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Genetic and hormonal differences between high (Cobb Broiler) and low (Native Fayoumi) growth rate breeds of chicken

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ABSTRACT

The present study aimed to investigate the genetic and hormonal differences between low (Native Fayoumi) and high (Cobb Broiler) growth gate breeds of chicken. A total number of 100 one-day-old Fayoumi chicks and 100 one-day-old Cobb chicks were used. Chicks of each breed were allocated into three equal replicates. The growth parameters [body weight, Body weight gain (BWG) and Feed conversion ratio (FCR)], genetic expression of some growth-related genes (growth hormone, insulin like growth factor1, ghrelin and Myostatin gene) and plasma level of some growth-related hormones (Insulin, T_3, T_4 and corticosterone) were recorded. The obtained results revealed that, Cobb chicken had significantly higher ($p<0.05$) body weight, BWG and feed intake than Fayoumi chicken but the FCR of Fayoumi chicken was higher ($p<0.05$) than that of broiler chicken. Cobb recorded significantly ($p<0.05$) lower plasma level of corticosterone, T_3 and T_4 than Fayoumi chicken while Insulin is higher ($p<0.05$) in cobb chicken. Cobb recorded highly significant ($p<0.05$) values of GH, IGF1 and ghrelin Gene expression while myostatin gene expression was higher ($p<0.05$) in Fayoumi chicken than in Cobb. From the obtained results it could be concluded that, the observed high growth rate in cobb chicken may be attributed the difference in gene expression related growth as well as hormonal difference.

1. INTRODUCTION

Poultry production is a significant and diverse part of far ming worldwide (Kaya and Yildiz, 2008). In chickens selected for low growth rate, there is an increased expression of genes required for the proliferation of progenitor and differentiation of muscular cells on day of hatching compared to chickens selected for high growth rate (Yin et al., 2014). Growth efficiency is very important economic characteristic in broiler development and is regulated by complex genes. Growth considered a complex process, controlled by many neuroendocrine pathways (Zhang et al., 2008). Applying candidate gene lead to higher efficiency in detecting the desired traits for improving production performance. The chicken (cGH) and (IGF-I) genes are the most important genes for chicken growth (Kansaku et al., 2008).

corticosterone, the dominant adrenal glucocorticoid in bird, plays an important role in metabolism (Ramenofsky, 2011). It can be argued that myostatin could be a major determinant of chicken muscle mass, as seen in other species (Kocamis and Killefer, 2002). However, little is known about the relationships between the somatotropic gene expression profiles and the growth performance of chickens and the somatotropic axis so relations among body size and growth performance on the one hand and plasma hormone levels and the mRNA expression profiles of the somatotropic axis genes on the other hand. (Raza et al., 2019).

The present study aimed to investigate the genetic and hormonal differences between a low growth rate chicken breed (a native breed, Fayoumi chicken) and a high growth rate chicken breed (Cobb broiler chicken).

2. MATERIAL AND METHODS

2.1. Experimental design

A total number of one hundred f healthy one-day-old Cobb chicks (45 ± 5 g body weight) and one hundred healthy one-day-old Fayoumi chicks (30 ± 3 g body weight) of both sexes were assigned into two groups. Each group was allocated into 3 replicates. Group1: broiler chicks received starter (1:10 days), grower (11: 22days), finisher1 (23:42days) and finisher 2 (43:60 days) rations. Group 2: Fayoumi chicks received starter (0:24days), grower (29; 49 days) and finisher (50:60 days) rations as shown in table1.

2.2. Determination of the relative expression of growth-related genes (GH, IGF1 and myostatin)

Samples were collected at zero day and every 2 weeks till the end of experiment (2 months) from liver, skeletal muscle (breast muscle and thigh muscle) and proventriculus to be placed in sterile tubes that immediately stored at -80 °C. Expression of growth-related genes (Growth hormone, insulin like growth factor1, ghrelin and myostatin) was determined according to Livak and Schmittgen (2001). Forward and Reverse primers of RT-PCR was presented in table (2)

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2.3. Determination of the plasma level of hormones

Blood samples were collected in vacutainer tubes (coated with Heparin) then was carefully collected and kept frozen at -20 ℃ till used for determination of T_3, T_4, Corticosterone and insulin plasma level (Ottinger et al., 2001).

