CHAPTER: 2

Effect of transient hypothyroidism in pullets on age at first egg and egg composition of RIR breed of domestic fowl

---

Both genetic and epigenetic factors contribute to egg production in poultry birds. Environmental factors could have profound influence on growth, seasonal maturity and egg production. Seasonal variations in poultry productivity have been documented (Hall and Marble, 1932; Rahn, 1976; Charles, 1984; Okumura *et al.*, 1988; Sharp, 1993). Experimental studies have also shown independent influence of various factors like humidity, temperature, management practices and, most importantly, nutrition and photic schedules (Dunn *et al.*, 1990; Lewis *et al.*, 1996a, b; Sandoval and Genet, 1996). Though the environmental factors serve as the proximate factors, endocrine secretions constitute the ultimate evocaters of sexual maturity and reproductive functions (Murton, 1978). Though gonadotrophic hormones are considered the classical hormones of reproduction, the influence of non-classical hormones like the adrenal steroids and the thyroid hormones is getting wider attention in mammals (Kallend *et al.*, 1978; Pankokoshi *et al.*, 1982; Palmero *et al.*, 1989, 1992, 1993; Francavilla *et al.*, 1991; Joyce *et al.*, 1993; de Krester *et al.*, 1995). The inter-relationships between the gonads and the thyroid or adrenal glands have been studied in adult birds and both parallel and inverse relationships have been inferred. Parallel adrenal-gonad (Patel *et al.*, 1986; Ramachandran and Patel, 1986; Ramachandran *et al.*, 1987; Ayyar *et al.*, 1992) and inverse adrenal-gonad (Riddle *et al.*, 1924; Legait and Legait, 1959; Fromne-Bouman, 1962; Ramachandran and Patel, 1988) relationships have been shown. Similarly, both parallel and inverse thyroid-adrenal relationships have also been reported (Thapliyal and Pandha, 1967a, b; Jallagea and Assenmacher, 1973, 1974; Oshi and Konishi, 1978; Patel *et al.*, 1985; Ramachandran and Patel, 1986; Ramachandran *et al.*, 1987). Pertinently, there are some studies suggesting some as yet unexplained influence of adrenal and thyroid hormones on ovarian functions and egg laying in poultry birds (Singh and Parshad, 1978; Wilson and Cunnigham, 1980; Lang *et al.*, 1989). The role of these hormones in relation to growth and metabolism has been studied in greater detail in the domestic birds (Blivaiss, 1947; Winchester and Davis, 1952; Nagra and Meyer, 1963; Nagra *et al.*, 1965; Raheja *et al.*, 1971; King and King, 1973; Kalliecharan and Hall, 1974; Bartov, 1982; Kuhn *et al.*, 1984; Carsia, 1987; Akiba *et al.*, 1992; Hayashi *et al.*, 1994; Kuher *et al.*, 1994).

A recent study from this laboratory has shown an influence of altered corticosterone levels in growing pullets on egg laying performance. Further, it was shown that there is an effect on even composition of eggs by presumably affecting the changes in the metabolic features of liver and oviduct (Dandekar, 1998). Apparently, the non- classical hormones have some effects on reproductive functions and part of their influence on sexual maturity and adult reproductive functions may be exerted at a crucial window during the sexually immature growth phase, as revealed from studies in mammals (Palmer *et al.,* 1989; 1992; 1993; deKrester *et al.,* 1995). It is in this context that the present study was undertaken to assess influence of hypothyroidism induced in pullets at different windows during the first 90 days of post hatched development on age at first egg, the number of eggs laid during the first month of lay, and the physical parameters and chemical composition of the eggs.

RESULTS:

Age at first egg and total number of eggs laid in the first month:

Whereas the control hens laid the first egg at an average age of 158 days, the group II to group IV hypothyroidic groups laid the first egg at 145, 137, 135 and 116 days respectively with significant early initiation of lay by 13, 17, 23 and 42 days respectively. The group I and II birds laid a significantly lower number of 10 eggs during the first month as against 25 eggs by control hens and 22 and 21 eggs by the hens of group III and IV (Table 2.1, Fig : 2.1,2.2)

Egg Weight:

The weight of first egg laid by hens of different groups were 28.3 gms (Control), 31.0 gms (Group I), 28.4 gms (Group II), 28.1 gms (Group III) and 23.3 gms (Group IV). There was an increment in egg weight from first laid egg to the 30th day egg in all the groups, the percentage increment was 23.3 %(Control), 31.4% (Group I), 34.5% (Group II), 21.7% (Group III) and 42.9% (Group IV).(Table, 2.2; Fig: 2.3, 2.4, 2.5)

Physical Parameters of Eggs:

First Day Egg:

Compared to controls, the egg weight was not significantly different in groups II and III but higher in group I and lower in group IV. Same was the case with egg volume. In general, shell weight was greater in all the experimental groups with the greatest being in group II. Shell thickness was lesser in all groups compared to control with maximum decrement in group I and almost identical in group IV. Egg width and height were both greater in all experimental groups except for group IV where it was identical to controls. Except for group IV, the yolk and albumen weights were greater in all other groups relative to controls except for group IV. (Table: 2.3)

30th day egg:

In general egg weight and volume were lesser in all experimental birds compared to controls. Shell weight tended to be lesser in all experimental groups, significantly in groups II and IV. Shell thickness showed almost no change except for a slight increase in groups II and III. Egg width and height were both lesser in the experimental groups. The total yolk weight was lesser in all experimental groups. Even the albumen weight is lesser in all groups except for group I in which it was slightly higher. (Table: 2.4)

Biochemical composition of egg:

Percentage water and dry content

Except for a slight increase in yolk water content and decrease in dry content in all the groups of either the 1st day egg or the 30th day egg, there was no difference in the albumen water or dry content compared to control eggs.

Metabolic content:

The yolk protein content of both 1st day egg as well as the 30th day egg was lesser in all groups. However the albumen protein content was lesser in the 1st day egg and more in the 30th day egg of all groups. The total lipid content of both yolk and albumen of 1st day egg was significantly more in all experimental groups but in the 30th day egg, the albumen lipid content was more while, the yolk lipid content was lesser. In general, the cholesterol content of both yolk and albumen of 1st day egg as well as the yolk of 30th day egg was lesser in all groups but that of albumen of 30th day egg was increased compared to control eggs. (Table: 2.5, Fig: 2.6 to 2.14)

Water and lipid indices and calorific values:

Both the water and lipid indices of yolk of all experimental groups were higher in the first egg laid compared to control. Water index of albumen was higher in group II and III eggs but the lipid index was however higher in all groups with respect to 30th day eggs. Though the yolk lipid index was not significantly different, the water index tended to be higher in groups II to IV. Though there was no significant difference in albumin water index of different groups, the lipid index tended to be higher in all groups. The whole egg calorific value of 1st day as well as 30th day eggs of all experimental groups was significantly lower than the corresponding control eggs.(Table: 1.8; Fig: 2.13, 2.14)

Table 2.1: Age at first egg and total no. of eggs in a month after initiation of lay under the effect of HPOT at NLD regimen

Experiment Groups	Age at first egg	Total no. of eggs/month
Control	158 ±1.502	25.33 ±2.027
Group-I	145.3^{c} ±2.33	10^{c} ±1.003
Group-II	137^{c} ±0.577	13.5^{b} ±2.500
Group-III	125.5^{c} ±0.707	22 ±1.00
Group-IV	119^{c} ±3.42	21.5 ±0.500

Group-I: 15-45 day HPOT, Group p-II: 30-60 day HPOT; Group-III: 45-75 day HPOT; Group-IV: 60- 90 days HPOT

