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

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Abstract: An experiment was conducted to investigate the effect of controlled thyroid gland activity (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) fed low ME diet (minus 150 kcal/ kg diet) with different thyroidal treatments and the third group (E2) fed very low ME diet (minus 300 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 was significantly decreased as affected by low energy 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 using calcium iodide to maximize the utilization of low energy diets, via its modulating action of thyroid gland activity.

Key words: Thyroid activity · Energy metabolism · Eltroxin · Carbimazole · Calcium iodide · Insulin · Glucagon · Broiler chicks

INTRODUCTION

Thyroid hormones considered the key controllers of metabolic heat production to maintain body temperature in homoeothermic birds [1]. Furthermore, thyroid and pancreatic hormones 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 [2, 3]. Any pronounced alteration in thyroid function (i.e., hyperthyroidism or hypothyroidism) is reflected 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 [4]. Therefore, the present study was conducted on broiler chicks with the following main objectives:

- To determine the relationship(s) between thyroid gland activity and pancreatic hormones in regulating physiological function of birds under stress condition (low energy, high summer temperature).
- To examine the role of exogenous administration of thyroxine versus calcium iodide on energy utilization and productivity.
- To determine the effect of thyroid gland status on the high energy phosphate derivatives (ATP, ADP, AMP), phosphate potential and total adenylate system.
- To study the histological changes in thyroid gland associated with treatments.

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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 1mg Eltroxin* / kg live body weight.
3	E0T2	Fed the basal diet and oral administration of 1mg 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 (minus 150 kcal/ kg diet) and weekly oral intubation of 1mg Eltroxin/ kg live body weight.
6	E1T2	Fed the basal diet with low ME level (minus 150 kcal/ kg diet) and oral administration of 1mg calcium iodide/ kg live body weight weekly.
7	E1T3	Fed the basal diet with low ME level (minus 150 kcal/ kg diet) and weekly oral intubation of 1mg carbimazole/ kg live body weight.
8	E2T1	Fed the basal diet with very low ME level (minus 300 kcal/ kg diet) and weekly oral intubation of 1mg Eltroxin/ kg live body weight.
9	E2T2	Fed the basal diet with very low ME level (minus 300 kcal/ kg diet) and oral administration of 1mg calcium iodide/ kg live body weight weekly.
10	E2T3	Fed the basal diet with very low ME level (minus 300 kcal/ kg diet) and weekly oral intubation of 1mg 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).

MATERIALS AND METHODS

The present study was carried out in the poultry farm, Fac. of Agric. Ain Shams Univ., 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 10 experimental treatment groups, 24 chicks each, in individual cages. 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/ treatment were collected in heparinized tubes and centrifuged at 4000 rpm for 10 min. Plasma obtained was stored at -20 °C until analysis. Plasma thyroxine (T_4) and triiodothyronine (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.* [5]. Plasma insulin (I) and glucagon (G) hormones (ng/ml) were determined by immunoradiometric assay kit (Immunotec, S.A.Cat/ 3210, Beckman coulter company, France) according to Shimizu *et al.* [6]. and immunotech, RIA kits according to Colca and Hazelwood [7], respectively.

Enzymatic determination of adenosine nucleotide (ATP) was carried out according to the method described by Lamprecht and Trautschold [8]. While, ADP and AMP were determined according to Jaworek *et al*. [9]. Plasma phosphorus was determined by using commercial kits purchased from Spinreact, S. A., Ctra. Santa Coloma, Spain, according to the method of Henry [10]. Adenylate Energy Charge (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 [11].

$$AEC = \frac{1/2\ (ADP) + ATP}{\text{Total adenylate}}$$

Total adenylate (μ moles/ 100 ml) = ATP + ADP +AMP

$$\text{Phosphate potential} = \frac{ATP}{(ADP)\ (Pi)}$$

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 zylene and then embedded in paraffin wax. Transverse sections

Table 2: Composition and calculated analysis of the experimental diets.

