J. Animal and Poultry Prod., Mansoura Univ., Vol.6 (2): 99 - 135, 2015

EFFECT OF IODINE SUPPLEMENTATION TO LOW ENERGY DIETS ON PRODUCTIVE AND REPRODUCTIVE PERFORMANCE IN LAYING HENS OF LOCAL SINAI STRAIN

Ibrahim,A.F.; M.M. Beshara and Hanan S. Mohamed
Anim. Prod. Res. Institute, Agric. Res. Center, Ministry of Agric. Dokki, Giza.

ABSTRACT

A total number of 297 Sinai hens (270 females and 27 males) 42-wks-old were used, weighed and divided into nine treatment groups, three replicates each, to investigate the effect of Iodine supplementation to low metabolizable energy (ME) layer diets in a factorial design (3x3) on laying performance, egg quality parameters, reproductive performance and nutrients digestibility as well as some blood constituents during the late stage of laying period (42-58 wks of age). The dietary ME of treatments were 2766 (as control); 2655 and 2565 kcal ME/kg, with three iodine levels of 0.3 (as control); 1.2, or 2.4, mg iodine/ kg diet. Results obtained could be summarized as the following:

1- Decreasing ME content in the Sinai layer diet resulted in a significant decrease in body weight and body weight gain (BWG) while diet supplemented with 2.4 mg/ iodinekg diet had the highest BWG compared to other groups. Also, BWG was significantly affected due to the interaction between iodine and ME.
2- Laying rate percentage and egg mass (g/hen) was significantly decreased by dietary contained 2565 Kcal/Kg diet. Conversely, the hens fed diet 1.2 and 2.4 mg I/Kg diet significantly improved the laying performance. Also, the superiority of the diet contained 2655 Kcal/Kg with 2.4 mg iodine /Kg diet where it was significantly greater laying performance than all other treatments.
3- No significant effect was observed on reproductive performance by feeding different levels of ME, while hatchability percentage was significantly improved as dietary supplemented with 1.2 and 2.4 iodine/ kg diet. Also, the best significant value of hatchability was recorded by the interaction between 2655 Kcal ME/ kg and 2.4 mg iodine/ kg diet.
4- Decreasing ME content from 2766 to 2655 and 2565 Kcal/kg diet showed linear significant higher feed consumption. While, only the low level of ME (2565 Kcal/Kg diet) significantly decreased feed conversion ratio compared to the control.
5- Iodine supplementation (1.2 and 2.4 mg/kg diet) resulted in a significant linear feed consumption decreased compared to the control diet. Also, hens fed diet contained 1.2 and 2.4 mg iodine/Kg diet produced significantly better feed conversion than control diet.
6- Feed conversion ratio was significantly improved by the diet containing ME 2655 Kcal/Kg diet + 2.4 mg I /Kg diet as compared to the control diet by about 15.5 %.
7- Digestion coefficient of Ether extract (EE) and ash retention were significantly increased by decreasing the ME to 2565 Kcal/Kg diet compared to the control diet (2766Kcal/Kg diet). All values of nutrients digestibility tend to be significantly linear increase for birds fed diets supplemented with 1.2 and 2.4 mg iodine/Kg layer diet as compared to control diet (0.3 mg I/Kg diet).
8- Dietary energy level has significant effect on blood metabolites, except triglycerides, and improved HDL concentration and thyroxin level, especially the low followed by the median ME level.

9- Dietary iodine supplementation, up to 2.4 mg/ kg diet improved blood parameters, hematological traits, T_3 level, and T_3/T_4 ratio without any negative effects on liver function and immune responses, in terms of ALT, AST activity and WBC′s count.

10- The combined effect between low and median ME and high iodine is the best for different productive and physiological parameters.

11- Decreasing dietary ME content from 2766 to 2655 Kcal/Kg diet resulted in no significant effect in economic efficiency. On the other hand, the high level of iodine (2.4mg/Kg diet) with decreasing ME from 2766 to 2655 Kcal/Kg diet resulted in significantly higher economic efficiency than all other treatments.

The results illustrated that the adequate level of ME for Sinai laying hens was 2655 Kcal/Kg diet to maximize the productive performance under the condition of this study, however the combination of same level of ME (2655 Kcal/ Kg diet) and 2.4 mg iodine/ Kg diet is the most successful requirement for improving laying performance and reproductive performance for Sinai laying hens during the late stage of laying period (42- 58 wks of age).