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

Table 2.2: Average egg weight (gm) under the effect of HPOT at NLD regimen

Treatment groups	On the day of initiation	30^{th} day after initiation of lay	Overall Egg weight after 30 days
Control	28.34 ±2.822	43.74 ±1.943	38.7 ±2.117
Group-I	31.04 ±0.600	40.83 ±0.281	35 9 ±1.63
Group-II	28.473 ±0.737	38.22^{a} ±1.843	33.3 ±1.79
Group-III	28.173 ±0.681	34.25^{c} ±0.918	29.71^{b} ±1.63
Group-IV	23.38 ±2.418	33.30^{c} ±0.650	28.34^{b} ±1.775

Group-I: 15-45 day HPOT, Group-II: 30-60 day HPOT; Group-III: 45-75 day HPOT; Group-IV: 60- 90 days HPOT

Values expressed as Mean ± S.E, n=6; a: $p \leq 0.05$, b: $p \leq 0.02$, c: $p \leq 0.00$

Table 2.3: Physical Parameters of Egg of HPOT hens on the day of initiation of lay at NLD regimen

Parameters	Experiment Groups				
	Control	Group-I	Group-II	Group-III	Group-IV
Weight (gm)	34.83 ±0.8158	31.04 ±3 025	28.47[c] ±0.73	28.17[c] ±0.68	23.38[c] ±1.4
Volume (CC)	32.54 ±2.245	29.9 ±2.800	25.43[a] ±1.396	23.40[a] ±2 011	17.93[c] ±1.880
Shell Weight (gm)	2.39 ±0 1194	2.809 ±0.212	3.047 ±0.251	2.747 ±0.235	2.594 ±0 154
Shell Thickness (cm)	0 033 ±0.0003	0.027 ±0.001	0.029 ±0.017	0.028 ±0 000	0.032 ±0.0012
Width (cm)	3.44 ±0.0223	4.16 ±0 490	3.542 ±0.075	3.501 ±0.049	3.412 ±0.031
Height (cm)	4.36 ±0.0683	4.612 ±0.103	4.835 ±2.791	4.758 ±0.185	4.272 ±0.029
Yolk Weight (gm)	8.00 ±0.247	5.97 ±1 33	9.404 ±0.163	8.25 ±0.834	5.88 ±0.115
Albumen Weight (gm)	23.3 ±0.87	21.41 ±1.342	16.62[a] ±1.905	18.08[a] ±1.285	15.73[c] ±0.262
Yolk: Albumen ratio	0.34	0.27	0.49	0.403	0.32

Group-I: 15-45 day HPOT, Group-II: 30-60 day HPOT; Group-III: 45-75 day HPOT; Group-IV: 60- 90 day HPOT

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

Table 2.4: Physical Parameters of Egg under the effect of HPOT, on 30th day after the day of initiation of lay at NLD regimen

Parameters	Experiment Groups				
	Control	Group-I	Group-II	Group-III	Group-IV
Weight (gm)	42.62 ±2.975	40.82 ±0.28	38.22 ±1.8	34.25[a] ±0.91	33 37[a] ±0.65
Volume (CC)	39.03 ±3.790	29.63 ±1.44	30.00 ±1.527	27.833[a] ±0.166	26.33[a] ±0.881
Shell Weight (gm)	3.38 ±0 278	2.864 ±0.032	3 208 ±0.157	2 77 ±0 127	2.624 ±0.080
Shell Thickness (cm)	0.026 ±0.002	0.025 ±0.001	0.028 ±0.001	0.028 ±0.001	0.025 ±0.0005
Width (cm)	3.86 ±0.1624	3.50 ±0.580	3.66 ±0.092	3.528 ±0 043	3.579 ±3.648
Height (cm)	5.43 ±0.2376	4.803 ±0.583	4.920 ±0.099	4.616 ±0.052	4.633 ±0.119
Yolk Weight (gm)	14.96 ±1.678	13.22 ±0.221	10.54 ±0.350	11.47 ±0 519	9.22[a] ±0.104
Albumen Weight (gm)	22.3 ±1.965	22.50 ±0.059	22.91 ±1.043	18.04 ±0.355	20.37 ±0.937
Yolk: Albumen ratio	0.67	0.58	0.46	0.63	0.45

Group-I: 15-45 day HPOT, Group-II: 30-60 day HPOT;
Group-III: 45-75 day HPOT; Group-IV: 60- 90 days HPOT

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

Table 2.5: Egg composition mg/100mg yolk or albumen under the effect of Hypothyroidism on the day of initiation of lay at NLD regimen

Experiment Groups	Total protein		Total lipid		Total cholesterol		Calorific value / Whole egg
	Yolk	Albumen	Yolk	Albumen	Yolk	Albumen	
Control	23.026 ±1.90	22.183 ±2.383	20.56 ±1.440	0.020 ±0.006	1.733 ±0.266	0.0095 ±0.0021	127.07
Group-I	19.350 ±2.540	15.94 ±1.825	31.80[a] ±4.182	0.029 ±0.010	1.036 ±0.175	0.0004 ±0.0001	132.52
Group-II	17.14[a] ±0.492	19.22 ±1.850	22.126 ±2.452	0.021 ±0.008	1.0915 ±0.161	0.0004 ±0.0000	98.07
Group-III	20.97 ±1.009	20.421 ±1.577	29.517[a] ±2.155	0.039 ±0.013	1.0326 ±0.1821	0.0005 ±0.000	121.59
Group-IV	16.506 ±2.824	21.544 ±1.699	25.485 ±1.579	0.048 ±0.011	1.430 ±0 151	0.007 ±0.002	89.145

Group-I: 15-45 day HPOT, Group-II: 30-60 day HPOT; Group-III: 45-75 day HPOT; Group-IV: 60- 90 day HPOT

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

Table 2.6: Egg composition mg/100mg yolk or albumen under the effect of Hypothyroidism on 30th day after initiation of lay at NLD regimen

Experiment Groups	Total protein		Total lipid		Total cholesterol		Calorific value/ Whole egg
	Yolk	Albumen	Yolk	Albumen	Yolk	Albumen	
Control	23.895 ±2.733	17.343 ±2.203	32.162 ±2.721	0.028 ±0.0085	2.461 ±0.293	0.0005 ±0.0001	191.7
Group-I	23.15 ±2.393	19.35 ±1.346	29.062 ±1.262	0.0568[a] ±0.0081	2.596 ±0.113	0.00127 ±0.0008	175.99
Group-II	22.710 ±2.12	19.244 ±1.138	33.964 ±2.345	0.0667[a] ±0.012	1.7568 ±0.106	0.0009 ±0.0002	151.52
Group-III	22.310 ±2.049	20.764 ±2.463	23.587 ±1.501	0.061[a] ±0.0063	1.996 ±0.132	0.0007 ±0.0001	131.59
Group-IV	18.130 ±1.380	20.026 ±2.381	30.687 ±5.363	0.0521 ±0.0126	2.3938 ±0.122	0.0009 ±0.0001	142.82

Group-I: 15-45 day HPOT, Group-II: 30-60 day HPOT; Group-III: 45-75 day HPOT, Group-IV: 60- 90 day HPOT

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

Table 2.7: Effect of HPOT on % water content and % dry content /100gm of egg's yolk and albumen under NLD regimen

Treatment	Day of Initiation of Egg lay				30th day after initiation of egg lay			
	Yolk		Albumen		Yolk		Albumen	
	% water content	% dry content	% water content	% dry content	% water content	% dry content	% water content	% dry content
Control	46.968 ±1.354	53.029 ±4.581	85.843 ±0.539	14.155 ±0.539	44 87 ±1.429	55.128 ±1.429	82.404 ±3 399	17.595 ±3.99
Group I	51.21 ±1.373	48.78 ±1.373	85.26 ±0.374	14.73 ±0.312	46.34 ±0.993	53.61 ±1 37	82.13 ±2.532	17.86 ±2.532
Group II	49.76 ±1.08	50.37 ±2.73	86.12 ±0.508	13 87 ±0.508	47.91 ±1.049	52.08 ±1.049	83.47 ±0.153	16.52 ±0.152
Group III	51.11 ±0.637	48.88 ±0.637	86.62 ±0.101	13.37 ±0.101	52.08 ±1.130	47.91 ±1.153	83.12 ±2.317	16.86 ±0.831
Group IV	43.04 ±7.885	56.94 ±2.01	83.20 ±0.300	16.73 ±0 302	51.07 ±1.237	48 91 ±1.996	81 40 ±0.549	18 59 ±0.549

