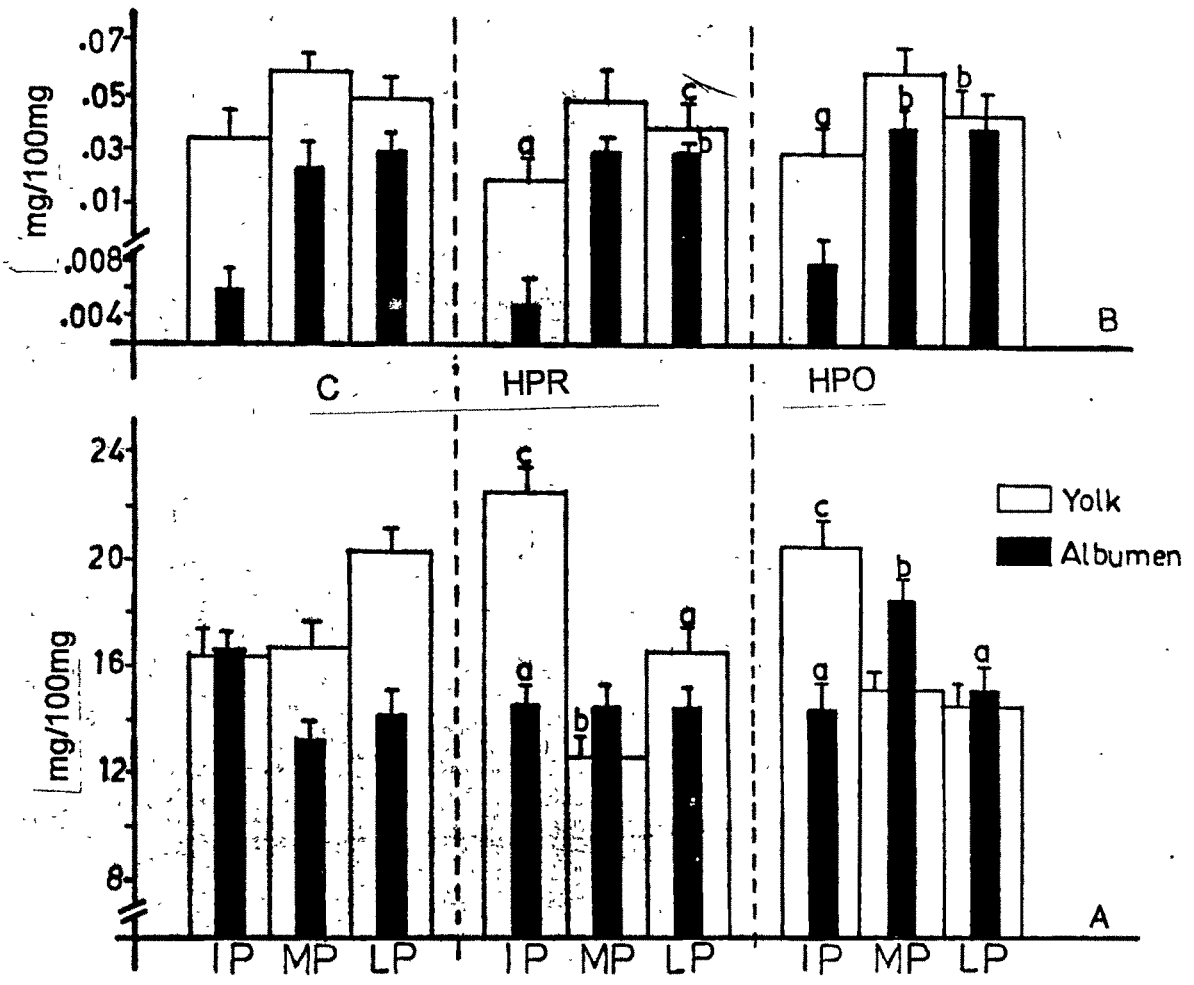

Fig. 3 Changes in egg composition from initial to late phase in Control (C), Hypercorticalic (HPR) and Hypocorticalic (HPO) hens.