2.4. Growth parameters

The chicks were weighed individually at the start of experiment, then every week for recording the live body weights till the 8th week. Food intake was measured weekly and body weight gains were recorded (Abdel-Gawad et al., 2013).

2.5. Statistical analysis

All the data were statistically analyzed using SPSS (version 16). Hypothesis testing methods included independent sample T test. P values of less than 0.05 were indicated statistical significance. All the results were expressed as mean ± SE.

Table 1 The ingredients composition (%) of diet of the experimental groups.

Ingredients	Units	Starter (0-10)		Grower (11-22)		Finisher1,2 (23-60)		
		A	B	A	B	A		B
Yellow corn	%	55.24	56.33	58.17	64.22	60.40	63.16	65.69
Soybean meal (44%)		35.00	33.60	33.70	25.20	30.80	28.96	24.70
Corn gluten meal		3.00	3.80	0.40	3.80	0.70	--------	3.10
Vegetable oil		2.60	1.70	3.80	2.50	4.50	4.46	2.50
Dicalcium phosphate		1.30	1.50	1.30	1.30	1.10	1.00	1.20
Limestone		1.30	1.30	1.15	1.20	1.20	1.15	1.15
L – Lysine		0.34	0.41	0.30	0.30	0.30	0.30	0.30
DL – Methionine		0.32	0.36	0.30	0.31	0.25	0.23	0.29
Vitamin &mineral premix*		0.30	0.30	0.24	0.47	0.14	0.13	0.38
Sodium chloride		0.23	0.33	0.07	0.10	0.60	0.05	0.09
L – Threonine		0.10	0.10	0.31	0.31	0.31	0.31	0.31
Sodium bicarbonate		0.09	0.09	0.08	0.10	0.05	0.05	0.10
Anticolesterdia		0.05	0.05	0.05	0.05	0.05	0.05	0.05
Antimycotoxin		0.05	0.05	0.05	0.05	0.05	0.05	0.05
Energy enzyme		0.05	0.05	0.05	0.05	0.05	0.05	0.05
Anticoccedia		0.03	0.03	0.03	0.03	0.03	0.03	0.03
Phytase enzyme		0.01	0.01	0.01	0.01	0.01	0.01	0.01
Rhonzymr proact		0.01	0.01	0.01	0.01	0.01	0.01	0.01
Chemical composition								
ME (Kcal \ Kg diet)	(Kcal \ Kg diet)	3037.08	2,999.60	3107.80	3142.13	3181.62	3203.00	3179.22
CP	%	22.0	22.02	20.3	19.02	19.02	18.00	18.05
CF		5.23	3.52	2.80	5.34	3.10	3.12	5.92
Linoliec Acid		2.28	1.93	6.39	3.09	7.13	7.13	3.07
Lysine		1.32	1.35	3.53	2.33	3.37	3.29	2.60
Lysine Dig		1.21	1.24	1.19	1.20	1.05	1.00	1.11
Methionine		0.64	0.69	1.09	1.10	0.95	0.90	1.02
Methionine Dig		0.60	0.65	0.58	0.61	0.53	0.49	0.57
Methionine + Cystine		0.99	1.04	0.55	0.57	0.50	0.46	0.54
Methionine + Cystine Dig		0.88	0.93	0.90	0.92	0.84	0.79	0.87
Threonine		0.92	0.90	0.80	0.82	0.74	0.70	0.77
Threonine Dig		0.77	0.75	0.83	0.80	0.78	0.73	0.76
Calcium		0.91	0.95	0.69	0.67	0.65	0.61	0.64
Acid Base Balance	me / kg	223.76	217.83	0.84	0.84	0.81	0.76	0.81
Avalible Phosphorus		0.45	0.48	216.74	179.11	203.29	194.94	176.39
Chloride	%	0.17	0.23	0.44	0.43	0.40	0.38	0.40
Sodium		0.13	0.17	0.22	0.22	0.22	0.22	0.22
Potassium		0.88	0.86	0.16	0.16	0.15	0.15	0.16