Group-I: 15-45 day HPOT, Group-II: 30-60 day HPOT; Group-III: 45-75 day HPOT; Group-IV: 60- 90 day HPOT

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

Table 2.8: Effect of HPOT on water and lipid indices of egg's yolk and albumen

Treatment	Day of Initiation of Egg lay				30th day after initiation of egg lay			
	Yolk		Albumen		Yolk		Albumen	
	Water Index	Lipid Index	Water Index	Lipid Index	Water Index	Lipid Index	Water Index	Lipid Index
Control	0.88	0.38	6.06	0.0014	0.81	0.58	4.68	0.0015
Group I	1.04	0.45	5.78	0.029	0.86	0.54	4.03	0.0028
Group II	1.06	0.323	6.20	0.0015	0.91	0.65	4.99	0.0021
Group III	1.045	0.412	6.47	0.0103	1.08	0.49	4.93	0.0032
Group IV	1.63	0.447	4.97	0.0028	1.04	0.62	4.37	0.0025

Group-I: 15-45 day HPOT, Group-II: 30-60 day HPOT; Group-III: 45-75 day HPOT; Group-IV: 60- 90 day HPOT

Fig.2.1: Age at first egg under the effect of HPOT in different groups of animals maintained in NLD

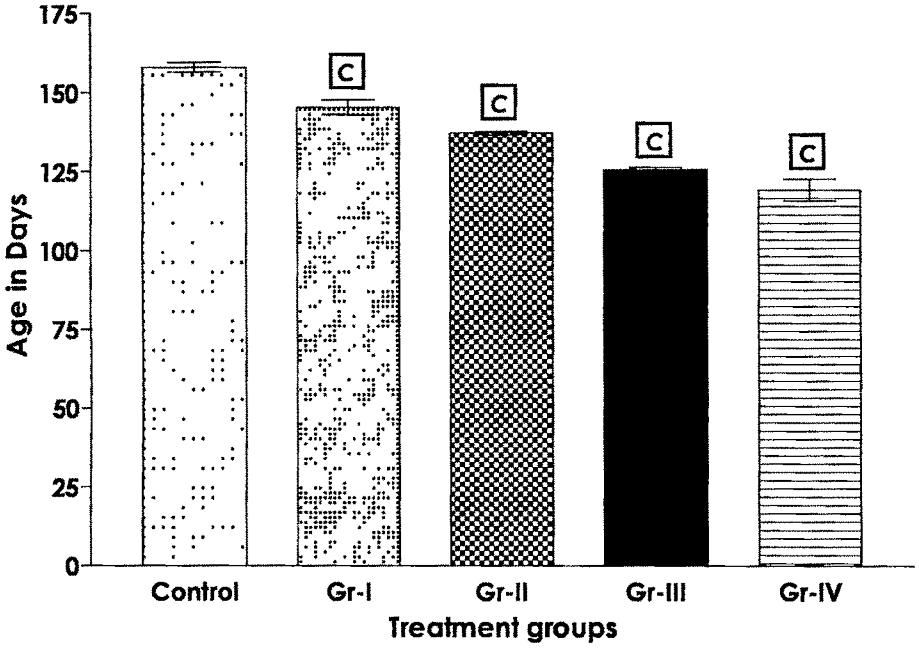
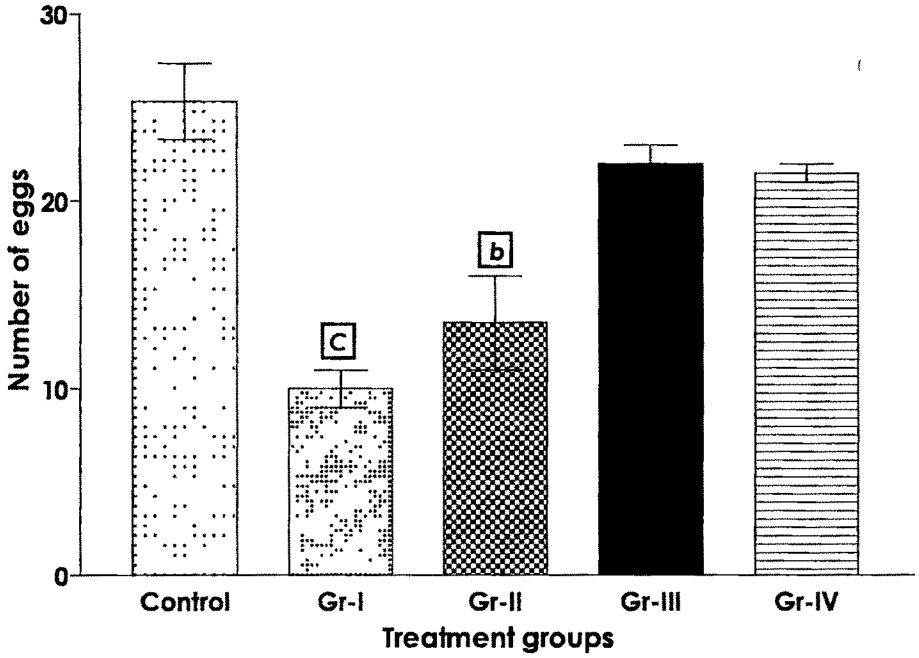


Fig.2.2: Total number of eggs per month in different groups under the effect of HPOT at NLD regimen



Control: NLD, Gr-I: 15-45day HPOT, Gr-II: 30-60day HPOT, Gr-III: 45-75day HPOT, Gr-IV: 60-90day HPOT, a: $p \leq 0.05$, b: $p \leq 0.02$, c: $p \leq 0.001$ of 6 animals.

Fig.2.3: Average egg weight of different groups on the day of initiation of lay at NLD regimen