	Control (E0)			Control -150kcal/kg (E1)			Control -300kcal/kg (E2)		
Ingredients (%)	Starter	Grower	Finisher	Starter	Grower	Finisher	Starter	Grower	Finisher
Yellow corn	61.8	70	72	61.8	69	72.1	56.8	63.4	67.1
Soybean meal 48%	23.2	15.65	13.1	29.5	23.8	19.3	34.9	26.7	24.6
Wheat bran	--	--	--	--	--	--	4.1	5.5	4.2
Corn gluten meal 62%	9	8.6	8.85	4.3	2.7	4.3	--	--	--
DL-methionine 99%	0.205	0.255	0.22	0.24	0.3	0.25	0.275	0.32	0.285
L-lysine HCl	0.46	0.64	0.58	0.265	0.395	0.39	0.09	0.285	0.215
Bone meal	3.1	3.015	2.9	3.05	2.965	2.815	2.98	2.9	2.735
Vegetable oil	1.4	1	1.5	--	--	--	--	--	--
Premix*	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Choline Chloride (50%)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Salt	0.285	0.26	0.25	0.245	0.26	0.245	0.255	0.245	0.215
Sodium Bicarbonate	0.15	0.18	0.2	0.2	0.18	0.2	0.2	0.25	0.25
Total (%)	100	100	100	100	100	100	100	100	100
Calculated analysis									
CP %	23.03	20.02	18.99	22.99	20	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	0.96	0.9
Av.Phosphorus%	0.5	0.48	0.46	0.5	0.48	0.46	0.5	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	0.96	0.9	1	0.96	0.9	1	0.96	0.9
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	2.8	2.97	3.08	2.68	2.89	2.96
CF %	2.38	2.26	2.21	2.57	2.48	2.4	3.06	3.04	2.9

*Each 3 Kg contains: vit A 14500000 IU, vit D3 6000000 IU, vit E 60g, vit K3 4g, vit B1 5g, vit B2 8g, vit B6 3.6g, vit B12 0.018g, Niacin 84g, Biotin 0.12g, Folic 1.8g, Pantothenic acid 22g, Manganese 144g, Iron 50g, Copper 24g, Iodine 1.2g, Selenium 0.36g, Zinc 120g.

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

	Item		
Treatment	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	3.45cd	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	0.251	0.935	0.001
Significance	**	**	**

*P≤0.05, ** P≤0.01, NS= non-significant.

a, b,c and d Means within columns with no common superscripts differ significantly

SEM=Standard error of means.

T0 = Control, T1 = Eltroxin, T2 = Calcium iodide, T3 = Carbimazole

E0 = Control diet, E1 = Low ME level (minus 150 kcal/ kg diet), E2 = Very low ME level (minus 300 kcal/ kg diet).

(4-5 microns, thickness) were taken, mounted on glass slides and stained with haemotoxyline and eosin (H&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 [12]. Differences among treatment means were detected by using Duncan's multiple range test [13].

RESULTS AND DISCUSSION

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 differnet 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 Eltroxin and CaI administration and decreased with carbimazole. It is interest to notice that Eltroxin and Calcium iodide administration to the low energy 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. Eltroxin 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 eltroxin 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 eltroxin (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. 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 due to mainly to the effect of the environmental temperature. It is worse to note that the present study was done during summer. In this respect several research dealt with the temporary hypothyroidism status during summer season as the environmental temperature increases.

Interstingly, the results concerning T_3/T_4 ratio which showed significantly 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 supplementation to thyroid gland to build up its hormones. In contrast, carbimazole effect take different magnitude by increasing T_3/T_4 ratio to compensate for the low levels of both hormones. In agreement with the present results are many studies dealing with thyroid function in poultry and factors that may affect its hormones [14-22].

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 eltroxin or CaI had significantly affected plasma

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

	Item		
Treatments	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	0.15	0.13	0.03
Significance	**	**	**

** P≤0.05, ** P≤0.01, NS= non-significant.*

a, b,c and d Means within columns with no common superscripts differ significantly

SEM=Standard error of means.

T0 = Control, T1 = Eltroxin, T2 = Calcium iodide, T3 = Carbimazole

E0 = Control diet, E1 = Low ME level (minus 150 kcal/ kg diet), E2 = Very low ME level (minus 300 kcal/ kg diet).

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

	Item			
Treatments	P (mg/ dl)	ATP (µ moles/µg protein/min)	ADP (µ moles/µg protein/min)	AMP (µ moles/µg protein/min)
E0T0	5.58^{abcd}	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	0.134	0.011	0.00^{5}	0.003
Significance	**	**	0.06	**

$^{*}P\leq0.05$, $^{**}P\leq0.01$, NS= non-significant.

a, b,c and d Means within columns with no common superscripts differ significantly

SEM=Standard error of means.

