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Effect of Thyroid Activity Modulation on Some Histological and Biochemical Aspects in Broiler Chicks

Research Article

I. El-Wardany[1], E.F. El-Daly[2], A.H. Abd El-Gawad[2], A.E.A. Hemid[1] and N.A. Abd El-Azeem[2*]

[1] Department of Poultry Production, Faculty of Agriculture, Ain Shams University, Shobra El-Kheima, Cairo, Egypt
[2] Department of Animal Production, National Research Centre, Dokki, Cairo, Egypt

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*Correspondence E-mail: nafisa.nrc@gmail.com

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ABSTRACT

An experiment was conducted to investigate the effect of thyroid gland activity modulation (Hyper or hypothyroidism) on energy utilization in broiler chickens. Two hundred and forty one-day-old Cobb broiler chicks were distributed into three dietary metabolizable energy (ME) treatment groups (80 chicks each). The control group (E0) was fed basal diet (3150 kcal/kg diet), the second group (E1) was fed low ME diet (3000, kcal/kg diet) with different thyroidal treatments and the third group (E2) was fed very low ME diet (2850 kcal/kg diet) with thyroidal treatments. Thyroidal treatments were applied at the beginning of the 2nd week, where (T0) was a control treatment; two hyperthyroidism groups induced by administration of Eltroxin (T1) or calcium iodide (T2), and hypothyroidism group induced by carbimazole administration (T3). Results showed that plasma thyroidal hormones (T_3, T_4) concentrations and their ratio T_3 / T_4 showed considerable changes related to thyroidal treatments. Plasma glucagon (G) level was significantly increased while insulin (I) level and I / G ratio were significantly decreased as affected by lowenergy diets. Carbimazole administration group had the lowest plasma insulin level and I / G ratio compared to other treatments. Moreover, calcium iodide significantly increased adenosine triphosphate (ATP), Total adenylate (TA) and phosphate potential (PP) while carbimazole significantly decreased adenosine diphosphate (ADP) and adenosine monophosphate (AMP). Histological examination of thyroid gland sections reflect the beneficial use of calcium iodide (CaI) as a safe additive without hazards effect on thyroid gland histology. Results suggested that calcium iodide could be used to maximize the utilization of lowenergy diets, via its modulating action of thyroid gland activity.

KEY WORDS broiler chicks, calcium iodide, carbimazole, Eltroxin, energy metabolism, thyroid activity.

INTRODUCTION

Thyroid hormones are considered to be the key controllers of metabolic heat production to maintain body temperature in homoeothermic birds (Danforth and Burger, 1984). Furthermore, thyroid and pancreatic hormones are involved in the regulation of growth, metabolism, heat production, glycogen synthesis and storage, and energy retrieval from body deposits when dietary energy intake does not meet the demands of tissues to perform their physiological functions (Hazelwood, 2000; McNabb, 2000).

Any pronounced alteration in thyroid function (i.e., hyperthyroidism or hypothyroidism) may reflect in metabolic disorders. If there is too much thyroid hormone, every function of the body tends to speed up. Depressed thyroid activity is reflected in reduced metabolic rate, increased fat deposition, and, in some cases, growth depression (Abdelatif and Elkhair, 2009).

Therefore, the present study was conducted on broiler chicks with the following main objectives:

1) To determine the relationship (s) between thyroid gland activity and pancreatic hormones in regulating physiological function of birds under stress conditions (low energy, high summer temperature).

2) To examine the role of exogenous administration of thyroxine versus calcium iodide on energy utilization and productivity.

3) To determine the effect of thyroid gland status on the high energy phosphate derivatives (ATP, ADP, AMP), phosphate potential and total adenylate system.

4) To study the histological changes in thyroid gland associated with treatments (Eltroxin (Eltr.), carbimazoleand calcium iodide).

MATERIALS AND METHODS

The present study was carried out in the poultry farm of the Facylty of Agriculture Ain Shams University, Cairo, Egypt during the period from July to September 2009.

A total of 240 one-day-old Cobb broiler chicks were wing banded, individually weighed and divided into three different dietary metabolizable energy (ME) groups (80 chicks each).

All chicks, within groups, had nearly similar initial body weights and they were brooded and housed in cages.

A continuous lighting programme was provided throughout the first week of rearing and then two hours of darkness was supplied until the end of the experiment.

At the beginning of the 2nd week, the previous groups were subdivided into 10 experimental treatment groups, 24 chicks each, in individual cages (2 chicks each). The experimental treatments are shown in Table 1. Feed and water were offered *ad-libtum* during the experimental period, which lasted for 6 weeks. All chicks were fed starter diets from 1 to 14 days of age and grower diets from15 to 28 days of age and finisher diets from 29 to 42 days of age. The basal control diets were formulated to satisfy nutrients needed as recommended by the manual of the strain used. The composition and chemical analysis of the experimental diets are presented in Table 2.

Measurements:

At 6 weeks of age, 8 blood samples per treatment were collected in heparinized tubes and centrifuged at 4000 rpm for 10 min. Plasma obtained was stored at -20 ˚C until analysis.