Keywords: Metabolizable energy, Iodine, Laying performance, Hatchability, Nutrients

INTRODUCTION

Nutritionists always are interested in achieving the most profitable and economical level of dietary energy in layer hens production (Harms *et al*., 2000). Obtaining high feed efficiency needs scientific and practical feeding methods (Lesson and summers, 2001). It should be mentioned that the effective level of energy is different between various breeds (Lippense et al., 2002). According to McDonald, *et al*. (1995) almost 2500–2900 Kcal/Kg metabolizable energy (ME) content in the diet for layer hens, is an optimal concentration of energy, lower amounts would result in reduced energy intake which will reduce egg mass production, whereas, higher amounts would result in increased body weight and in some cases egg weight instead of egg mass .However, Wu *et a*l. (2005) mentioned that there is a wide range of dietary energy levels (2,684 to 2,992 kcal of ME/kg) currently being used by the egg industry. kout El-kloub *et al*.(2005) reported that the diets containing 14%CP and 2600 kcal ME/kg achieved the best productive and reproductive performance of Mamourah laying hens (local strain). But, Hussein *et al*. (2010) reported that the optimal dietary protein and metabolizable energy levels for Sinai laying hens are 15% CP and 2750 kcal ME/kg diet to achieve acceptable productive and reproductive performance during the period from 25 to 49 weeks of age.

The amount of feed intake in poultry depends on the level of energy they received in the diet; consequently, the balance of nutrients to dietary energy content is an important factor in poultry nutrition (Wu *et al*., 2005). It is well established that hens generally adjust their feed intake according to their energy requirements. Harms *et al*. (2000) showed that hens fed diets containing 2,519 kcal of ME/ kg had 8.5% more feed intake than hens fed diets containing 2,798 kcal of ME/kg, and hens fed diets containing 3,078 kcal of ME/kg had 3.0% less feed intake than hens fed diets containing 2,798 kcal of ME/kg.

The results of studies of the effects of dietary energy on the laying rate are conflicting. For example, Ciftci *et al*. (2003) found that decreasing the energy content of feed from 2,751 to 2,641 kcal of ME/kg increased the laying rate from 86.44 to 88.27%. But, Mathlouthi *et al*. (2002) reported increased laying rates at an energy content of 2,753 kcal of ME/kg of feed compared with 2,653 kcal of ME/kg of feed. Responses of egg weight to changes in feed energy content are typically insignificant (Mathlouthi *et al*., 2002 and Ciftci *et al*., 2003). However, some authors have reported significant, although small, increases in egg weight caused by increased dietary energy (Marsden *et al*., 1987and Peguri and Coon, 1991).

Iodine is considered as a trace mineral, supplied naturally by feed and water, which is essentially required for birds in small amount for normal production and metabolic function (Sturki, 1986). Iodine occurs in poultry diet in its free form, or as an iodate or iodide. EURL (2012) showed that potassium iodide is a white to yellow crystalline powder with a minimum content of 67 % total iodine and 21% potassium. Iodine is a crucial involved in thyroid gland function and thyroid hormone synthesis and secretion (Nuovo and Wartofsky, 1995). Without iodine a variety of developmental disorders results affecting the quality of life (World Health Organization, 1990). Zelanka *et al*. (1993) and McDowell (1992) indicated that the standardized requirement of Iodine is 0.3 mg/kg diet for hens of light laying type and 0.5 mg iodine per kg of diet for hens of heavier laying type. Kaufmann *et al*. (1998) stated that iodine intake by 0, 0.5, 1, 2 and 5 mg/kg in diet, did not influence feed efficiency and egg production, but they found that iodine content in egg increased significantly by iodine supplementation. No significant differences were found in body weight, feed consumption, egg yield, egg shell index, shell thickness and egg yolk index, by 0, 3, 6, 12 and 24 mg/kg-1 iodine as dietary calcium iodate (Yalcin *et al*., 2004). Also, a study in chickens comparing various levels of iodine supplementation (0, 1.0, 2.5 and 5.0 mg I/kg feed) from two sources (potassium iodide and calcium iodate), did not show any adverse effect of iodine supplementation on performance and thyroid weight (Röttger *et al*., 2011). Saki *et al*. (2012) concluded that egg production and better performance can be obtained by 5 and 10 mg/kg of dietary calcium iodate without any adversely effects.