A. Lipid **B.** Cholesterol. IP - Initial Phase, MP - Mid Phase, LP - Late Phase.

Values : Mean, ±S.E, N= 12 **$^{a}P < .05$, $^{b}P < .005$, $^{c}P < .0005$.**

Table: 5 Table showing overall weight of water, lipid, non-lipid and water and lipid indices of Control, HPR and HPO eggs.

	HPR		CONTROL		HPO	
	Yolk	Albumen	Yolk	Albumen	Yolk	Albumen
Wt. of water	7.34	21.90	7.28	22.23	7.62	23.33
Total Lipids	3.70	0.065	3.63	0.100	3.25	0.058
Non-Lipids	3.89	3.16	3.34	3.43	4..57	3.46
Water Index	1.88	6.93	2.17	6.48	1.66	6.74
Lipid Index	0.95	0.020	1.08	0.029	0.711	0.016
Calorofic value						
Edible egg	59.68		58.98		57.67	
/ 100gm egg	148.97		147.41		136.36	

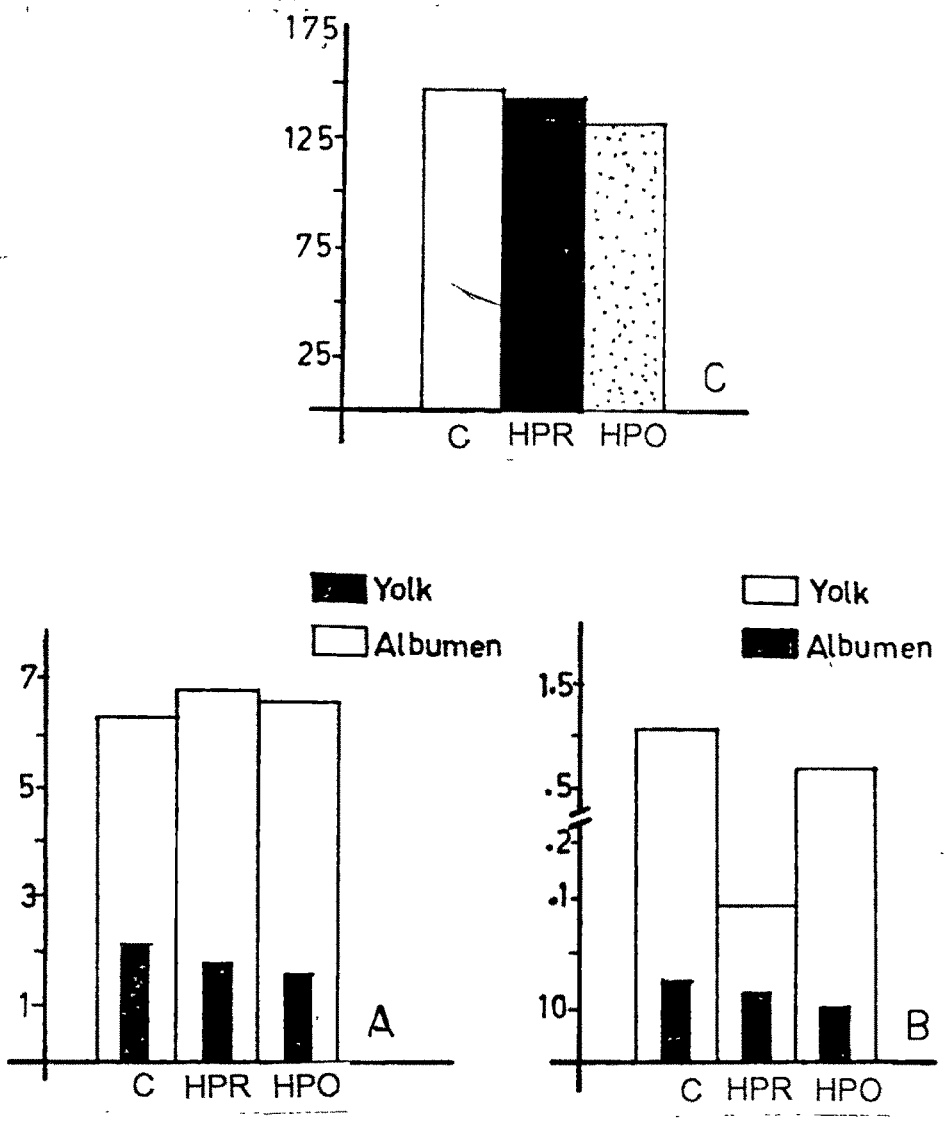

Fig. 4 A - C Figure showing Water Index (A), Lipid Index (B) and Calorific value/ 100gm egg (C).