1. Plasma thyroxine and triiodothyronine (T_3 and T_4)

Plasma T_4 and T_3 were determined by RIA technique using Gamma- Coat ^{125}I RIA Kits, Clinical Assay, Cambridge, Medical Diagnostics, Boston, MA, as reported by Akiba *et al.* (1982).

2. Plasma insulin (I) and glucagon (G)

Plasma insulin and glucagon hormones (ng/mL) were determined by immunoradiometric assay kit (Immunotec, S.A.Cat / 3210, Beckman coulter company, France) according to Shimizu *et al.* (1994) and immunotech, RIA kits according to Colca and Hazelwood (1982), respectively.

3. Enzymatic determination of adenosine nucleotides (ATP, ADP and AMP) and phosphorus

Determination of ATP was carried out according to the method described by Lamprecht and Trautschold (1974). While, ADP and AMP were determined according to the method described by Jaworek *et al.* (1974).

Plasma phosphorus was determined by using commercial kits purchased from Spinreact, S. A., Ctra. Santa Coloma, Spain; according to the method of Henry (1974).

4. Adenylate Energy Charge (AEC)

AEC has been suggested as a measure of the energy potential available from the adenylate system of the cellular metabolism. This measure is calculated from the following equation according to Atkinson and Walton (1974).

AEC= (1/2(ADP)+ATP) / (Total adenylate)

Total adenylate (µmoles/100 mL)= ATP + ADP + AMP

Phosphate potential= (ATP) / (ADP) (Pi)

Histological observations

At six weeks of age representative tissue samples from thyroid gland were taken to study the histological changes associated with the experimental treatments.

Samples were fixed in a 10% formalin-saline solution before preparing the histological sections by using paraffin method technique.

All sections were dehydrated in ascending grades of ethanol, cleared in xylene and then embedded in paraffin wax. Transverse sections (4-5 microns, thickness) were taken, mounted on glass slides and stained with haemotoxyline and eosin (H and E) stains. All sections were examined under electric microscope provided with computerized Camera.

Statistical analysis

Data were subjected to the analysis of variance by using the General Linear Models Procedure (GLM) of the Statistical Analysis System (SAS, 1994). Differences among treatment means were detected by using Duncan's multiple range test (Duncan, 1955).

Table 1 The experimental treatments

Expermintal groups	Symbol	Description
1	E0T0	Fed the basal diet, which was formulated to satisfy the recommended requirements of broiler chicks without any treatment.
2	E0T1	Fed the basal diet and weekly oral intubation of 1 mg Eltroxin (Eltr.)*/kg live body weight.
3	E0T2	Fed the basal diet and oral administration of 1 mg calcium iodide**/kg live body weight weekly.
4	E0T3	Fed the basal diet and weekly oral intubation of 1mg carbimazole***/kg live body weight.
5	E1T1	Fed the basal diet with low ME level (3000 kcal/kg diet) and weekly oral intubation of 1 mg Eltr./kg live body weight.
6	E1T2	Fed the basal diet with low ME level and oral administration of 1 mg calcium iodide/kg live body weight weekly.
7	E1T3	Fed the basal diet with low ME level and weekly oral intubation of 1 mg carbimazole/kg live body weight.
8	E2T1	Fed the basal diet with very low ME level (2850 kcal/kg diet) and weekly oral intubation of 1 mg Eltr./kg live body weight.
9	E2T2	Fed the basal diet with very low ME level and oral administration of 1 mg calcium iodide/kg live body weight weekly.
10	E2T3	Fed the basal diet with very low ME level and weekly oral intubation of 1 mg carbimazole/kg live body weight.

* Eltroxin is a therapeutic drug manufactured by GlaxoSmithKline GmbH- Germany and packed by GlaxoSmithKline S.A.E., El Salam City, Cairo, A.R.E. (Tablets containing 0.1 mg anhydrous thyroxine sodium).
** Calcium iodide was purchased from NISR SEED ADDITIVE Company (containing 68% iodide).
*** Carbimazole is a therapeutic drug manufactured and packed by CID Company for Pharmaceuticals industries, Cairo, A.R.E. (Tablets containing 5 mg carbimazole).
ME: metabolizable energy.

RESULTS AND DISCUSSION

1. Plasma thyroidal hormones

Thyroid hormones (T_3 and T_4) concentration of broiler chicks at 6 weeks of age as influenced by dietary energy level and thyroidal treatments are presented in Table 3. It is clear from the results that calcium iodide (CaI) administration with different dietary energy levels significantly increased plasma T_3 and T_4 concentrations except plasma T_4 concentration in the very low energy treatment (E2T2). In general, thyroid hormones increased with Eltr. and calcium iodide (CaI) administration and decreased with carbimazole. It is of interest to notice that Eltr. and CaI administration to the lowenergy diets significantly increased T_4 concentration to approximately similar levels (19.34 and 19.56 ng/mL, respectively) compared with a low concentration in the control treatment (17.30 ng/mL). On the other hand, dietary energy levels combined with CaI administration was shown to affect T_3 / T_4 ratio to greater extent than did other thyroidal treatments. It is clear from the previous results that CaI administration to low energy diets could increase plasma T_3 and T_4 concentrations when compared with the other thyroidal treatments. This increase was more obvious for T_3 level which may be related to its metabolic activity as the most potent thyroid hormone regulating the metabolism in the living organisms.