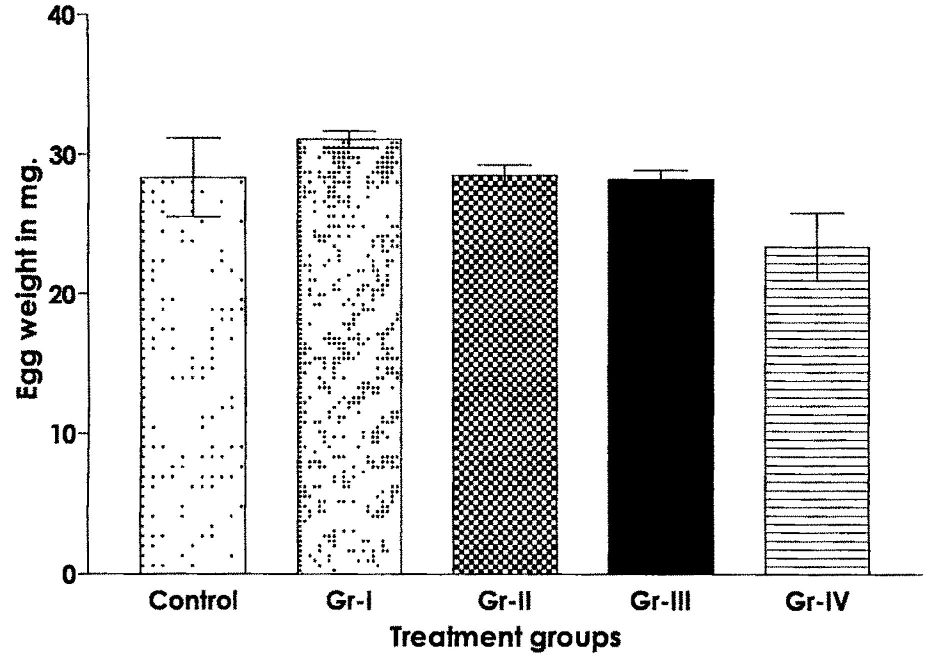
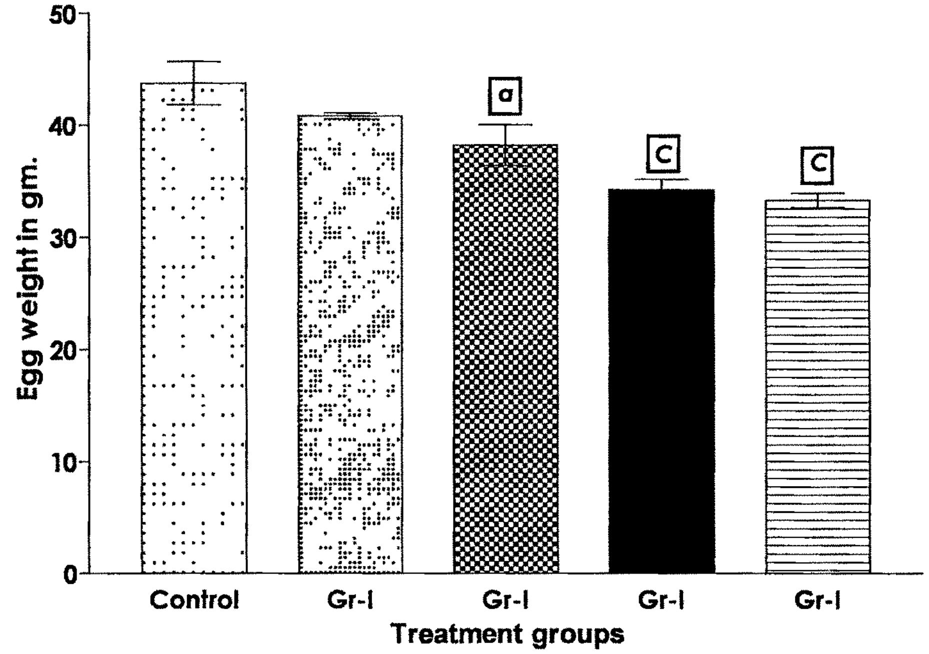


Fig.2.4: Average egg weight of different groups on 30th day after initiation of lay at NLD regimen.



Control: NLD, Gr-I: 15-45day HPOT, Gr-II: 30-60day HPOT, Gr-III: 45-75day HPOT, Gr-IV: 60-90day HPOT, a: $p \leq 0.05$, b: $p \leq 0.02$, c: $p \leq 0.001$ of 6 animals.

Fig.2.5: Overall egg weight after 30 days under the effect of HPOT and NLD tegimen

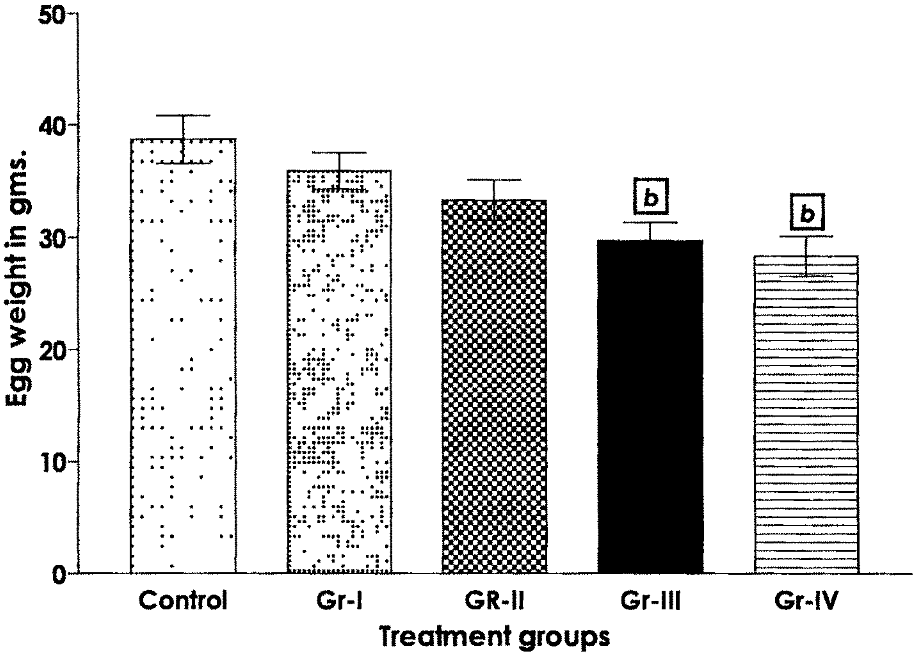
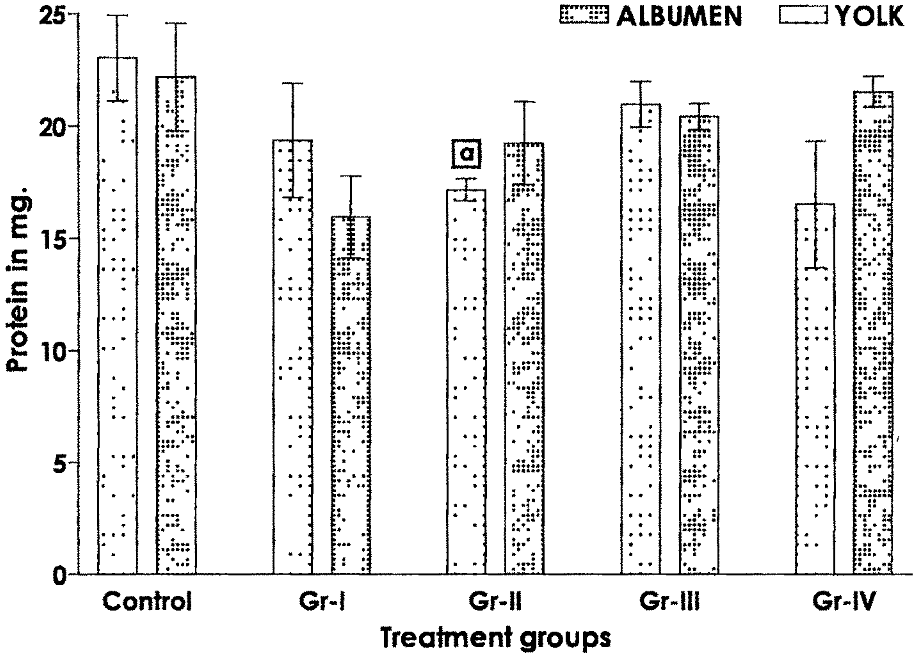


Fig.2.6:Total protein in mg./100 mg. yolk/albumen under the effect of HPOT at NLD regimen on the day of initiation of lay



Control: NLD, Gr-I: 15-45day HPOT, Gr-II: 30-60day HPOT, Gr-III: 45-75day HPOT, Gr-IV: 60-90day HPOT, a: $p \leq 0.05$, b: $p \leq 0.02$, c: $p \leq 0.001$ of 6 animals

Fig. 2.7: Total lipid in mg./100mg. yolk under the effect of HPOT at NLD regimen on the day of initiation of lay.