Values : Mean, ±S.E, N= 12

lipid contents were significantly less in HPR eggs with no difference in albumen carbohydrate or yolk lipid contents. In HPO eggs, protein and carbohydrate contents of albumen were significantly increased, with no change in the yolk. The lipid content of both yolk and albumen was significantly decreased with no difference in cholesterol content of either yolk or albumen. The yolk protein content was significantly higher in the initial phase in both HPR and HPO eggs: however, this was neutralized by significant decrease during the late phase. The overall increase in the albumen protein content of HPO eggs was due to the significantly higher content during the mid phase, though in the initial phases it was lower. The yolk carbohydrate content of HPR eggs was consistently lower in all the three phases. The albumen carbohydrate content was significantly higher in HPO eggs in all the three phases. The yolk lipid content in the HPO eggs and the albumen lipid content in HPR eggs were also persistently lower (table 4 a-c; figs. 2 A & B, 3 A & B).

DISCUSSION

The use of corticosterone either through feed or through parenteral administration has been experimentally tried out in poultry birds for its effects on growth and fattening (Bartov, 1982; Saadaun *et al.,* 1987; Seigel *et al.,* 1989; Akiba, 1992; Hayashi *et al.,* 1994). Previous studies from this laboratory showed for the first time the influence of induced HPR or HPO in pullets during the rearing period on laying performance (Chapter 2) and further on the structure and composition of the eggs (Chapter 5). The present study is an attempt to evaluate the effect of HPR / HPO in relation to an altered photoperiod (SP). Since differential effects have been clearly manifested, the changes under HPR and HPO are being discussed separately for the sake of convenience and clarity.

HPR :

The mean values of none of the physical measurements showed any significant difference compared with the control eggs. Though the egg weight in the initial phase was significantly greater, the overall mean is none the less same, due to a less prominent increase in egg size (5.7%) by mid phase as compared to very prominent increase in egg size (16.6%) in control eggs. The egg weight, egg width and shell thickness recorded for the control eggs under SP are significantly less than those under normal light dark (NLD) condition (Chapter 1). Apparently, the effect of SP on these parameters is not nullified by HPR. The absolute weights of yolk and albumen of HPR eggs are similar to those of control SP eggs and they were recorded to be significantly less than those for NLD eggs (Chapter 1). However, as percentage of total egg weight the yolk content was significantly sincreased. This increment in the percentage yolk content, is also more than that of NLD eggs (Chapter 5). A similar effect of HPR on percentage content of yolk was also seen under NLD condition: clearly HPR has a favourable influence on percentage yolk load of the egg and this effect is more pronounced under SP condition than under NLD (Chapter 5). The changes during the course of lay also highlight the above, as the yolk content of HPR eggs increased from 27.1% to 34.6% as against 28% to 38.4% in the control eggs, from the initial to late phase. The albumen content in the initial phase was significantly higher in HPR eggs (67% Vs 58.1%). However, this difference got totally nullified by the more pronounced decrement by the late phase (52% Vs 49.9%). The significantly higher initial albumen content, suggest that SP provides a favourable background for the HPR condition, as under NLD, HPR had no effect in this respect (Chapter 5). The percentage water and solid contents of yolk were altered under HPR condition with significant decrease in the former and concomitant significant increase in the latter. Since HPR had

no effect in this respect under NLD condition, it is evident that HPR has a nullifying influence on the SP induced alterations in water and solid contents of yolk.

Though there was no difference in the overall protein content of yolk, on a temporal basis, the content in the initial phase was very high and in the mid and late phases it was significantly less. Apparently, HPR under SP has a positive effect on the protein load of yolk in the initial phase. Moreover, there was also a pronounced effect, on the trend of decreasing protein content during lay. Such a prominent effect of HPR was not manifested under NLD condition. There was no noticeable effect on the albumen protein content, neither on an overall basis nor on a temporal basis.