Eltr. treatment did not increase plasma T_3 concentration to similar values of CaI which is due mainly to a possible negative feed back mechanism between the excessive exogenous circulating hormone and the endogenous release of both T_3 and T_4. This effect of Eltr. was more obvious for increasing plasma T_4 level to be equal to that of CaI effect on plasma T_4 concentration regardless the dietary energy level. It seems that Eltr. (T_4-like) can increase plasma T_4 as an exogenous supply, but it has no impact in the turnover of T_4 to T_3.

Table 2 Composition and calculated analysis of the experimental diets

Ingredients (%)	Control (E0)			Control -150 kcal/kg (E1)			Control -300 kcal/kg (E2)		
	Starter	Grower	Finisher	Starter	Grower	Finisher	Starter	Grower	Finisher
Yellow corn	61.800	70.000	72.000	61.800	69.000	72.100	56.800	63.400	67.100
Soybean meal 48%	23.200	15.650	13.100	29.500	23.800	19.300	34.900	26.700	24.600
Wheat bran	------	------	------	------	------	------	4.100	5.500	4.200
Corn gluten meal 62%	9.000	8.600	8.850	4.300	2.700	4.300	------	------	------
DL-methionine 99%	0.205	0.255	0.220	0.240	0.300	0.250	0.275	0.320	0.285
L-lysine HCl	0.460	0.640	0.580	0.265	0.395	0.390	0.090	0.285	0.215
Bone meal	3.100	3.015	2.900	3.050	2.965	2.815	2.980	2.900	2.735
Vegetable oil	1.400	1.000	1.500	------	------	------	------	------	------
Premix*	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300
Choline Chloride 50%	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
Salt	0.285	0.260	0.250	0.245	0.260	0.245	0.255	0.245	0.215
Sodium Bicarbonate	0.150	0.180	0.200	0.200	0.180	0.200	0.200	0.250	0.250
Total (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated analysis									
CP (%)	23.03	20.02	18.99	22.99	20.00	19.02	23.02	20.02	19.01
ME (kcal/kg)	3152	3200	3253	3001	3050	3100	2853	2900	2951
Calcium (%)	1.01	0.96	0.92	1.01	0.96	0.91	1.00	0.96	0.90
Av.Phosphorus (%)	0.50	0.48	0.46	0.50	0.48	0.46	0.50	0.48	0.46
Methionine (%)	0.61	0.62	0.57	0.62	0.63	0.58	0.63	0.63	0.59
Methionine + Cystine (%)	1.00	0.96	0.90	1.00	0.96	0.90	1.00	0.96	0.90
Lysine (%)	1.35	1.27	1.15	1.35	1.27	1.15	1.35	1.27	1.15
EE (%)	4.24	4.07	4.62	2.80	2.97	3.08	2.68	2.89	2.96
CF (%)	2.38	2.26	2.21	2.57	2.48	2.40	3.06	3.04	2.90

* Each 3 kg contains: vitamin A 14500000 IU; vitamin D_3 6000000 IU; vitamin E 60 g; vitamin K_3 4 g; vitamin B_1 5 g; vitamin B_2 8 g; vitamin B_6 3.6 g; vitamin B_{12} 0.018 g; Niacin 84 g; Biotin 0.12 g; Folic 1.8 g; Pantothenic acid 22 g; Manganese 144 g; Iron 50 g; Copper 24 g; Iodine 1.2 g; Selenium 0.36 g; Zinc 120 g.
CP: crude protein; ME: metabolizable energy; EE: ether extract; CF: crude fiber.

Table 3 Plasma triiodothyronine (T_3) and thyroxine (T_4) levels of broiler chickens at 6 weeks of age

Treatments[1, 2]	T_3 (ng/mL)	T_4 (ng/mL)	T_3 / T_4 ratio
E0T0	3.47^{cd}	17.30^{cd}	0.20^{bc}
E0T1	3.63^{bcd}	22.65^{a}	0.16^{c}
E0T2	4.83^{a}	21.85^{ab}	0.22^{ab}
E0T3	3.45^{cd}	16.30^{cd}	0.21^{b}
E1T1	3.95^{abcd}	19.34^{bc}	0.20^{bc}
E1T2	4.56^{ab}	19.56^{abc}	0.23^{ab}
E1T3	3.47^{cd}	14.91^{d}	0.23^{ab}
E2T1	3.63^{bcd}	17.84^{cd}	0.21^{bc}
E2T2	4.30^{abc}	15.96^{d}	0.27^{a}
E2T3	3.22^{d}	15.04^{d}	0.21^{b}
SEM[3]	**0.251**	**0.935**	**0.001**

[1] T0: control; T1: eltroxin; T2: calcium iodide; T3: carbimazole; E0: control diet (3150 kcal/kg diet), E1: low ME level (3000 kcal/kg diet); E2: very low ME level (2850 kcal/kg diet).
[2] The means within the same column with at least one common letter, do not have significant difference (P>0.01).
[3] SEM: standard error of the means.