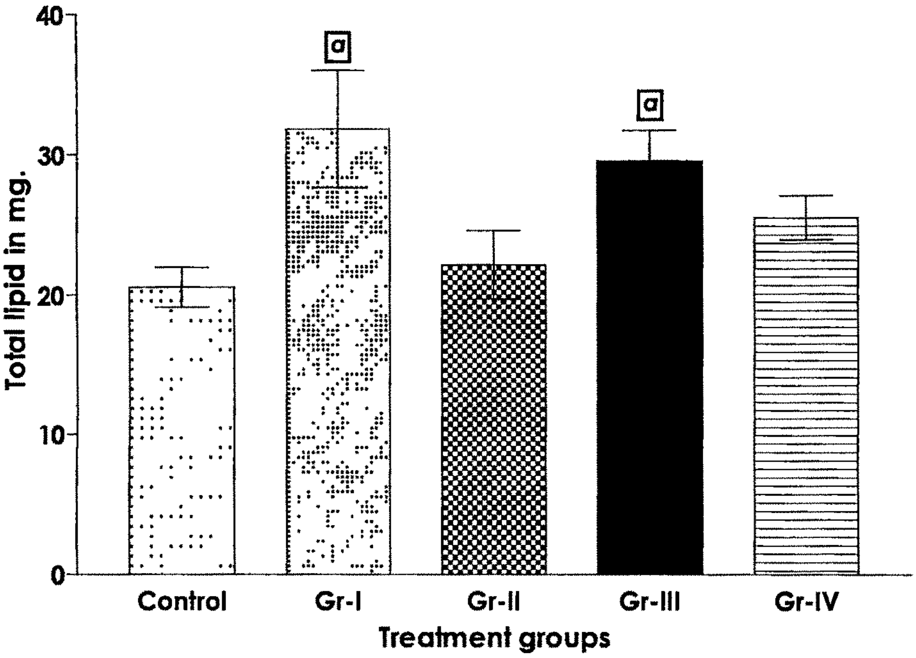
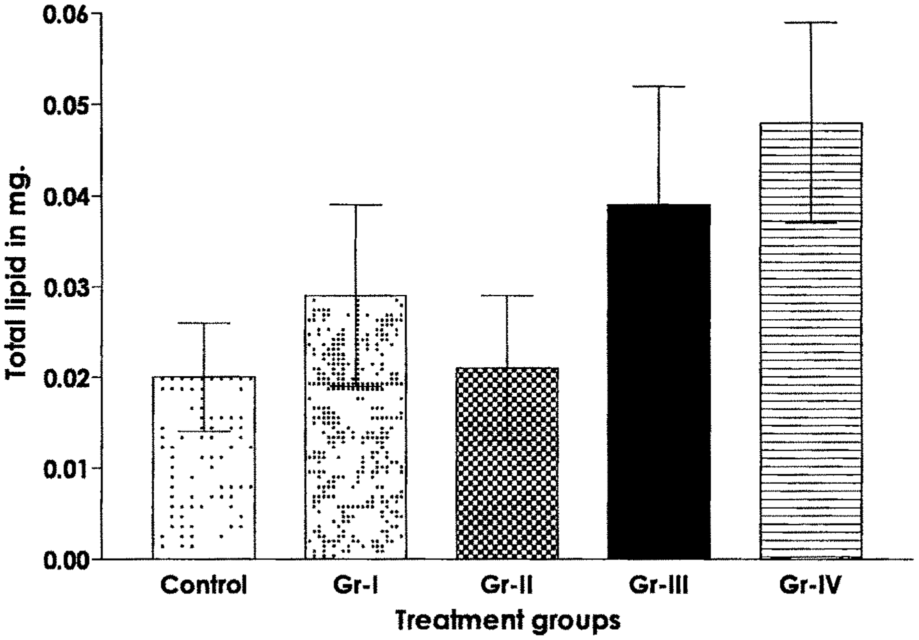


Fig. 2.8: Total lipid in mg./100mg. albumen under the effect of HPOT at NLD regimen on the day of initiation of lay.



Control: NLD, Gr-I: 15-45day HPOT, Gr-II: 30-60day HPOT, Gr-III: 45-75day HPOT, Gr-IV: 60-90day HPOT, a: $p \leq 0.05$, b: $p \leq 0.02$, c: $p \leq 0.001$ of 6 animals.

Fig.2.9: Total cholesterol in mg./100mg yolk under the effect of HPOT at NLD regime on the day of initiation of lay.

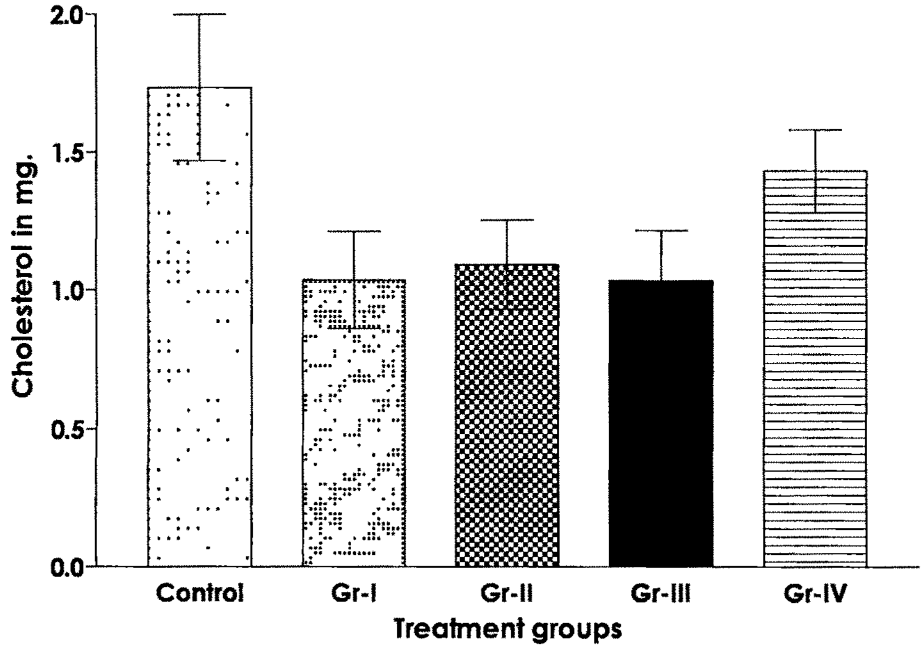
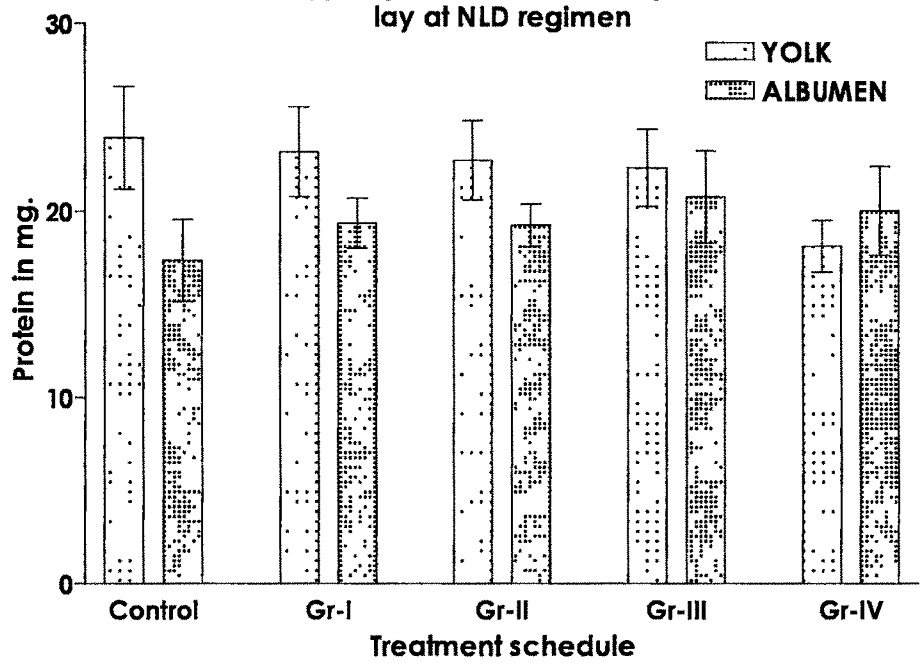


Fig.2.10:Total protein in mg/100mg yolk or albumen under the effect of Hypothyroidism on 30th day after initiation of lay at NLD regimen



Control: NLD, Gr-I: 15-45day HPOT, Gr-II: 30-60day HPOT, Gr-III: 45-75day HPOT, Gr-IV: 60-90day HPOT, a: $p \leq 0.05$, b: $p \leq 0.02$, c: $p \leq 0.001$ of 6 animals

Fig.2.11: Total lipid in mg/100mg. yolk under the effect of HPOT at NLD regimen on 30th day after initiation of lay.