T0 = Control, T1 = Eltroxin, T2 = Calcium iodide, T3 = Carbimazole

E0 = Control diet, E1 = Low ME level (minus 150 kcal/ kg diet), E2 = Very low ME level (minus 300 kcal/ kg diet).

insulin level where the control dietary energy (E0) diet with eltroxin (E0T1), CaI (E0T2), (E1T2) and (E2T2) significantly increased insulin level compared with the carbimazole treatments with different dietary energy levels. Plasma glucagon level was affected significantly by 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 eltroxin compared with the control energy diet. However, calcium iodide with different energy diets significantly decreased glucagon levels compared with the control, eltroxin and carbimazole treatments. Results also showed that dietary energy levels and thyroidal treatments had significantly affected insulin to glucagon ratio (I/G ratio) where the very low dietary energy diet with eltroxin and carbimazole significantly decreased (I/G ratio) compared with the control energy treatments and low dietary energy diets with CaI (E1T2). Administration of carbimazole with different dietary treatments also significantly affected (I/G ratio) where carbimazole administration had the lowest values for (I/ G ratio) compared by the highest value for calcium iodide and those for control and eltroxin treatments. In general, carbimazole with the very low energy diet (E2T3) had the lowest (I/G ratio) 0.62 ng/ml while chicks that fed low dietary energy level with calcium iodide (E1T2) had the highest value (1.94 ng/ml). These results support the well known fact that insulin is an anabolic hormone in birds, where its level was higher in both CaI and eltroxin treatment. It may be that insulin and thyroidal hormones acts together in a synergetic mechanism to regulate energy metabolism. Indeed, this fact was proved by several studies incluing different avian and mammalian species [23-26]. Glucagon level was higher indicating a stress condition due to low energy 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 feul 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 [27, 28].

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 affected by dietary energy level and thyroidal treatments. Chicks fed the control energy diet with eltroxin (E0T1) and very low dietary energy level with eltroxin or CaI (E2T1, E2T2) had the lowest (P) value compared with the other treatments. Adenosine triphosphate (ATP) was significantly changed by dietary energy level and thyroidal treatments where calcium iodide and eltroxin significantly increased (ATP) level. On the other hand, carbimazole significantly decreased (ATP) level regardless the energy level in the diet. Moreover, adenosine diphosphate (ADP) level was, to 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 0.40. A similar trend was observed for (AMP) level where carbimazole and control treatments (E0T0) recorded the lowest values.

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

	Item		
Treatment	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	0.022	0.001	0.008
Significance	**	**	**

$^{*}P\leq 0.05$, $^{**}P\leq .01$, NS= non-significant.

a, b,c and d Means within columns with no common superscripts differ significantly

SEM=Standard error of means.

T0 = Control, T1 = Eltroxin, T2 = Calcium iodide, T3 = Carbimazole

E0 = Control diet, E1 = Low ME level (minus 150 kcal/ kg diet), E2 = Very low ME level (minus 300 kcal/ kg diet).

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 changed by dietary energy level and thyroidal treatments. Eltroxin and calcium iodide administration to low energy diets had the highest TA values compared with the control and carbimazole treatments. It well known that (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 [29]. From the previous view, taking in mind our hypothesis, that birds might compensate for the low energy supply by explosive release of energy from different body stores, the adenylate system was examined. Indeed, an interesting results are obtained where the thyroidal treatments significantly 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. This assumption was true as insulin level in the thyroidal treatments (eltroxin and CaI) was higher than the hypothyroid treatment groups (Table 4). On the other hand, total adenylate pool (TA), adenylate energy charge (AEC) and phosphate potential (PP) increased in hyperthyroidal treatments compared with the others (Table 6), although some of these differences lacked the significant level. That (AEC) values are nearly similar in all treatments may support the fact that living organism could obtain their required energy via different magnitudes to be survive. This may be via degradation of body stores (protein, fat) to support energetic demands.

In this respect, Hazelwood [28] and Blem [30] reported that in stress conditions, including malnutrition or imbalanced diets, birds can rely on decreasing basal metabolic rate by 30 to 50% via modulating thyroid activity and initiating the stored energetic power of the body. This is in close agreement with our results.

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 Fig. 1 that thyroid follicles of the control (T0E0) group are filled with colloid and their epithelial linning appeared cuboidal indicative of euthyroid

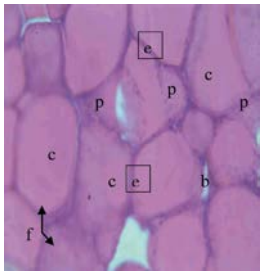

Fig. 1: T. S. of thyroid gland from T0- E0 broiler chicks (H&E x 40).

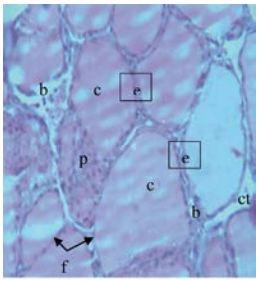

Fig. 3: T. S. of thyroid gland from T1- E1 broiler chicks (H&E x 40).