The lowest plasma T_3 and T_4 levels observed in carbimazole treatment are related to the hypothyroidism status due to the goitrogenic effect of carbimazole. In the same manner, but with another reason, is the lowest plasma level of thyroid hormones in the control group (E0T0) which mainly due to the effect of the environmental temperature. It is worth to note that the present study was done during summer. The results concerning T_3 / T_4 ratio (Table 3) showed significantly (P<0.01) higher ratios in CaI and carbimazole treatments. It appears that CaI increased the peripheral turnover of T_4 to T_3 in a natural physiological manner via iodide supplemen tation to thyroid gland to build up its hormones.

In contrast, carbimazole increased T_3/T_4 ratio to compensate for the low levels of both hormones. (Liu *et al.* 2006; Moravej *et al.* 2006; Akhlaghi and Zamiri, 2007).

2. Plasma insulin and glucagon levels:

Results of plasma insulin and glucagon levels of broiler chicks as influenced by dietary energy level and thyroidal

treatments are shown in Table 4. All dietary energy levels combined with Eltr. or CaI significantly (P<0.01) increased plasma insulin level. The control diet with Eltr. (E0T1), CaI (E0T2), (E1T2) and (E2T2) significantly (P<0.01) increased insulin level compared to the carbimazole treatments. Plasma glucagon level was significantly (P<0.01) affected by the dietary energy levels and the thyroidal treatments. Chicks fed very low dietary energy level with all thyroidal treatments had the highest glucagon levels along with the low energy diet with Eltr. compared with the control energy diet. However, calcium iodide with different energy diets significantly (P<0.01) decreased glucagon levels compared with the control, Eltr. and carbimazole treatments. The results show also that the dietary energy levels and thyroidal treatments significantly (P<0.01) affected insulin to glucagon ratio (I/G ratio), where the very low dietary energy diet with Eltr. and carbimazole significantly (P<0.01) decreased I/G ratio compared to the control and the low dietary energy diets with CaI (E1T2). Administration of carbimazole also significantly (P<0.01) affected I / G ratio, where carbimazole administration and calcium iodide had the lowest and the highest values for I / G ratio, respectively. These results support the well known fact that insulin is an anabolic hormone in birds, where its level was higher in both CaI and Eltr. treatments. It may be that insulin and thyroidal hormones act together in a synergetic mechanism to regulate energy metabolism. Indeed, this fact was reported by several studies including different avian and mammalian species (Tur *et al*. 1987; Rosebrough *et al*. 1988; Buyse *et al*. 1990; Rosebrough and McMurtry, 2003). Glucagon level was higher indicating a stress condition due to low energy content in the diets, since birds of these groups are in catabolic mode. This holds true as the insulin to glucagon ratio (I/G ratio) of these treatments was lower when compared with the other treatment groups. In this case, the concern is how to obtain adequate fuel to sustain the bird viability, even though little or no nutrients are available. Thus the bird must go to its endogenous nutrient bank and withdraw deposits made at an earlier time. Such a change favors the retrieval of nutrients previously stored but needed at the current moment. The same conclusion was reported by Hazelwood (1989, 1993).

3. Plasma P, ATP, ADP and AMP levels:

The effects of dietary energy level and thyroidal treatments on plasma Phosphorus, ATP, ADP and AMP levels in broiler chicks at 6 weeks of age are shown in Table 5. Plasma phosphorus (P) was significantly (P<0.01) affected by dietary energy level and thyroidal treatments. Chicks fed the control energy diet with Eltr. (E0T1) and very low dietary energy level with Eltr. or CaI (E2T1, E2T2) had the lowest (P) values compared with the other treatments.

Adenosine triphosphate (ATP) was changed by dietary energy level and thyroidal treatments where calcium iodide and Eltr. significantly (P<0.01) increased ATP level. On the other hand, carbimazole significantly (P<0.01) decreased ATP level regardless of the energy level in the diets. Moreover, adenosine diphosphate (ADP) level was, to a lesser extent, changed by dietary energy level and thyroidal treatments; where chicks fed very low dietary energy level combined with carbimazole recorded the lowest ADP value (0.4). A similar trend was observed for adenosine monophosphate (AMP) level where carbimazole and control treatments (E0T0) recorded the lowest values.

4. Total adenylate (TA), adenylate energy charge (AEC) and phosphate potential (PP) levels:

The TA, AEC and PP levels as influenced by different treatments are presented in Table 6. TA, AEC and PP levels were significantly (P≤0.01) changed by dietary energy level and thyroidal treatments. Eltr. and calcium iodide administration to the low energy diets had the highest TA values compared with the control and carbimazole treatments. ATP is a chemical compound that present in all cells and it is always available to release its energy rapidly and almost explosively wherever in the cell it is needed. The energy released from the nutrients is used to form ATP. The major portion of ATP is formed in the mitochondria (about 90%), and it has the ability of entering into many coupled reactions, *ie*. with the food to extract energy, and reactions related to many physiological mechanisms to provide energy for their operations (Martin, 1976). Therefore, it could be hypothesised that birds might compensate for the low energy supply by explosive release of energy from different body stores.