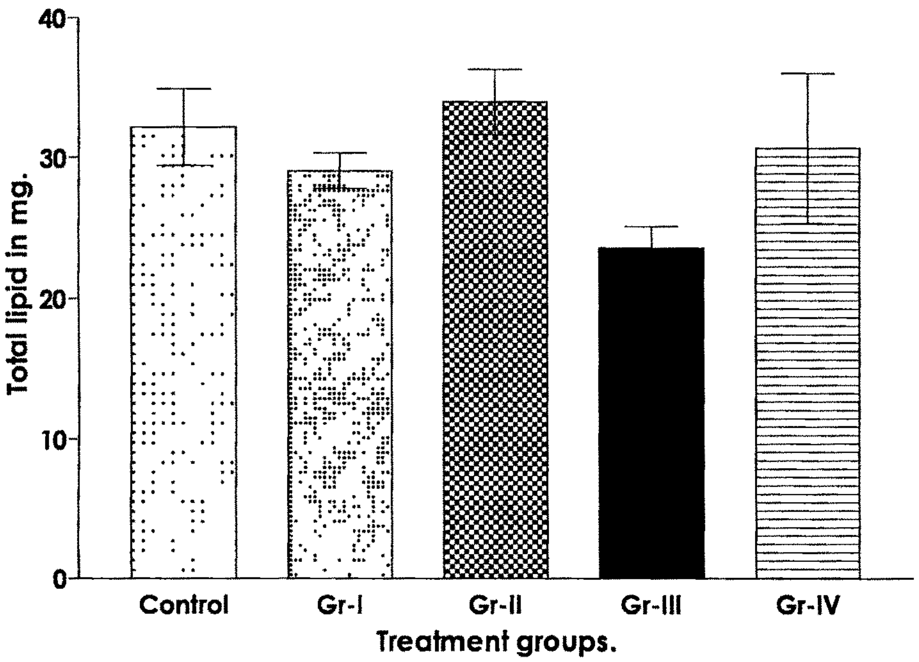
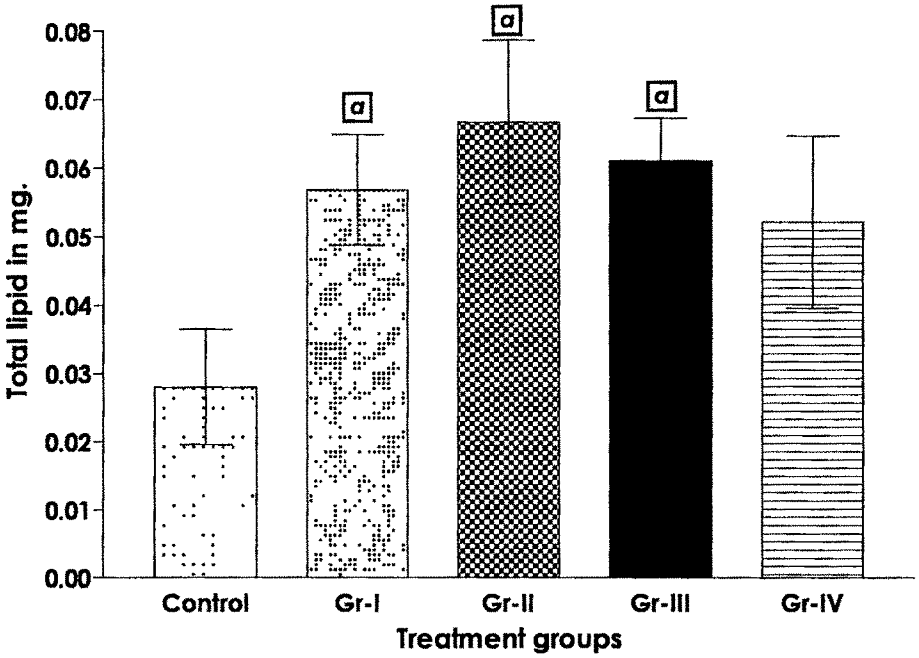


Fig.2.12: Total lipid in mg/100mg. albumen under the effect of HPOT at NLD regimen on 30th day after initiationof lay.



Control: NLD, Gr-I: 15-45day HPOT, Gr-II: 30-60day HPOT, Gr-III: 45-75day HPOT, Gr-IV: 60-90day HPOT, a: $p \leq 0.05$, b: $p \leq 0.02$, c: $p \leq 0.001$ of 6 animals

Fig.2.13: Total cholesterol in mg/100mg yolk under the effect of HPOT at NLD regimen on 30th day after initiation of lay.

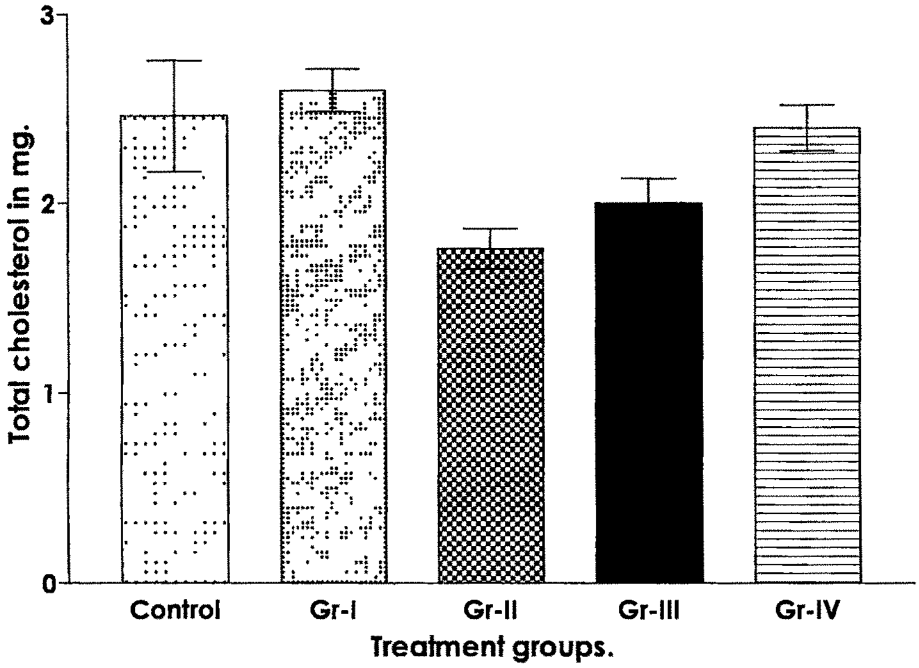
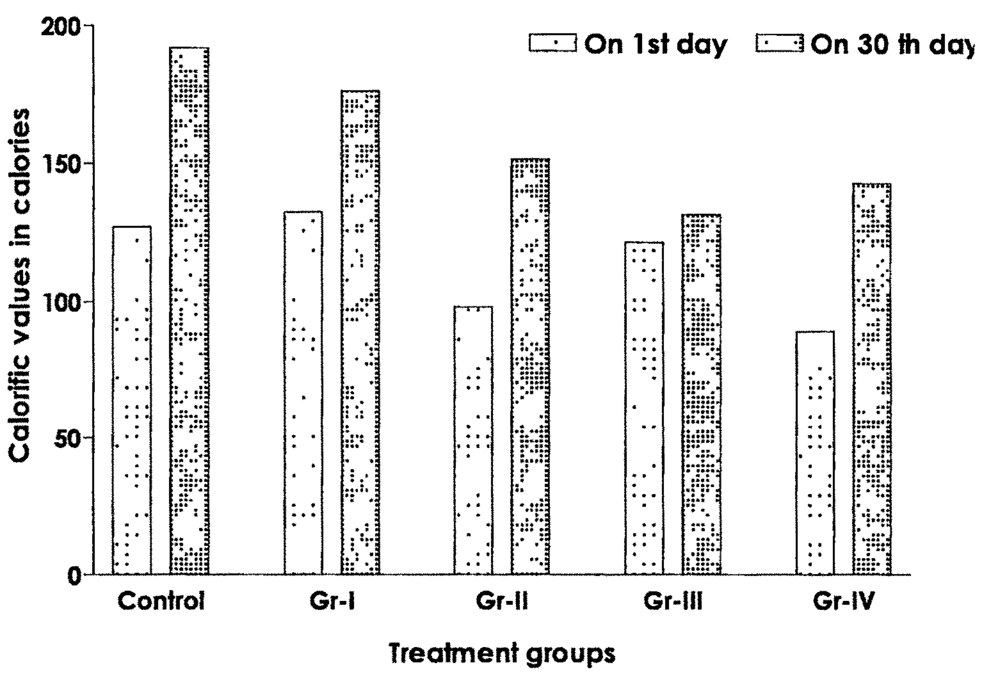


Fig.2.14: Calorific values of eggs under the effect of HPOT at NLD regimen .