Table 2 Forward and Reverse primers of RT-PCR

Gene		Primers (′5----------′3)
GH	Forward	AAGGGATCCAAGCTCCTGAT
	Reverse	ATAACCACGTCCCTCAGTGC
IGF1	Forward	CACCTAAATCTGCACGCT
	Reverse	CTTGTGGATGGCATGATCT
Myostatin	Forward	CGCTACCCGCTGACAGTGGAT
	Reverse	CAGGTGAGTGTGCGGGTATTTCT
Ghreline	Forward	CCT TGG GAC AGA AAC TGC TC
	Reverse	CAC CAA TTT CAA AAG GAA CG
18S	Forward	CGCGTGCATTTATCAGACCA
	Reverse	ACCCGTGGTCACCATGGTA

3. RESULTS

3.1. Differences between Fayoumi chicken and Cobb chicken on growth parameters

The obtained results (Tables 3-5) revealed that, male and female Cobb had significantly ($p<0.05$) increased body weight, BWG and feed intake than male and female Fayoumi, respectively during all ages (from 0 to 8 weeks of age). On the other hand, Fayoumi recorded significantly ($p<0.05$) increased FCR than Cobb during all experimental weeks except the 7th and 8th weeks of age where Cobb had significantly ($p<0.05$) increased FCR.

3.2. Differences between Fayoumi chicken and Cobb Chicken in GH, IGF1, ghrelin and Myostatin gene expression

The obtained results (Table 6 & Fig. 1) showed that, Cobb had significantly ($p<0.05$) increased expression of GH and IGF1, and ghrelin genes than Fayoumi chickens during all ages except at the first week of age. On the other hand, Fayoumi chicken recorded significantly ($p<0.05$) increased expression of myostatin gene than Cobb chickens during all ages except at the first week of age.

3.3. Differences between Fayoumi chicken and Cobb Chicken in corticosterone, T_3, T_4 and insulin hormone level

The obtained results (Table 7 & Fig. 2) revealed that, Fayoumi chickens had significantly ($p<0.05$) increased corticosterone, T_3 and T_4 level and significantly decreased insulin level than Cobb chickens during all ages (from 0 to 8 weeks of age).

4. DISCUSSION

In the present, results revealed that, male and female Cobb had significantly ($p<0.05$) higher body weight , body weight gain and feed intake than male and female Fayoumi, respectively during all ages. On the other hand, Fayoumi recorded significantly higher feed conversion ratio than Cobb during all experimental weeks except the 7th and 8th weeks of age where Cobb had significantly higher feed conversion ratio. Similar results were recorded by Jia et al., (2018) The Avian broilers had highly increased feed intake but lower FCR. The mean average weight gain recorded for Fayoumi chicks from hatch to 8 weeks was about 48.71 g is low. (Kebede, 2017). The Avian broilers showed the highest BW gains and had highest growth rate (daily BW gain) (Jia et al., 2018).

Table 3 Live body weights (g) of Fayoumi and Cobb Chickens (means ± SE):

Weeks	Male Fayoumi Chicken	male cobb Chicken	female Fayoumi Chicken	female cobb Chicken
W0	32.83[b]± 0.44	50.87 [a] ± 0.26	28.34 [b] ± 0.60	45.39 [a] ± 0.59
W1	74.49 [b] ± 1.22	167.62 [a] ± 1.59	62.73 [b] ± 4.00	134.06 [a] ± 1.08
W2	133.00 [b] ± 1.63	423.33 [a] ± 3.09	109.93 [b] ± 0. 74	376.88 [a] ± 2.30
W3	222.77 [b] ± 2.33	772.92 [a] ± 4.75	187.14 [b] ± 1.49	708.70 [a] ± 2.79
W4	325.38 [b] ± 1.99	1312.90 [a] ± 8.50	238.57 [b] ± 6.87	1131.20 [a] ± 12.45
W5	370.50 [b] ± 5.50	1529.60 [a] ± 22.40	298.00 [b] ± 7.05	1370.60 [a] ± 18.90
W6	430.70 [b] ± 4.80	1826.70 [a] ± 26.99	314.40 [b] ± 4.46	1711.90 [a] ± 14.17
W7	585.00 [b] ±14.58	2371.70 [a] ± 26.27	467.14 [b] ± 6.06	2328.80 [a] ± 26.45
W8	767.31 [b] ±14.76	2764.60 [a] ± 35.90	645.70 [b] ± 7.67	2675.60 [a] ± 22.60

Means with different letters at the same row differ significantly at (P<0.05)

Table 4 Average weekly weight gain (g) of Fayoumi and Cobb Chickens (means ± SE).