In addition, dietary iodine and adequate maternal thyroid function are essential for reproduction in poultry breeder hens (Christensen and Donaldson, 1994). Hansborough and Khan (1951) and Stoll and Blanquet (1953) concluded that the embryonic chick thyroid becomes functional and secretes thyroxine after 10 – 11 days of incubation. An increase of both triiodothyronine (T3) and thyroxin (T4) in plasma was found during the last days of incubation, reaching a maximum the day of piping (Thommes and Hylka, 1977 and Decuypere *et al*., 1979). Thyroid hormones involved in the regulation of growth, metabolism and energy retrieval from body deposits when dietary energy intake does not meet the demands of tissues to perform their physiological functions (Hazelwood, 2000). Calcium iodide administration to low energy diets could increase plasma T3 and T4 concentrations when compared with the other thyroidal treatments. This increase was more obvious for T3 level which may be related to its metabolic activity as the most potent thyroid hormone regulating the metabolism in the living organisms (El –Wardany *et al*., 2011).

The age related decrease in circulating T3 levels may result at least partly from the age-related increase in hepatic type III deiodinase activity (increased T3 degradation) (Kühn *et al*., 1996). Also, Therefore, the present study was conducted to investigate the effect of variety levels of iodine nutrition associated with Sinai laying hens fed diets contained different levels of low dietary metabolizable energy on the laying and reproductive performance during the late stage of laying period (42- 58 wks of age).

MATERIALS AND METHODS

This study was carried out at El – Serw Poultry Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. The experiment was conducted from December 2013 to April 2014. A total number of 297 Sinai hens (270 females and 27 males) 42-wks-old were randomly taken and distributed into nine experimental groups, nearly similar in initial body weights, 33 birds each (30 females and 3 males) in three equal replicates (10 females and one male for each). All birds were reared under similar hygienic and managerial conditions. Throughout the experimental period (42-58 wks of age), feed and fresh water were available ad libitum. The experimental groups include three levels of dietary metabolizable energy (ME) (2766 as control, 2655 and 2565 kcal of ME/ kg diet) and three iodine levels (0.3 as control, 1.2 and 2.4 mg/ kg diet) in a (3×3) factorial arrangement were used in this experiment. Laying hens were fed basal layer diet according to Hussein *et al*. (2010) recommendations and the other experimental diets containing a low ME (2766 as control vs. 2655, or 2565, kcal of ME/ kg diet). One treatment assigned a control treatment which contains 0.3 mg iodine/kg diet to meet the recommended level as reported by Zelanka *et al*. (1993) and McDowell (1992). Other treatments received diets supplemented with potassium iodide (KI) to get iodine concentration of 1.2 and 2.4 mg/ kg diet over the basal requirements. The composition and calculated analysis of the experimental diets are shown in Table-1, wherever, the distribution of various experimental groups inTable-2.

Data collection and parameters estimated:

1. **Laying performance traits:** Body weights of hens were recorded during the experiment period (42 – 58 wks of age). Egg number and mass and feed consumption were recorded then were averaged and expressed per hen/ 4 wks through the periods 42-46, 46-50, 50-54, 54-58 and the overall experimental period (42-58 wks of age). Laying rate and feed conversion ratio were calculated through the same periods as well as the body weight gain was calculated through the whole experimental period.
2. **Egg quality parameters:** At the middle (50 wks of age) of the experiment, a total number of 135 eggs (15 from each treatment) were randomly taken to determine some egg quality parameters such as shape

index, yolk index, yolk, albumen and shell weights as a percentage of egg weight, shell thickness (mm) and Haugh units.

3. **Hatchability parameters:** For evaluating fertility and hatchability, three hatches along with different ages were made in each experiment. The hatching eggs were collected for 7 days for incubation in each. The incubated eggs were candled at the 7th day of incubation. The number of fertile and infertile eggs and the eggs with dead embryo were recorded. Fertility (%) was calculated as a percentage of number of fertile eggs to the number of total set eggs. Hatchability (%) was calculated as a percentage of the number of healthy chicks to number of total set or fertile eggs, whereas, dead embryos (%) were calculated as a percentage of number of dead embryos to number of fertile eggs. Post hatching weights of healthy hatched chicks were also recorded.