Control: NLD, Gr-I: 15-45day HPOT, Gr-II: 30-60day HPOT, Gr-III: 45-75day HPOT, Gr-IV: 60-90day HPOT, a: $p \leq 0.05$, b: $p \leq 0.02$, c: $p \leq 0.001$ of 6 animals

Fig.2.15: % water and dry content in yolk/albumen under the effect of HPOT at NLD regimen on the day of initiation of lay.

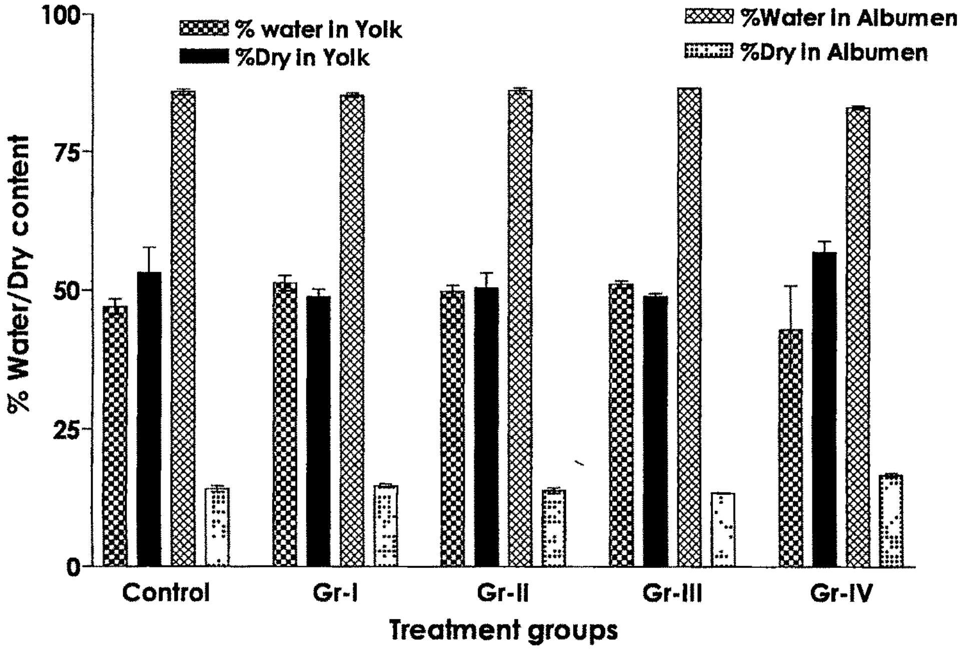
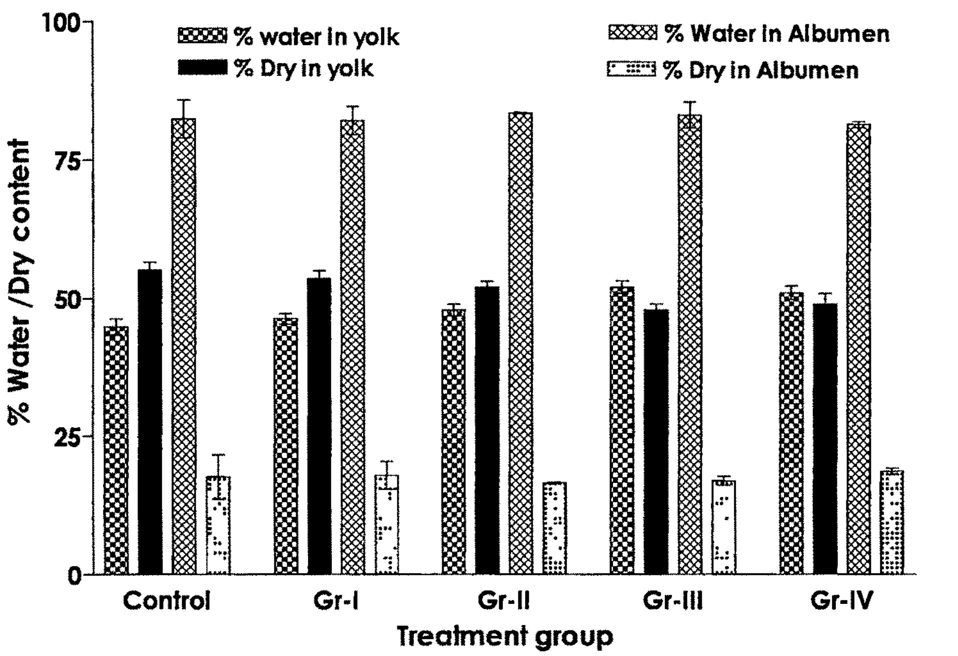


Fig.2.16: % water and dry content in yolk/albumen under the effect of HPOT at NLD regimen on 30th day after initiation of lay.



Control: NLD, Gr-I: 15-45day HPOT, Gr-II: 30-60day HPOT, Gr-III: 45-75day HPOT, Gr-IV: 60-90day HPOT, a: $p \leq 0.05$, b: $p \leq 0.02$, c: $p \leq 0.001$ of 6 animals

DISCUSSION:

The results of the present study involving induction of transient hypothyroidism by Methimazole given through feed at different windows during the rearing stage have shown differing effect on various parameters taken for evaluation. For the sake of convenience and ease of understanding, individual parameters have been discussed separately and an overall integrated conclusion drawn at the end.

Features of Egg lay:

It is clear from the data that hypothyroidism during the rearing period has a definite favourable influence on early sexual maturation and initiation of egg laying. Considering 23 weeks as a period of initiation of egg laying and, 158 days as the age of 1st egg as seen in control pullets, hypothyroidism induced at the mid phase prior to sexual maturation, seems to be more favourable in terms of early initiation of egg laying as well as the number of eggs laid during the 1st month. This is indicated by the herein observed initiation of egg laying by 125 days and a cumulative lay of 22 eggs in the 1st month of pullets rendered hypothyroidic between 45 – 75 days (6 – 11 weeks) and, initiation of laying at 119 days with a cumulative lay of 21.5 eggs during the 1st month by pullets hypothyroidic between 60 – 90 days (9 – 13 weeks), compared with the initiation of lay by 158 days and a cumulative lay of 25 eggs in the control pullets. An advancement in egg laying by 39 and 33 days respectively by the 60 – 90 and 45 – 75 days hypothyroidic birds is quiet significant. However, the average egg weight for the month shows a clear cut descending trend with the highest weight of 38.7 gms. In controls to a lowest weight of 28.3 gms. In the 9 – 13 weeks hypothyroid group. An earlier study on white leghorn pullets had reported better performance in respect of age at first egg, age at sexual maturity and rate of lay when the chicks were treated with Methimazole from 2 weeks to 15 weeks of age (Singh and Parshad, 1978). The above study showed advancement in age at first egg of only 9 days as against presently observed advancement by 39 days, which is quite significant. However, two points of differences between the two studies are the breeds of chicks used (White leghorn VS Rhode Island Red) and the period of hypothyroidism (2-15 weeks vs 9-13 weeks). Obviously, a timed transient hypothyroidism in the mid phase from hatching to attainment of sexual maturity is more favourable in early egg laying. The present study also shows that hypothyroidism induced much earlier during the first 9 weeks of rearing period is more detrimental as the number of eggs laid was poor though advancement in initiation of lay by 13-21 days occurred. Peebles *et al.* (1994) have shown better egg production after 5-6 weeks from initiation of egg lay in single comb white leghorn birds subjected to thyroid Suppression from 0-6 weeks of age. The above study also shows Suppressed egg weight along with reduced egg production during the first 5 weeks of egg lay. Similar decrease in egg weight but an increased egg production later between 32 and 50 weeks of age was also recorded by Peebles *et al.* (1997) in a later study by induction of hypothyroidism from 0-6 weeks of age.