Weeks	male Fayoumi Chicken	male cobb Chicken	female Fayoumi Chicken	female cobb Chicken
W0-w1	41.65 [b] ± 1.47	116.67 [a] ± 1.54	37.30 [b] ± 1.10	88.67 [a] ± 0.54
W1-w2	58.50 [b] ± 2.17	255.71[a] ± 1.68	44.91 [b] ± 0.80	242.81[a] ± 1.39
W2-w3	89.77 [b] ± 1.58	349.58 [a] ± 2.90	78.00 [b] ± 0.50	331.88 [a] ± 1.60
W3-w4	102.60 [b] ± 2.77	540.00 [a] ± 4.39	107.50 [b] ± 5.95	422.50 [a] ± 9.77
W4-w5	47.00 [b] ± 6.11	216.67 [a] ± 20.84	53.30 [b] ± 10.30	239.38 [a] ± 9.10
W5-w6	145.77 [b] ± 45.20	297.08 [a] ± 18.28	44.17 [b] ± 3.90	341.25 [a] ± 9.05
W6-w7	154.77 [b] ± 16.38	545.00 [a] ± 33.73	130.00 [b] ± 6.10	616.88 [a] ± 14.54
W7-w8	182.31[b] ± 14.16	392.90 [a] ± 27.17	170.80 [b] ± 6.70	346.88 [a] ± 39.14
W0-W8	734.40 [b] ± 14.07	2761.60 [a] ± 36.00	617.30 [b] ± 7.25	2630.00 [a] ± 22.70

Means with different letters at the same row differ significantly at (P<0.05)

Table 5 FCR and feed intake in Fayoumi and Cobb Chickens (means ± SE):

	FCR		Feed intake	
Weeks	Fayoumi Chicken	Cobb Chicken	Fayoumi Chicken	Cobb Chicken
W0-w1	3.20 [a] ± 0.38	1.10 [b] ± 0.04	113.72 [b] ± 0.96	120.70 [a] ± 0.30
W1-w2	3.37 [a] ± 0.11	1.30 [b] ± 0.01	172.50 [b] ± 1.50	333.33 [a] ± 0.68
W2-w3	2.39 [a] ± 0.12	1.18 [b] ± 0.01	198.15 [b] ± 3.80	404.73 [a] ± 0.96
W3-w4	3.90 [a] ± 0.40	1.40 [b] ± 0.04	263.50 [b] ± 1.90	692.58 [a] ± 0.85
W4-w5	8.39 [a] ± 1.09	3.10 [b] ± 0.23	334.00 [b] ± 3.20	651.00 [a] ± 10.28
W5-w6	3.93 [a] ± 0.50	1.30 [b] ± 0.06	183.60 [b] ± 3.20	378.47 [a] ± 3.60
W6-w7	3.66 [a] ± 0.23	2.00 [b] ± 0.08	424.20 [b] ± 2.10	1034.40 [a] ±12.60
W7-w8	3.14 [b] ± 0.15	3.85 [a] ± 0.23	559.13 [b] ± 2.10	1329.10 [a] ± 8.40
W0-W8	3.40 [a] ± 0.07	1.89 [b] ± 0.01	113.72 [b] ± 0.96	120.70 [a] ± 0.30

Means with different letters at the same row differ significantly at (P<0.05)

Table 6 GH, IGF1, myostatin and Ghrelin genes expression of Fayoumi and Cobb Chickens (means ± SE)