Table 1: Composition and calculated analysis of the experiment diets.

Diets / Ingredients (%)	Dietary ME level, kcal/ kg diet		
	2766 (Control)	**2655 (Control – 111 kcal)**	**2565 (Control – 201 kcal)**
Yellow corn	66.85	62.00	58.00
Soy bean meal (44 %)	21.00	19.80	18.85
Corn gluten (60 %)	1.00	1.00	1.00
Wheat bran	1.50	7.55	12.50
Di-calcium phosphate	1.50	1.50	1.50
Limestone	7.50	7.50	7.50
Vit & Min. premix [1]	0.30	0.30	0.30
NaCl	0.30	0.30	0.30
DL- Methionine (99%)	0.05	0.05	0.05
Total	**100**	**100**	**100**
Calculated Analysis [2]			
Crude protein %	15.26	15.27	15.28
ME (Kcal / kg)	**2766**	**2655**	**2565**
Ether extract . %	2.94	2.98	3.00
Crude fiber %	3.26	3.72	4.11
Calcium (%)	3.21	3.22	3.22
Av. phosphorus (%)	0.40	0.43	0.43
Lysine %	0.80	0.79	0.79
Methionine %	0.34	0.34	0.34
Methio + Cyst %	0.60	0.61	0.61
Sodium	0.14	0.14	0.14
Price (LE/kg) [3]	2.833	2.797	2.768

[1]Supplied per kg of diet: Vit. A, 12000 IU; Vit. D3, 2200 ICU; Vit. E, 10 mg; Vit K3, 2 mg; Vit.B1, 1mg; Vit. B2 5mg; B6 1.5 mg; B12 10 mcg; Nicotinic acid 30mg; Folic acid 1mg, Pantothenic acid 10mg; Biotin 50 mcg; Choline 250mg; Copper 10mg; Iron 30mg; Manganese 60mg; Zinc 50mg; Iodine 0.3 mg; Selenium 0.1mg; Cobalt 0.1mg.

[2]According to Feed Composition Tables for animal and poultry feedstuffs used in Egypt (2001).

[3]Price of one kg (LE) at time of experiment for different ingredients : yellow corn ,2.27 ; Soy bean meal, 5.05; corn gluten, 6.50; Wheat bran, 2.22; Di Di-calcium, 4.55; limestone, 0.15; Vit&Min., 20.0; Nacl, 0.5, Meth., 32.0 and potassium iodide,852 .

Table 2: Distribution of birds on various experimental groups according to metabolizable energy (ME) and iodine (I) level of the diet

ME level, kcal/ kg diet	Iodine supplementation level, mg/ kg diet						Total	
	0.3 (control)		1.2		2.4			
	♂	♀	♂	♀	♂	♀	♂	♀
2766 (control)[1]	3	30	3	30	3	30	9	90
2655[2]	3	30	3	30	3	30	9	90
2565[3]	3	30	3	30	3	30	9	90
Total	**9**	**90**	**9**	**90**	**9**	**90**	**27**	**270**

[1] the control level is 0.3 mg iodine/kg basal diet, which was standardized requirement for hens of light laying type. [1] the control level is 2766 kcal/ kg basal diet.

[1] fed the basal diet, which was formulated to satisfy the recommended requirements of local Sinai hens. [2] fed the basal diet with low ME level (minus 111 kal/ kg diet from the control ME level).

[3] fed the basal diet with very low ME level (minus 201 kal/ kg diet from the control ME level).