Hypercorticalism tended to reduce yolk glucid content. This effect of HPR on the overall yolk glucid content is a distinct feature by itself and independent of photoperiod as, this influence, is seen both under NLD and SP conditions and despite the significant glucid lowering effect of SP (Chapter 5). On a temporal scale, this effect of HPR was manifested in all the three phases of lay though, the pattern of changes was same as in the controls. The albumen glucid content showed no difference between the SP control and HPR eggs. However, the albumen glucid content of SP eggs is significantly higher than that of the NLD eggs. Interestingly, though HPR had no effect on albumen glucid content under SP, it had a significantly elevating effect under NLD (Chapter 5). It is inferrable from these, that both SP and HPR have independent positive influence on albumen glucid content with, no additive influence under a combination status.

Unlike the glucid content, which showed a significant decrease in yolk, the total lipid content showed a significant decrement in the albumen only, with no effect on the yolk lipid content. This albumen lipid loading effect of HPR was seen even under NLD. But the lowering effect was more pronounced under SP than under NLD as, the decrement under NLD was only 55% of that under SP. Apparently, the degree of effect of HPR on the albumen lipid content is photoperiod dependent with a more remarkable effect under SP. In terms of phases of lay, whereas the albumen lipid content decreased from initial to late phase in the SP eggs, it was significantly increased in the late phase with significantly lesser contents in the initial and mid phases in the HPR eggs. With reference to yolk lipid content, though there was no effect of HPR under SP, there was a significant increment under NLD. However, SP alone had a yolk lipid elevating effect, again portraying a picture of independent influence of HPR and SP with no cumulative effect as in the case of albumen glucid content.

Total cholesterol content of the eggs was not affected by HPR as the cholesterol content of both yolk and albumen was similar in the control and HPR eggs. Though there was no statistically significant effect on yolk cholesterol content, it was nevertheless persistently lower during the different phases of lay with a markedly reduced level during the late phase. Though HPR has a significant yolk cholesterol elevating effect under NLD, its seems to have a tendency to resist the same under SP. Again, considering the albumen cholesterol contents recorded in the present study and, those recorded under a previous study under NLD (Chapter 5), it becomes apparent that HPR has a significant albumen cholesterol lowering effect under NLD, while, it has no further effect under SP over and above the decrease occurring under SP alone. This again alludes to independent

effects of HPR and SP as brought out earlier.

The water and lipid indices representing the ratio of water and lipid to the non-lipid dry material, are referred to show correspondence with the water and lipid indices of newly hatched chick as, the non-lipid component is considered to be the most conservative fraction used primarily for synthesis and thereby assimilation by the embryo, while, the water and lipid contents of egg decreased during *in ovo* development due to evaporation, and metabolism during respiration, respectively (Recklefs, 1977). Both the water and lipid indices of the edible egg were similar in the SP and HPR eggs. Similarly, the calorific value of HPR eggs was also the same as that of SP eggs (table 5; fig. 4C). Apparently, HPR has no effect on the indices of water and, lipid and, on the calorific value, under SP condition. However, the values represented for all these three parameters, are significantly higher than those in NLD eggs, suggesting an influence of SP (Chapter 4). Further, HPR condition also had such an effect under NLD (Chapter 5). A comparison of the degree of increase with reference to these parameters caused by HPR or SP, indicate a more dominant effect of the former than that of the latter (table 5; fig. 4 A & B).

HPO:

Of the various physical measurements made, it was only the egg weight and volume which were increased by 5% and 6% respectively under hypocorticalism. The effect on egg weight seems to be a resistant action of HPO on the SP induced reduction in egg weight. Both the egg weight and volume were persistently higher during the course of lay, with marked difference in the initial phase in the case of former and, during *both* the initial and mid phases in the latter. Since the egg volume which was not altered under SP in comparison to NLD, was significantly increased in

HPO birds exposed to SP, the effect of HPO on egg volume has a definite relationship with the status of photoperiod. This is further emphasised by the slightly increased egg weight (statistically insignificant) in HPO birds reared under NLD, recorded earlier and, clearly indicate the potentiating influence of SP on the effect of HPO on egg weight and egg volume. Though there was no statistically significant difference in the weight of yolk and albumen, in terms of percentage contents, there was a tendency of slightly higher content in the HPO eggs mainly due to increased contents during initial and late phases of lay, which were 28.3% and 37.4% respectively as against 27.1% and 34.6%. This is clearly evident in the slightly lower laden ratio during these phases. The percentage content of solids was significantly decreased in yolk with, concomitant reduction in water content. The percentage contents of solids was maximal in the mid phase and minimal in the late phase in the yolk with concomitant reciprocal changes in water content in both control SP and HPO eggs. The yolk of HPO eggs showed consistently higher percentage solid content in all the three phases, indicating a definite influence of HPO under SP to increase the solid content which is unlike that seen under NLD condition (Chapter 5).