	GH gene expression		IGF1		Myostatin		Ghrelin gene expression	
Weeks	Fayoumi Chicken	cobb Chicken	Fayoumi Chicken	cobb Chicken	Fayoumi Chicken	cobb Chicken	Fayoumi Chicken	cobb Chicken
W0	1.10 [a] ± 0.07	1.10 [a] ± 0.02	1.1[a] ± 0.04	1.1[a] ± 0.02	1.20 [a] ± 0.020	1.10 [a] ± 0.050	1.10 [a] ± 0.100	1.10[a] ± 0.03
w2	1.55 [b] ± 0.11	4.80 [a] ± 0.09	1.3[b] ± 0.09	2.5 [a] ± 0.40	0.90 [a] ± 0.010	0.70 [b] ± 0.400	1.65 [b] ± 0.050	3.04 [a] ± 0.090
W4	4.10 [b] ± 0.03	7.80 [a] ± 0.33	1.6 [b] ± 0.20	3.8 [a] ± 0.70	0.70 [a] ± 0.030	0.40 [b] ± 0.008	2.17 [b] ± 0.040	5.50 [a] ± 0.100
W6	4.99 [b] ± 0.00	9.09 [a] ± 0.45	3.8 [b] ± 1.70	3.3 [a] ± 0.67	0.72 [a] ± 0.020	0.20 [b] ± 0.007	2.90 [b] ± 0.020	4.90 [a] ± 0.180
W8	5.90 [b] ± 0.06	7.70 [a] ± 0.20	2.3 [b] ± 0.38	3.3 [a] ± 0.63	0.50 [a] ± 0.010	0.40 [b] ± 0.009	2.99 [b] ± 0.008	4.10 [a] ± 0.120

Means with different letters at the same row differ significantly at (p <0.05)

Table 7 Plasma levels of corticosterone, T3, and T4 hormone in Fayoumi and Cobb chickens (means ± SE):

	Corticosterone hormone		T3		T4		Insulin	
Weeks	Fayoumi Chicken	cobb Chicken	Fayoumi Chicken	cobb Chicken	Fayoumi Chicken	cobb Chicken	Fayoumi Chicken	cobb Chicken
W0	13.04 ^{a} ± 1.4	4.56 ^{b} ± 0.57	29.46 ^{a} ± 3.59	16.98 ^{b} ± 2.04	0.60 ^{a} ± 0.06	0.28 ^{b} ± 0.02	9.07 ^{b} ± 1.21	16.91 ^{a} ± 1.75
w2	19.87 ^{a} ± 0.00	8.21 ^{b} ± 0.77	47.20 ^{a} ± 3.40	28.52 ^{b} ± 2.37	1.37 ^{a} ± 0.30	0.69 ^{a} ± 0.11	13.84 ^{b} ±1.39	22.93 ^{a} ±1.99
W4	19.56 ^{a} ± 0.00	5.80 ^{b} ± 0.81	78.63 ^{a} ± 7.37	30.71 ^{b} ± 1.04	0.88 ^{a} ± 0.03	0.33 ^{b} ± 0.04	14.26 ^{b} ± 2.00	24.53 ^{a} ± 1.95
W6	20.23 ^{a} ± 0.00	9.41 ^{b} ± 1.14	80.45 ^{a} ± 6.82	46.97 ^{b} ± 3.63	1.70 ^{a} ± 0.27	0.83 ^{b} ± 0.05	7.43 ^{b} ± 0.82	15.06 ^{a} ± 1.17
W8	40.65 ^{a} ± 0.00	12.65 ^{b} ± 0.84	61.84^{a} ± 2.03	36.77 ^{b} ± 2.40	1.91 ^{a} ± 0.13	1.31 ^{a} ± 0.23	6.60 ^{b} ± 0.70	16.38 ^{a} ± 0.75

Means with different letters at the same row differ significantly at ($p < 0.05$)