Examination of the adenylate system revealed that the thyroidal treatments significantly (P<0.01) increased ATP, AMP and to a lesser extent ADP which may be due to its continuous conversion to ATP. In the same manner, inorganic phosphate level was lower in thyroidal treatments as it is important for the formation of ATP. It appears that thyroid hormones increase the rate of formation of ATP to energize cellular functions.

This effect may be due to that thyroid hormones could stimulate almost all aspects of carbohydrate metabolism including rapid uptake of glucose by the cells, enhanced glycolysis and gluconeogenesis, increase rate of nutrients absorption and even increased insulin secretion with its resultant secondary effect on carbohydrate, fat and protein metabolism.

The results of the current study concur with this assumption, as insulin level in the thyroidal treatments (Eltr. and CaI) was higher than the hypothyroid treatment groups (Table 4).

Table 4 Plasma insulin and glucagon levels of broiler chickens at 6 weeks of age

Treatments[1, 2]	Insulin (ng/mL)	Glucagon (ng/mL)	I/G ratio
E0T0	3.21^{def}	2.47^{ef}	1.32^{b}
E0T1	3.83^{bcd}	2.98^{bcde}	1.29^{b}
E0T2	5.08^{a}	2.72^{def}	1.87^{a}
E0T3	2.97^{efg}	2.88^{cde}	1.03^{c}
E1T1	3.45^{cde}	3.53^{abc}	0.99^{cd}
E1T2	4.20^{b}	2.16^{f}	1.94^{a}
E1T3	2.44^{gh}	3.21^{bcd}	0.77^{de}
E2T1	2.75^{fgh}	3.91^{a}	0.70^{e}
E2T2	3.98^{cde}	3.04^{bcde}	1.32^{b}
E2T3	2.24^{h}	3.61^{ab}	0.62^{e}
SEM[3]	0.15	0.13	0.03

[1] T0: control; T1: eltroxin; T2: calcium iodide; T3: carbimazole; E0: control diet (3150 kcal/kg diet), E1: low ME level (3000 kcal/kg diet); E2: very low ME level (2850 kcal/kg diet).
[2] The means within the same column with at least one common letter, do not have significant difference (P>0.01).
[3] SEM: standard error of the means.

Table 5 Plasma phosphorus, ATP, ADP and AMP levels in broiler chicks at 6 weeks of age

Treatments[1, 2]	P (mg/dL)	ATP[3]	ADP[3]	AMP[3]
E0T0	5.58^{abcd4}	1.30^{d}	0.57^{a}	0.26^{e}
E0T1	4.87^{e}	1.30^{d}	0.56^{a}	0.35^{cd}
E0T2	6.06^{a}	1.34^{cd}	0.55^{a}	0.36^{bc}
E0T3	5.72^{abc}	1.32^{d}	0.60^{a}	0.19^{b}
E1T1	5.93^{ab}	1.41^{bcd}	0.54^{a}	0.35^{e}
E1T2	5.33^{bcde}	1.54^{bc}	0.49^{ab}	0.34^{ab}
E1T3	5.12^{cde}	1.31^{d}	0.48^{ab}	0.33^{f}
E2T1	4.95^{de}	1.61^{ab}	0.55^{a}	0.38^{d}
E2T2	4.89^{de}	1.74^{a}	0.47^{ab}	0.36^{e}
E2T3	5.29^{bcde}	1.45^{bcd}	0.40^{b}	0.23^{a}
SEM[4]	0.134	0.011	0.005	0.003

[1] T0: control; T1: eltroxin; T2: calcium iodide; T3: carbimazole; E0: control diet (3150 kcal/kg diet), E1: low ME level (3000 kcal/kg diet); E2: very low ME level (2850 kcal/kg diet).
[2] The means within the same column with at least one common letter, do not have significant difference (P>0.01).
[3] µ moles / µg protein / min.
[4] SEM: standard error of the means.

Table 6 Total adenylate (TA), adenylate energy charge (AEC) and phosphate potential (PP) levels in broiler chicks at 6 weeks of age

Treatments[1, 2]	TA (µ moles/100 mL)	AEC	PP
E0T0	2.13^{bc}	0.74^{bc}	0.41^{d}
E0T1	2.21^{bc}	0.72^{c}	0.48^{cd}
E0T2	2.25^{bc}	0.71^{c}	0.41^{d}
E0T3	2.11^{bc}	0.77^{ab}	0.40^{d}
E1T1	2.30^{abc}	0.73^{bc}	0.44^{cd}
E1T2	2.37^{ab}	0.75^{abc}	0.59^{bc}
E1T3	2.12^{bc}	0.73^{bc}	0.55^{bcd}
E2T1	2.53^{a}	0.74^{bc}	0.60^{bc}
E2T2	2.57^{a}	0.77^{ab}	0.77^{a}
E2T3	2.08^{c}	0.79^{a}	0.68^{ab}
SEM[3]	0.022	0.001	0.008

[1] T0: control; T1: eltroxin; T2: calcium iodide; T3: carbimazole; E0: control diet (3150 kcal/kg diet), E1: low ME level (3000 kcal/kg diet); E2: very low ME level (2850 kcal/kg diet).
[2] The means within the same column with at least one common letter, do not have significant difference (P>0.01).
[3] SEM: standard error of the means.