4. **Nutrients digestibility**: At the end of experiment, 27 Sinai cocks (three from each treatment) were taken to evaluate the digestibility of nutrients for all experimental diets. Cocks were fed their experimental diets for seven days as a preliminary period, followed by three days collection period, where excreta were quantitatively collected. Simultaneously, records of daily feed consumption for each cock were maintained. The daily excreta was voided from males in each treatment, pooled and thoroughly mixed. Then, representative excreta samples were taken and dried immediately in a forced oven at 65 ^{o}C for 48 hours for chemical analysis (AOAC, 1995). The procedure described by Jakobsen *et al*. (1960) was used for separating fecal protein from excreta samples. Urinaly organic matter (UOM) was determined according to Abou-Raya and Galal (1971). Digestion coefficients were calculated according to the following equation: Digestion coefficient% = [(Nutrient intake (g) – Fecal nutrient content (g)) / Nutrient intake (g)] ×100.
5. **Blood biochemical constituents:** At the end of experimental period, three females per treatment (one from each replicate) were randomly taken and slaughtered. At time of slaughter, blood samples from each female was collected without anticoagulant and kept at room temperature for one hour to clot. Tubes were centrifuged at 3500 rpm for 15 minutes to separate clear serum that used for determination of serum total protein (Peters, 1968), total cholesterol (Ellefson and Caraway, 1976), triglycerides (Bucolo and David, 1973), HDL , LDL cholesterol (Siedel, 1983) , AST and ALT enzymes (Reitman and Frankel, 1957). These biochemical determinations were performed colorimetrically by using commercial kits.
6. **Hematological parameters:** At 58-weeks-old, three blood samples per treatment (one from each replicate) were collected randomly in vial tubes containing EDTA as anticoagulant. Differential white blood cells (WBC) counts were performed by using standard avian guidelines introduced by Ritchie *et al*. (1994). Total white blood cells were determined by the Unopett method (Campbell, 1995). Heterophils (H) and lymphocytes (L)

were counted in different microscopic fields in a total of 200 WBC by the same person, and the H: L ratios were calculated (Gross and Siegel, 1986).

7. **Economical efficiency:** At the end of the study, economical efficiency for egg production was expressed as hen-production thought the study and calculated using the following equation: Economic efficiency (%) = (Net return LE/Total feed cost LE) × 100.
8. **Statistical analysis:** Data obtained were statistically analyzed using the General Liner Model of SPSS (2008). Significant differences among means were tested by Duncan's Multiple Range Test (Duncan, 1955) at 5% level of significance. All data collected were analyzed by two-way analysis of variance, considering the dietary ME and iodine level as the main effect, using the following model: $Y_{ijk} = \mu + E_i + T_j + (ET)_{ij} + e_{ijk}$ where: Y_{ijk} =an observation; μ = Overall mean; E_i = effect level of dietary ME (i =1, 2 and 3); T_j = effect level of dietary iodine supplementation (j = 1, 2 and 3); $(ET)_{ij}$ = effect of interaction ME level E_i by in iodine level T_j and e_{ijk} = random error.

RESULTS AND DISCUSSION

Laying performance:

Data of Table -3 indicated that metabolizable energy (ME) at levels of 2766, 2655 and 2565 kcal/ kg diet to Sinai layer diets, had a significant effect on the average values of final body weight (FBW) and body weight gain (BWG) which were decreased with decreasing the low ME level, regardless the dietary iodine level. The significant differences in body weight gain among experimental treatments were supported by the findings of Stilborn and Waldroup (1990) who concluded that lower dietary energy levels tended to reduce body weight gain when hens fed diets containing 2500, 2600, 2700 and 2800 kcal ME/kg. Decreasing ME is available for fat deposition when lower dietary ME levels are utilized and high levels of fibrous feed with low energy diets will reduce the amount of weight gain that occurs during the laying period (Piliag *et al*., 1982). Balnave and Robinson (2000).observed that body weight gain increased with increasing dietary ME level (2500, 2700 and 2900 kcal ME/kg) in the diet for Brown layer strains.

Sinai laying hens at 42 weeks of age already reached the average body weight of this strain (1600 g/ hen); consequently any increase above body weight indicates that hens tend to deposit abdominal fat which considered a disadvantage with laying hens. Thus, from these results the decreasing ME content (2655 Kcal/kg diet) in diets for laying hens during the period from 42- 58 wks of age could be successful management to improve the laying performance.

Generally, hens fed diet supplemented with iodine (I) at the 2.4 mg/ kg diet had the highest BWG compared to other groups. BWG was significantly affected due to the interaction between ME and I levels during overall period (42-58 wks). BWG was significantly increased in hen groups fed diet contained 2766 Kcal ME/ kg (control) and 2.4 mg I/ kg, followed by those fed 2655 Kcal ME/ kg and 2.4 mg I/kg, followed by those fed 2565 Kcal ME/ kg and 2.4 mg I/ kg, respectively. This increment in BWG may be attributed to the hyperthyroid status induced by the high level of iodine (2.4 mg/ kg) which may be considered the best level for the low ME diets.