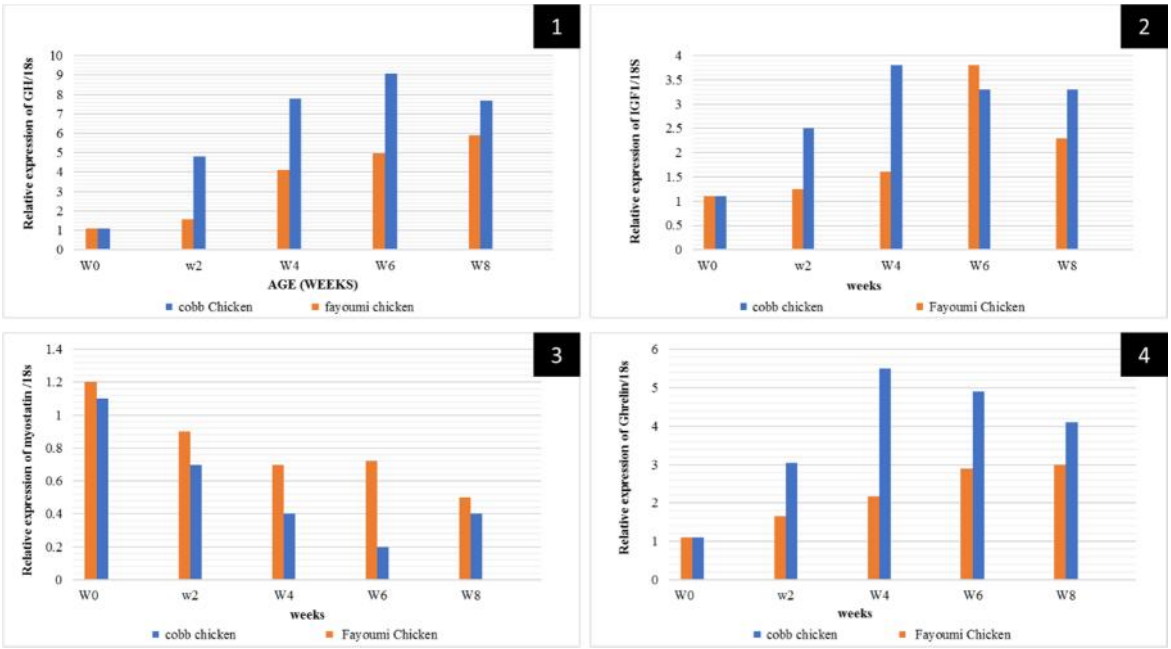

Figure 1 Graphical presentation of real-time quantitative PCR analysis of the expression of (1) GH, (2) IGF1, (3) myostatin and (4) Ghrelin genes in muscular tissues of Cobb and Fayoumi chicken

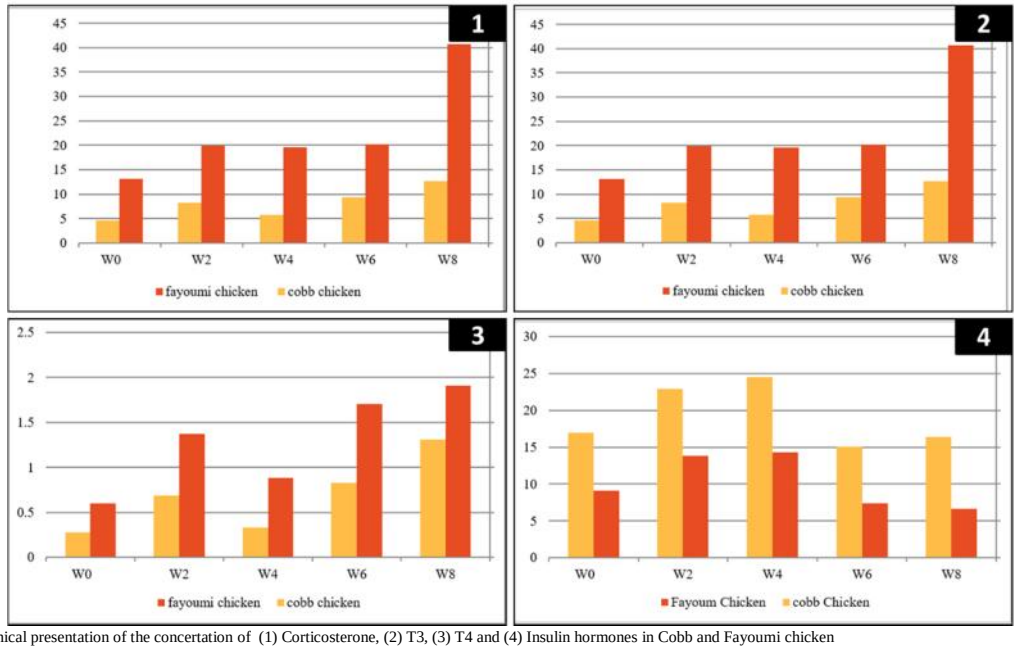

Figure 2 Graphical presentation of the concertation of (1) Corticosterone, (2) T3, (3) T4 and (4) Insulin hormones in Cobb and Fayoumi chicken