On the other hand, TA pool, AEC and PP increased in hyperthyroidal treatments compared with the others (Table 6), although some of these differences lacked the significant level. The values of AEC were nearly similar in all treatments, which may lend the fact that living organisms could obtain their required energy via different magnitudes to survive. This may be via degradation of body stores (fat and protein) to support energetic demands. In this respect, Hazelwood (1993) and Blem (1990) revealed that in stress conditions, including malnutrition or imbalanced diets, bir-

ds can rely on decreasing basal metabolic rate by 30 to 50% via modulating thyroid activity and initiating the stored energetic power of the body. The results of the current study are in agreement with this assertion.

5. Histological observations of thyroid gland:

Histological examination of thyroid gland sections from different treatment groups showed considerable changes associated with the thyroidal treatment and energy level. It is clear from Figure 1 that thyroid follicles of the control (T0E0) group are filled with colloid and their epithelial linning appeared cuboidal indicative of euthyroid status and normal thyroid hormones secretion. Eltroxin administration stimulates hyperactivity of thyroid gland in both E0 (control) and E1 (low energy diet) as shown in Figure 2 and 3. Thyroid follicles became larger, containing dense colloidal and scattered parafollicular cells (Figure 2) with many fibroblasts and lymphocytic cells. Connective tissues inbetween thyroid follicles along with blood vessels can be observed. High columnar epithelial linning of thyroid follicles could be seen especially in Figure 3 and 4 indicative of hyperactivity (or) continious stimulation for exogenous Eltr. to these follicles.

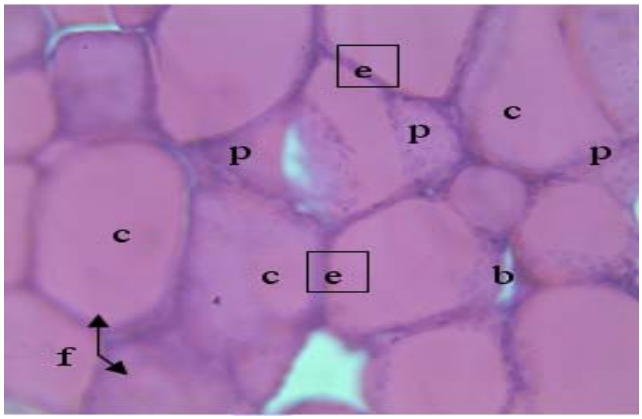

Figure 1 T.S. of thyroid gland from T0-E0 broiler chicks (H and Ex40)

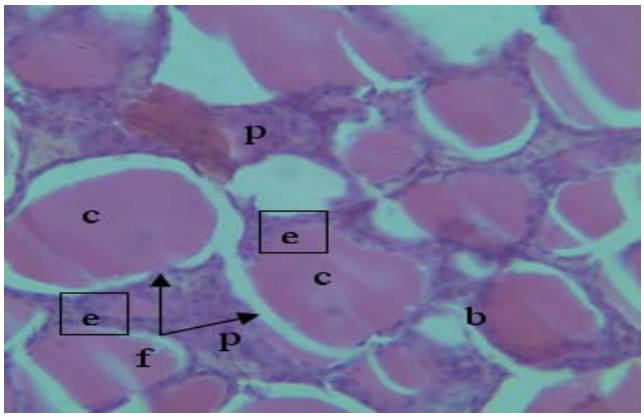

Figure 2 T.S. of thyroid gland from T1-E0 broiler chicks (H and Ex40)

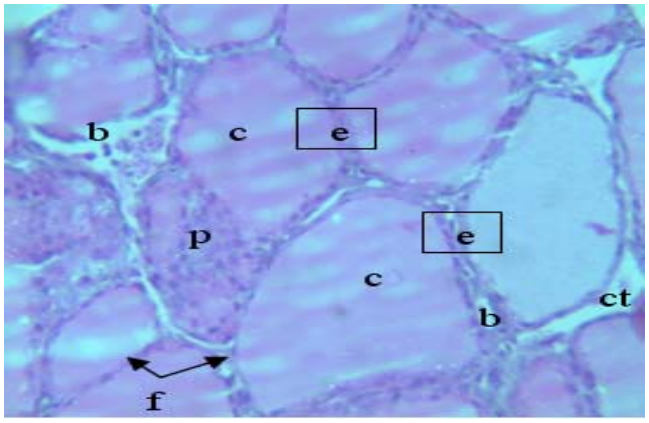

Figure 3 T.S. of thyroid gland from T1-E1 broiler chicks (H and Ex40)