Table 3: Effect of different dietary ME and iodine levels and their interaction on LBW and BWG of local Sinai hens during the late stage of laying (42-58 wks)

Main effects \ Traits			Initial LBW (g)	Final LBW (g)	BWG (g)
ME level, kcal/ kg diet (EM)	2766 (C)		1591.6	1752.4^{a}	160.9^{a}
	2655		1625.7	1738.3^{a}	112.7^{b}
	2565		1613.7	1662.0^{b}	48.3^{c}
	Pooled SEM		**19.6**	**19.9**	**2.45**
	Sig.		**NS**	**0.05**	**0.001**
Iodine supplementation level, mg/ kg diet (I)	0.3 (C)		1592.2	1708.7	85.2^{c}
	1.2		1615.2	1721.3	106.1^{b}
	2.4		1623.4	1722.8	130.6^{a}
	Pooled SEM		**19.6**	**19.9**	**2.45**
	Sig.		**NS**	**NS**	**0.001**
Interaction (ME × I)	**ME**	**I**			
	2766(c)	0.3(C)	1586.7	1732.3	145.7^{bc}
		1.2	1599.3	1749.7	150.3^{b}
		2.4	1588.7	1775.3	186.7^{a}
	2655	0.3(C)	1664.3	1747.3	83.0^{e}
		1.2	1624.7	1745.3	120.7^{d}
		2.4	1588.0	1722.3	134.3^{c}
	2565	0.3(C)	1619.3	1646.3	27.0^{g}
		1.2	1621.7	1669.0	47.3^{f}
		2.4	1600.0	1670.7	70.7^{e}
	Pooled SEM		**33.9**	**34.2**	**4.24**
	Sig.		**NS**	**NS**	**0.05**

LBW = live body weight, BWG = body weight gain.
a,b,c,e,.. : means in the same column within each item with different superscripts are significantly different (P ≤ 0.05).
NS= non-significant

Egg number and laying rate:

Results in Table-4 showed significant differences among the experimental groups in egg number (EN) and laying rate (LR) during all experimental intervals due to varying ME or I levels in the diet. EN per hen and LR % for hens fed 2565 Kcal ME/kg diet was significantly lowered by 10.34, 13.13, 12.95, 10.74 and 11.45 % during the periods 42-46, 46-50, 50-54, 54-58 and 42-58 wks of age as compared to groups fed 2655 Kcal ME/kg, respectively. On the other hand, hens fed diet containing 2655 Kcal of ME/kg diet had insignificantly higher EN and LR as compared with those fed 2766 Kcal/kg diet during all experimental intervals.

4

Accordingly, the level of 2655 Kcal of ME/kg could be considered suitable for Sinai laying hens during the late stage of laying period (42- 58 wks of age). Egg production in birds is costly in terms of energy and nutrients. The required energy and nutrients for egg formation may be derived from daily feed intake or from stored reserves. If energy or nutrients are limiting, birds can compensate by reducing egg size or the number of eggs laid, or by increasing the laying interval and spreading the cost of egg formation over a longer period (Brand *et al*., 2003). These results are in agreement with those obtained by Ciftci *et al*. (2003) who found that decreasing the energy content of feed from 2751 to 2641 Kcal of ME/kg increased the laying rate from 86.44 to 88.27%. In this connection, kout El-kloub *et al*.(2005) reported that the diets containing 14%CP and 2600 kcal ME/kg achieved the best productive and reproductive performance of Mamourah laying hens (local strain). These results explained that low energy intake to protein intake ratio in low energy diet versus high energy diet may be a reason for greater egg production in lower energy than in higher energy diets (Rezvani *et al*., 2000).

Concerning the level of iodine in the diet, it had high significant effect on EN per hen and LR during all experimental intervals. EN and LR were significantly improved by 9.58 and 12.87 % for the groups fed 1.2 and 2.4 mg I/ kg diets, respectively as compared to those fed the control diet during the overall experimental period (42-58 wks of age). This effect may be due to the effect of dietary iodine as a component of thyroxin which regulates metabolism and has a strong influence on performance and growth of birds. Deficiency of iodine can cause metabolic disorders, decreased hatchability and laying rate, and stimulates enlargement of the thyroid gland follicles (Lewis, 2004). In addition, Abdel-Malak *et al*. (2012) concluded that laying hen diet supplemented with 2.4, 1.2 or 0.6 mg iodine /kg diet in the form of potassium iodide increased egg iodine concentration without any adverse effect on egg production for Golden Mantazah laying hens.