No difference was found between broiler and Fayoumi chicken (expression of GH, IGF1,myostatin and ghrelin gene is equal in both broiler and Fayoumi chicken as they not receive any food) While w2 ,w4 ,w6 ,w8 in broiler chicken had a significant higher expression of GH gene than Fayoumi chicken , broiler chicken had a significant lower expression of myostatin gene than Fayoumi chicken and by aging or by increasing weight ,myostatin gene expression decreased. Similar results, Avian broilers had significantly increased hepatic GH mRNA levels (Jia et al., 2018). Variations in feed intake were observed between high and low growth rate chickens due to differences in gene expression (Yin et al., 2014). The chicken growth hormone gene is considered one of the most important

candidate genes that affects the performance of chicken due to its crucial growth and metabolic role (Vasilatos-Younken et al. 2000) cGH genes expression occur within the liver (Al-Kelabi et al ., 2019).

Avian broiler chickens had significantly low plasma levels of insulin like growth factor binding protein before week 8 (Te Pas et al , 2001 and 2004). Insulin like growth factor had similar structure to insulin (Duclos , 2005) and induces insulin-like metabolic effects in adipose tissues and muscle (Monzavi and Cohen, 2002) In the proliferation, differentiation and metabolism of myogenic cell in poultry, this protein has significant role (Duclos, 2005). In normal chicken occur hepatic expression of IGF1 (Tanaka et al ., 1996). IGF-1 stimulates growth of the skeletal muscle by increasing protein synthesis rate and increasing level of IGF1 lead to increase BW in broiler chickens (Scanes et al., 2009; Wen et al., 2014).

Myostatin is expressed mainly in muscular tissues, considered as the typical negative regulator of myogenesis in animals (Sato et al .,2006). There is negatively relationship between myostatin and skeletal muscle growth (McPherron et al., 1997).

Chicks with low growth rate had high level of anorexigenic neuropeptides, this may explain low appetite in these chicks (Yi et al., 2015). These results agreed with our results as ghrelin (which is anorexigenic hormone in chicken) lower in Fayoumi than broiler chicken.

In poultry, CORT is the principal glucocorticoid involved in the regulating of appetite and metabolism (Zulkifli et al., 2004; Yuan et al., 2008) , plasma level of corticosterone regulate broiler growth (Houshmand et al., 2012; Li et al., 2019). The low growth rate by corticosterone lead to increasing energy expenditure, gluconeogenesis and proteolysis (Lin et al., 2004a,b). High CORT levels significantly decrease feed intake and BW gain in Chicken (Luo et al., 2013). Corticosterone delay skeletal muscle growth via increasing protein degradation and decreasing protein synthesis in chickens (Dong et al. 2007).

Broiler chicken had a significant higher insulin level than Fayoumi chicken during whole period of age as insulin has anabolic effect so high level of insulin increase growth rate as in broiler chicken. Insulin plays significant role in control carbohydrate and lipid metabolism, while it increases growth by increasing protein synthesis and affecting many growth-related genes expression (Taniguchi et al., 2006). Insulin has extensive anabolic effects in various tissues (Glass, 2003). The insulin cascade is a refractory chicken muscle (Dupont *et al*., 2004, 2008).

Fayoumi chicken had a significant higher T3 level than broiler chickens during whole period of age, Fayoumi chicken had a significant higher T4 level than broiler chickens except w2 and w8 had no significant difference between broiler and Fayoumi chicken. From major hormones promote normal chick growth are 3,5,3´-triiodothyronine (T3) and thyroxine (T4) (Scanes et al., 2009). Within the chicken also control embryonic development and post-hatch growth (Tsukada et al., 1998). Level of T3 and T4 enhanced by stress (Sahin et al., 2002; Dai et al., 2011). T3 and T4 influence nearly every physiological process in the body, and are important hormones that promote chicken growth (Xiao et al., 2017). This ensure our result about high level of thyroid hormones in Fayoumi chicken which also have stress hormone as corticosterone in high level . It has a double role in metabolism, high levels are catabolic and low levels are anabolic (Darras et al., 2000)

5. CONCULOSIONS

From the present study, it could be concluded that growth rate in chicken not only influenced by growth related genes but also some hormones as corticosterone, T3, T4 and Insulin.

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