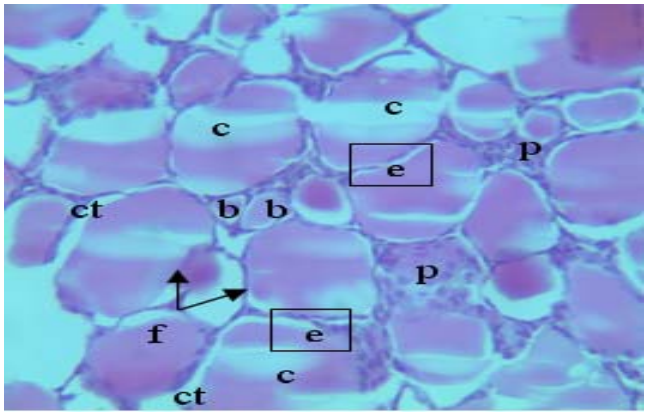

Figure 4 T.S. of thyroid gland from T1-E2 broiler chicks (H and Ex40)

Abbreviation key for thyroid sections:

f= thyroid follicles; c= colloid; e= epithelial linning; b= blood vessels; p= parafollicular cells; ct= connective tissue

E0= control diet (3150 kcal/kg of diet); E1= low ME level (3000 kcal/kg of diet); E2= very low ME level (2850 kcal/kg of diet)

Thyroid follicles of the E2 (very low energy) group were smaller in size with larg amount of colloid causing a pressure on the epithelial cells since, they appear as low cuboidal or even flattened cells which may reflect the aforementioned stimulation by T_4 or via hypothalamus (TRH). Parafollicular cells and CT septa are also present between the follicles (Figure 4).

Calcium iodide effects on the histological structure of thyroid glands in broiler chicks fed different dietary energy levels are shown in Figure 5, 6 and 7.

It is clear from Figure 5 that CaI induced hyperthyroidism in broiler chicks that fed the control diet (E0). This holds true as the follicles became elongated and containing smaller amounts of colloids indicative of continuel release of thyroid hormones.

This observation was also observed in Figure 6 and 7 which may reflect the beneficial effect(s) of CaI supplementation for enhancing thyroid activity, especially in the very low energy (E2) treatment.

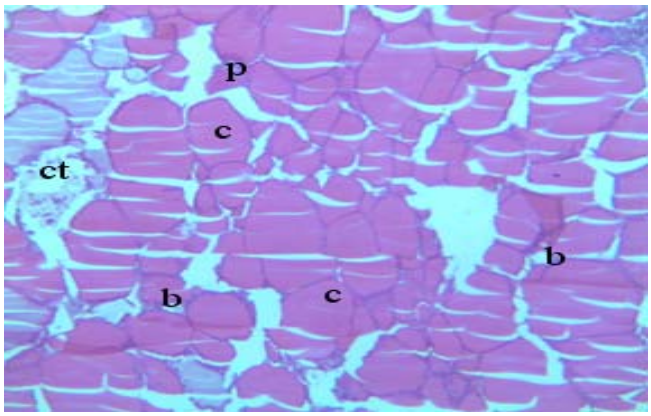

Figure 5 T.S. of thyroid gland from T2-E0 broiler chicks (H and Ex40)

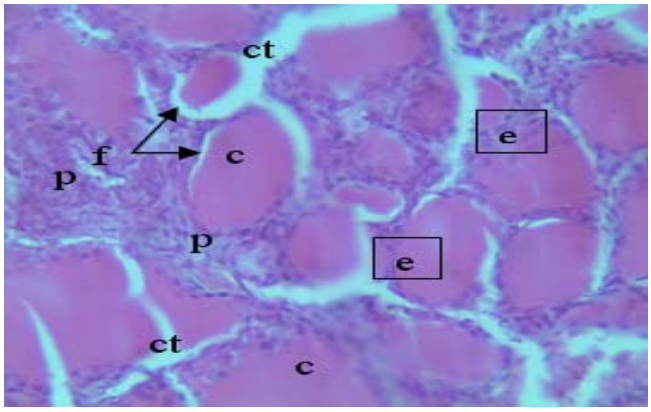

Figure 6 T.S. of thyroid gland from T2-E1 broiler chicks (H and Ex40)

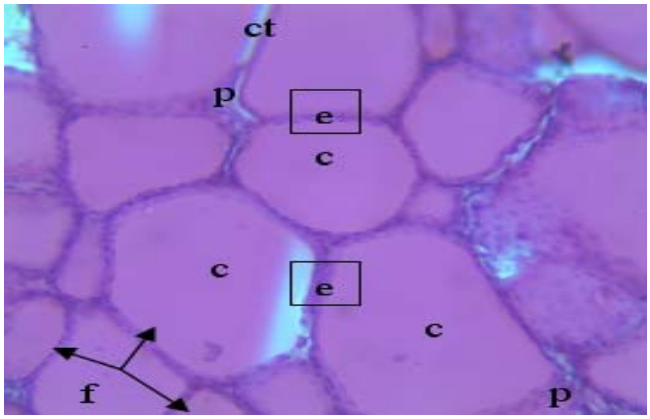

Figure 7 T.S. of thyroid gland from T2-E2 broiler chicks (H and Ex40)
Abbreviation key for thyroid sections:
f= thyroid follicles; c= colloid; e= epithelial linning; b= blood vessels; p= parafollicular cells; ct= connective tissue
E0= control diet (3150 kcal/kg of diet); E1= low ME level (3000 kcal/kg of diet); E2= very low ME level (2850 kcal/kg of diet)

The most obvious observation was the presence of many parafollicular cells and CT septa (Figure 6) and the ideal structure of thyroid follicles in Figure 7 with their columnar epithelial linning and moderate colloid material within follicles. Carbimazole, as goitrogenic drugs, administration causes considerable changes in thyroid histology as illustrated in Figure 8, 9 and 10.