Interaction between ME and iodine levels in the diet had high significant effects on EN per hen and LR during all the experimental periods. Groups fed diet contained 2655 Kcal ME/kg and 2.4 mg/ kg recorded the best EN per hen and LR (20.50 and 73.81%, respectively) during the overall experimental period. Accordingly, 2655 kcal of ME/kg and both of 1.2 or 2.4 mg/ kg of the diet provided the best energy and iodine ratio to Sinai laying hens.

Egg weight:

No significant differences were observed among the experimental groups in egg weight (EW) per hen during experimental intervals, due to varying ME levels in the diet (Table- 5). EW was insignificantly improved by feeding 2655 and 2565 Kcal ME/kg diet comparing to the group fed 2766 Kcal ME/kg during most experimental periods. In this connection, Wu *et al*. (2005) reported that increasing only dietary energy without the increase of other nutrients (protein and amino acid) levels did not improve egg weight, and both dietary energy and protein (amino acids) are important to optimize egg weight.

5-

In this study, high ME level had low egg weight in most experimental intervals without significant effects as compared to low ME level in the diet. These results are in disagreement with that of Jalal *et al*. (2006) who reported that egg weight was not influenced by dietary energy.

On the other hand, different levels of iodine in the diet had significant effects on EW during all the experimental periods. The groups fed 1.2 or 2.4 mg I/ kg of the diet had significantly heavier egg weight during all experimental periods than those fed the control (0.3 mg I/kg). These results are in agreement with those obtained by Liu and Han (1998) reported that hyperthyroid laying hens had higher laying rates and egg weight than controls. Also, Hamdy and Abdel Latif (1999) found that supplementation of Japanese quail water with iodine as KI at levels of 300 or 600 ppm improved egg number and egg weight, whereas the use of KI at level of 900 ppm showed the opposite trend. In addition, Samar *et al*. (2005) inducing a mild hyperthyroidism can improve reproductive performance of the studied local strains (Silver Montazah and Gimmizah hens) past peak of production depending on the dose and the strain used. The interactions between varying levels of ME and iodine show that no significant effect exist on EW of Sinai laying hens.

Egg mass:

Significant differences were observed among the experimental groups in egg mass (EM) during most experimental intervals due to varying ME or I levels in the diet Table- 5. EM per hen which fed 2565 Kcal of ME/kg diet was significantly lowered by 10.89, 12.83, 10.77, 10.87 and 11.35% during the periods 42-46, 46-50, 50-54, 54-58 and 42-58 wks of age as compared to groups fed 2655 Kcal ME/kg, respectively. On the other hand, hens fed diet containing 2655 Kcal of ME/kg diet significantly higher EM as compared with those fed 2766 Kcal of ME /kg diet during most experimental intervals. These results may be due to the high egg number and weight associated with this diet. Also, these results indicated that Sinai laying hens fed 2655 Kcal ME/Kg diet had the highest egg mass per hen during the late stage of laying period. According to Nahashon *et al*. (2007) mean egg mass was higher ($P \leq 0.05$)in hen receiving diets with 2800 Kcal ME/kg of feed than those fed diets containing 2900 Kcal of ME /kg diet during 26 - 50 wks of age. Egg mass responded significantly ($P \leq 0.001$) to iodine supplementation during all experimental periods. Hens fed diet supplemented with 1.2 and 2.4 mg I/ kg of the diet had significantly higher EM than those fed the control diet (0.3 mg I/kg) during 42-46, 46-50, 50-54, 54-58 and 42-58 intervals. EM per hen was significantly higher by 8.74 and 16.91% for the groups fed 1.2 and 2.4 mg I/ kg of the diet than those fed (0.3 mg I/kg) diet, respectively during the overall experimental period. Results obtained are in agreement with the findings of Samar *et al*. (2005) who reported that, with a mild hyperthyroidism, egg mass increased significantly by 6.07 and 14.81% in compared with control in two local hen strains after peak of egg production. On the other hand, thyroid hormones resulted in stimulation of cellular protein synthesis which may explain improving egg production level and feed conversion when potassium iodide was supplemented (Hinkle and Kinsella, 1986).