The albumen protein content showed significant increment in the HPO eggs and it was mainly due to significantly increased content in the mid phase (44.3%), along with the marginal increment in the late phase, though the same was 12% less in the initial phase. This effect of HPO to increase albumen protein content was seen even in the NLD eggs (Chapter 5) suggesting a generalized effect of HPO irrespective of the photoperiod. Similar to the protein content, the albumen free glucid content was also significantly increased in the HPO eggs. This increased glucid content of albumen was a consistent feature throughout lay, with a maximal increase

in the mid phase (65.9%), with a common temporally increasing trend in both the control and HPO eggs. The albumen glucid content of the control SP eggs is in itself significantly more than that of the NLD eggs (Chapter 5), and hence, the further increment recorded in the HPO eggs, indicates, the cumulative effect of both SP and HPO. Moreover, as HPO did not alter the albumen protein content under NLD, the effect of HPO is clearly photoperiod dependent. Interestingly, the total lipid content was reduced in both yolk and albumen of HPO eggs by 17.2% and 43% respectively. The effect of HPO in reducing the yolk total lipid content was prominently evident throughout lay with the maximum effect in the mid phase of the lay. However, in the case of total lipid content of albumen, the decrement was mainly due to the initial and mid phases, despite higher content in the late phase 84.1%. The photoperiod- HPO interaction in terms of egg lipid contents seems to be intricate as, both the yolk and albumen contents were increased under SP (Chapter 4) while, the yolk lipid content was increased with no effect on albumen lipid content in HPO eggs under NLD (Chapter 5). This clearly indicates a common yolk lipid elevating influence of both SP and HPO. However, as the yolk lipid content in HPO eggs under SP is significantly reduced almost to the level of NLD eggs, HPO apparently has a differential effect under NLD and SP photoperiodic schedules. Whereas, HPO has a yolk lipid elevating influence under normal photoperiodic condition, this effect is resisted under SP, suggesting an antagonistic effect of each other or, resistant action of HPO against SP when both conditions prevailed together. In contrast, the effect of HPO on albumen lipid content is photoperiod dependent and, while it has no effect under NLD, it has a highly potentiating decreasing effect under SP; as, not only the increase in albumen lipid content occurring under SP was resisted but it was decreased beyond NLD level. Apparently, HPO has a significant albumen lipid reducing effect under SP.

Though there was no significant effect on the overall cholesterol content, there was a tendency for slightly reduced yolk cholesterol content under HPO in the mid and late phases. In the previous chapter (Chapter 5), it was shown that SP has a permanent resisting effect on the lipoprotein metabolism, with proportionately higher lipid content in relation to non - cholesterol lipid contents. This effect of SP on lipoprotein is not altered by HPO. However, in the albumen lipoprotein, the cholesterol content appears to be significantly increased in proportion to the non cholesterol lipid content. Apparently, HPO has a qualitative effect on the lipoprotein metabolism of oviduct under SP.

The water and lipid indices of the HPO eggs were markedly lesser than those of the control eggs. Whereas the decrease in the water index was mainly due to an increase in the non-lipid dry matter, the decrease in the lipid index was not only due to an increase in the non-lipid dry matter but, also due to reduced lipid content in both yolk and albumen, more significantly in the latter (table 5; fig 4 A & B).

The calorific value of the HPO eggs, though not significantly different is nevertheless, slightly less than the control eggs by 7.5%. Obviously, HPO has no significant effect on the calorific value and water and lipid indices of SP eggs, though there is noticeable minor effects.

The present study on the whole shows that HPR and HPO along with SP during the rearing stages, have some influences on egg composition and, that the endocrine-photoperiod interactions can result in either additive , nullifying or even, novel effects in terms of egg composition (table 5; fig. 4C).