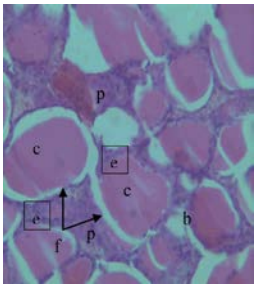

Fig. 2: T. S. of thyroid gland from T1- E0 broiler chicks (H&E x 40).

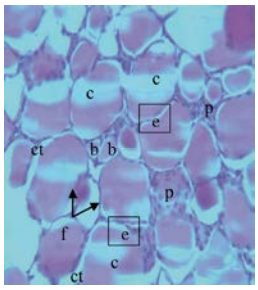

Fig. 4: T. S. of thyroid gland from T1- E2 broiler chicks (H&E x 40).

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, E1 = Low ME level (minus 150 kcal/ kg diet), E2 = Very low ME level (minus 300 kcal/ kg diet), T1 = Eltroxin.

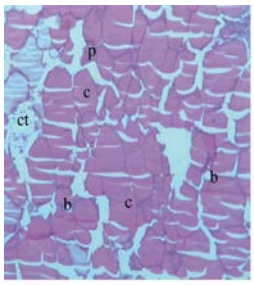

Fig. 5: T. S. of thyroid gland from T2- E0 broiler chicks (H&E x 40).

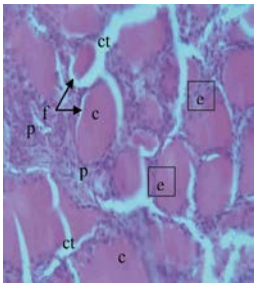

Fig. 6: T. S. of thyroid gland from T2- E1 broiler chicks (H&E x 40).

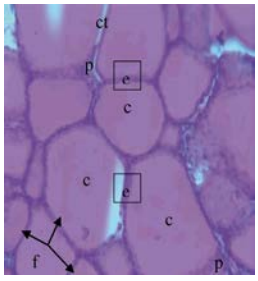

Fig. 7: T. S. of thyroid gland from T2- E2 broiler chicks (H&E x 40).

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, E1 = Low ME level (minus 150 kcal/ kg diet), E2 = Very low ME level (minus 300 kcal/ kg diet), T2 = Calcium iodide.

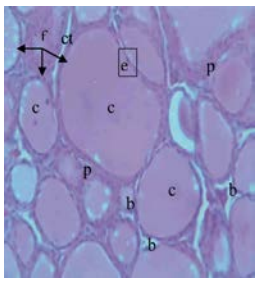

Fig. 8: T. S. of thyroid gland from T3- E0 broiler chicks (H&E x 40).

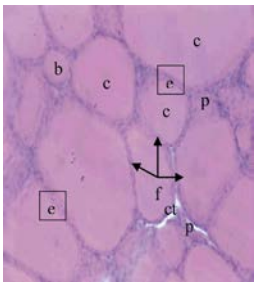

Fig. 9: T. S. of thyroid gland from T3- E1 broiler chicks (H&E x 40).

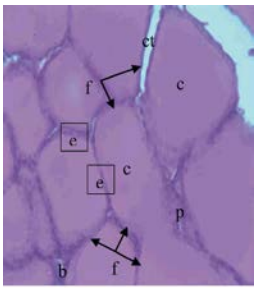

Fig. 10: T. S. of thyroid gland from T3- E2 broiler chicks (H&E x 40).

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, E1 = Low ME level (minus 150 kcal/ kg diet), E2 = Very low ME level (minus 300 kcal/ kg diet), T3 = Carbimazole.

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 Fig. 2 and 3. Thyroid follicles became larger, containing dense colloidal and scattered parafollicular cells (Fig. 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 Fig. 3 and 4 indicative of hyperactivity (or) continious stimulation for exogenous eltroxin to these follicles. 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 appears 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 (Fig. 4). Calcium iodide effects on the histological structure of thyroid glands in broiler chicks fed different dietary energy levels are shown in Fig. 5, 6 and 7. It is clear from Fig. 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 Fig. 6 and 7 which may reflect the beneficial effect(s) of CaI supplementation for enhancing thyroid activity, especially in the very low (E2) energy treatment. The most obvious observation was the presence of many parafollicular cells and CT septa (Fig. 6) and the ideal structure of thyroid follicles in Fig. 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 Fig. 8, 9 and 10. There were many large follicles, being swollen, filled with larger amounts of colloid and linned with low cuboidal or apparently flattened epithelium (Fig. 9) indicative of hypothyroid status. Smaller parafollicular areas could be seen, especially in Fig. 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 Gilman and Murad by [31] and Chopra *et al*. [32], who reported that carbimazole inhibits and even prevents the peroxidase enzyme from coupling and iodinating tyrosine residues, since causing hypothyroidism.

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