Physical Parameters of Eggs:

The egg volume shows a graded decrease from control to 9-13 weeks hypothyroid group, through 2-6 week, 4-9 weeks and 6 – 11 weeks hypothyroid groups, corresponding to the egg weight of both 1st day as well as 30th day eggs. Significantly the change in egg weight from the 1st day egg to the 30th day egg is as high as 42% in 9-13 week hypothyroid group compared to only 11% increase in control group. This is suggestive of increasing egg quality in the hypothyroid group to compensate for the decreased egg weight due to early initiation of egg lay. The shell weight of 1st day egg is higher in hypothyroid groups and the weight 30th day egg was lower. Among the hypothyroid groups, 2-6 week and 4-9 week groups had the highest weights and the 6 – 11 week and 9 -13 week groups had the lowest weights. The altered shell weight of hypothyroid groups is essentially due to alterations in shell length and width rather than any alterations in shell thickness. Decreased shell thickness due to hypothyroidism has also been reported in the white leghorn (Singh and Parshad, 1978). In this connection it has been opined that altered thyroid activity can affect egg shell formation (Wentworth and Ringer, 1986). Asmundson and Pinsky (1935) had observed increased shell weight in birds fed with desiccated thyroid during lay and further, Peebles *et al.* (1992) has recorded decreased shell weight per unit area in white leghorn chickens fed 0.1% dietary thiouracil. Though in the present study a definite influence of timed transient hypothyroidism is noticeable, earlier work on thiouracil induced hypothyroidism from 0-6 weeks or form 6-16 weeks could not register any change in egg quality (Peebles *et al.*, 1994).

In terms of yolk and albumen weight, the first day eggs of hypothyroid groups show significantly lesser yolk and albumen content compared to control eggs. But in the 30th day eggs, there is no significant difference in albumen weight while, the yolk weight is significantly lesser in the control eggs whereas, the albumen content remains the same. The yolk content is significantly increased from the 1st egg to the 30th egg; similar increment in the yolk content is also seen in hypothyroid group of eggs. The increment in yolk content from 1st day to 30th day egg, results in significantly increased yolk : albumen ratio which is seen in all groups except, in group II, where increase in both yolk and albumen content to the same proportion contributes to no net increase in yolk : albumen ratio.

Biochemical Composition

A comparison of the percentage content of water and solids in the yolk and albumen shows that there is a marginal increase in the solid content of both yolk and albumen from the 1st egg to the 30th day egg of the control hens. Similar pattern of changes is seen in the eggs of all experimental groups except the 9-13 week hypothyroid group. The egg of this group shows significantly increased solid content of both yolk and albumen in the 1st day egg as well as the 30th day egg. The conservative and critical importance of water content for avian embryonic development and the relatively lesser content of water in the yolk due to increased lipid load have been well recognized (Roca *et al.*, 1984). Seen in this perspective, hypothyroidism between 9–13 weeks seems to favour developmental activities due to the increased solid content in both yolk and albumen. Whereas there is no difference in the total protein content of yolk from the 1st day egg to the 30th day egg of the control hens, the albumen content is significantly decreased in the 30th day egg. Whereas the 1st day egg of all hypothyroid groups show reduced yolk protein content, in the 30th day egg, significant decrement in yolk- protein content is seen only in the 9 – 13 week hypothyroid group. In contrast, there is no difference in the albumen protein content of 1st day eggs between groups; there is significantly increased albumen protein content in the 30th day eggs of all hypothyroid groups. In general, the total lipid content of albumen is significantly high both in the 1st day egg as well as the 30th day egg of all hypothyroid groups. However there is an initial increased yolk lipid content in the 1st day eggs of all hypothyroid groups, which gets nullified in the later laid eggs. Apparently, hypothyroidism seems to have an influence on the total lipid content of albumen. The content of water and lipids of eggs portrayed as ratio of the non lipid dry material (Water index and lipid index respectively) is expected to show correspondence with the water and lipid indices of newly hatched chicks due to the fact that, the non lipid dry component is the most conservative fraction of the egg used primarily for synthesis and thereby assimilated by the embryo, while the water and lipid content of the eggs decrease during incubation owing to evaporation and metabolism respectively during respiration (Ricklefs, 1977). Both the water and lipid indices are higher in the eggs of hypothyroid hens. A scrutiny of the water and lipid indices of the yolk and albumen fractions reveals similar water index for yolk and decreased water index of albumen and increased lipid index of both yolk and albumen from the 1st day eggs to the 30th day eggs of the control hens. In general, lipid index of albumen of both 1st day and 30th day and, the lipid index of yolk of 1st day eggs of all hypothyroid groups are increased relative to controls. The 1st day eggs of all hypothyroid hens show decreased cholesterol content in both yolk and albumen. However in the 30th day egg, the albumen cholesterol content is significantly increased with reduction of yolk cholesterol content of groups II and III. Hall and McKay (1993) had inferred the occurrence of higher yolk cholesterol content in the early eggs of hens, commencing lay at an earlier age due to a high cholesterol laden plasma lipoprotein in the immature birds as against low cholesterol laden plasma lipoprotein in the mature birds. However the presently observed relatively lesser yolk cholesterol content in the eggs of hypothyroid hens, is contradictory, and may be related with altered lipoprotein metabolism due to hypothyroidism in the rearing ages. The observed difference in the albumen cholesterol content could also be an indication of the induced alteration in the lipoprotein metabolism of the oviduct as well.

In terms of nutritional value, the eggs of hypothyroid hens are apparently inferior as, the energy content of whole egg is lower by 8% - 51% relative to the control eggs at 30 days. However, with respect to 1st day eggs, whereas there is no difference in the nutritional value of the eggs of 2 – 6 and 6- 10 weeks hypothyroid hens, the eggs of 4 – 8 and 9 – 13 weeks hypothyroid hens show a reduction in nutritional value by 23 – 30%.

Overall the present study indicates the favourable influence of appropriately timed hypothyroidism on age at 1^{st} egg, egg production and biochemical composition and nutritive value of eggs, though the present study has not tried to evaluate the biochemical composition, and nutritive value of eggs laid after 1^{st} month of initiation. The low caloric eggs of 1^{st} month could be useful from the human health perspective.

Summary:

The present study was undertaken to assess the influence of hypothyroidism induced in pullets at different windows during the first 90 days of post hatched development on age at first egg, the number of eggs laid during the first month of lay, and the physical parameters and chemical composition of the eggs. The birds were subjected to hypothyroidism (HPOT) at different ages for the duration of 30 days, and maintained under normal photoperiod. The results found were group II to IV showed significant early initiation of lay, by13, 17, 23 and 42 days respectively. There was an increment in egg weight from first laid egg to the 30^{th} day egg in all the groups. The yolk protein content of both $1^{st\ day}$ egg as well as the 30^{th} day egg was lesser in all groups. The whole egg calorific value of 1^{st} day as well as 30^{th} day eggs of all experimental groups was significantly lower

than the corresponding control eggs. Overall the present study indicates the favourable influence of appropriately timed hypothyroidism on age at 1st egg, egg production and biochemical composition and nutritive value of eggs.