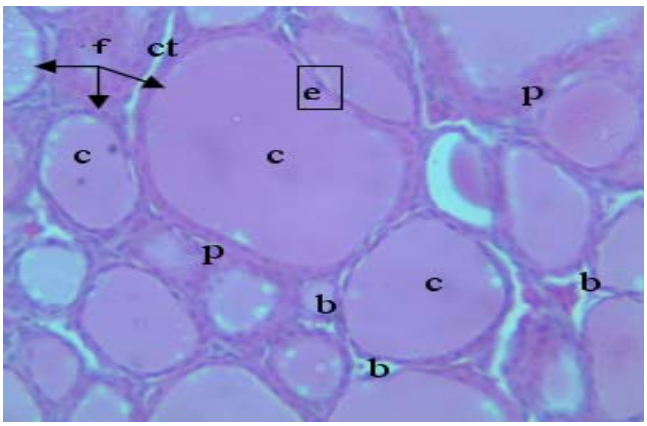

Figure 8 T.S. of thyroid gland from T3-E0 broiler chicks (H and Ex40)

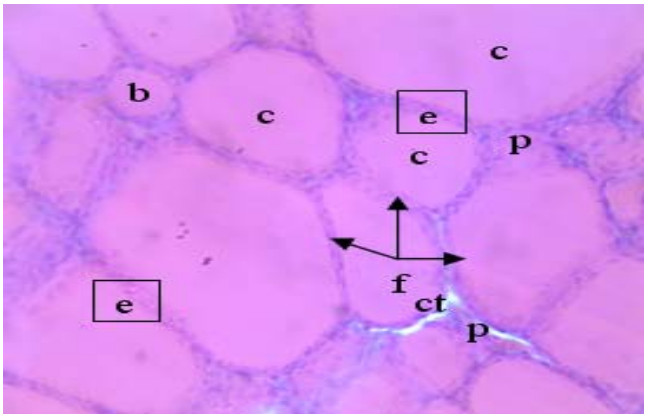

Figure 9 T.S. of thyroid gland from T3-E1 broiler chicks (H and Ex40)

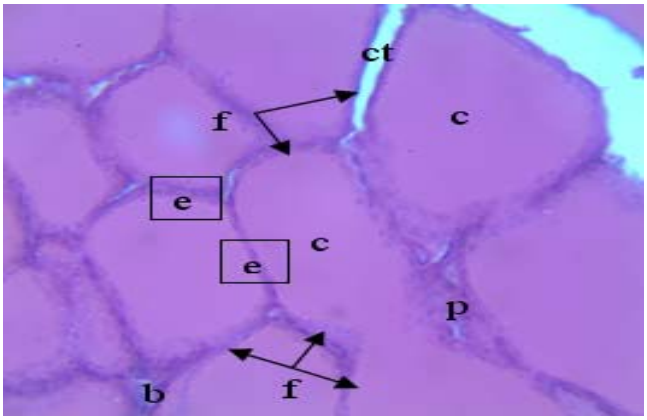

Figure 10 T.S. of thyroid gland from T3-E2 broiler chicks (H and Ex40)
Abbreviation key for thyroid sections:
f= thyroid follicles; c= colloid; e= epithelial linning; b= blood vessels; p= parafollicular cells; ct= connective tissue
E0= control diet (3150 kcal/kg of diet); E1= low ME level (3000 kcal/kg of diet); E2= very low ME level (2850 kcal/kg of diet)

There were many large follicles, being swollen, filled with larger amounts of colloid and linned with low cuboidal

or apparently flattened epithelium (Figure 9) indicative of hypothyroid status.

Smaller parafollicular areas could be seen, especially in Figure 9 and 10. Accumulation of colloidal materials within thyroid follicles in carbimazole- treated chicks was due mainly to a direct effect of carbimazole on iodide pump or iodine uptake by thyroid gland. This was confirmed by the earlier studies by Gilman and Murad (1975) and Chopra *et al*. (1982) who reported that carbimazole inhibits and even prevents the peroxidase enzyme from coupling and iodinating tyrosine residues, since causing hypothyroidism.

CONCLUSION

Administration of calcium iodide, Eltroxin and carbimazole resulted in considerable changes in thyroidal hormones and the ratio of T_3 / T_4. The most considerable effect on thyroid activity was associated with calcium iodide where broiler performance was improved energy utilization. The results of this study suggest that the utilization of low energy diets by broiler chicks could be maximized by administring calcium iodide via its modulating action of thyroid activity.

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