In respect of EM per hen, it was significantly ($P \leq 0.001$) affected due to the interaction between ME and I level in the diet during all experimental periods. The best record of EM per hen (4428.96 g) was occurred by the group fed diet contained 2655 Kcal of ME/kg diet and 2.4 mg I/ kg of the diet during the overall experimental period (42-58 wks of age).

Feed consumption and feed conversion ratio:

Results given in Table-6 represented feed consumption (g/ hen) and feed conversion ratio (g feed/g egg mass) in response to the decreasing ME content, dietary supplement with iodine and their interaction. In comparison with the control diet (2766 kcal/Kg diet) it is clear that the mean values of feed consumption and feed conversion ratio during every interval and for the collective periods had fixed trend , where the low levels of ME content (2655 and 2565 Kcal/ kg diet) showed linear significant higher feed consumption records during the whole experimental periods. On the other hand, it is evident that the low level of ME (2565 Kcal/Kg diet) significantly decreased feed conversion ratio compared to the control diet, but decreasing ME to 2655 Kcal/ Kg diet and the control diet did not significantly differ from each other as their feed conversion ratio during the experimental periods except for during the period from 46 to 50 wks of age where, the diet contained 2565Kcal/ Kg diet produced significantly lower feed conversion ratio than control diet.

Results of the present study revealed that feed consumption and feed conversion ratio records as a result of iodine supplementation in layer diets almost showed the same trend during the experimental periods with a significant variations, where, in respect of feed intake, iodine supplementation (1.2 and 2.4 mg/ kg diet) resulted in a significant linear feed consumption decreased during all the experimental periods compared to the control diet except for the period 46-50 wks of age. Also, feed conversion ratio closely related to feed intake, hens fed diet contained 1.2 and 2.4 mg iodine/Kg diet produced significantly better feed conversion than control diet which included 0.3 mg iodine/Kg diet.

The effects of interaction between ME and iodine in feed intake and feed conversion ratio illustrated that the lowest ME (2565Kcal/ Kg diet) with 0.3mg iodine/Kg diet showed significantly the highest feed intake followed by the diet contained ME 2565 kcal/Kg diet + 1.2 mg iodine/Kg diet comparing with the control diet. It could be concluded that irrespective of fluctuations observed in these results during the laying periods, average feed intake was significantly decreased by dietary contained ME 2766 and 2655 Kcal/Kg diet + 2.4 mg iodine/ Kg diet compared to control and other interaction treatments. Also, feed conversion ratio was significantly improved by the diet containing ME 2655 Kcal/Kg diet + 2.4 mg iodine/Kg diet followed by the diet contained ME 2766 Kcal/Kg diet + 2.4 mg iodine/Kg diet as compared to the control diet by about 15.5 and 11.2 % respectively.

6

On the other hand, decreasing ME to 2565 Kcal/Kg diet + 0.3 or 1.2 mg iodine/Kg diet had significantly the worst record of feed conversion compared to the control and other treatments.

According to these results the feed consumption was increased by decreasing ME content, where with decreasing dietary energy levels from 2766 to 2655 and 2565 Kcal/Kg diet, feed intake linearly increased from 115.03 to 116.61 and 121.58 g/hen/day, resulting in a net increase of 1.58 and 6.55 g/hen/day or 1.37 and 5.69% of feed intake compared to the control diet. Therefore, a decrease of 111 kcal/kg dietary energy decreased feed intake by 1.37 %. Grobas *et al*. (1999) indicated that an increase of 33 kcal/kg dietary energy decreased feed intake by 1%, which was similar to the result in the current study. In addition, this is in agreement with Harms *et a*l. (2000) who showed that hens fed the diets containing 2519 kcal/kg had 8.5% more feed intake than hens fed the diets containing 2798 kcal/kg. The present study illustrated that there were slightly differences in dietary energy required to produce one gram egg among hens fed two dietary energy levels (control and 2655 Kcal/Kg diet) as shown in Table-5 where, decreasing dietary energy level from 2766 to 2655 kcal/kg, hens adjusted feed intake from 115.03 to 116.61 g/hen/day, so that 8.86 and 8.56 Kcal /day was used to produce one gram egg for hens fed diet 2766 and 2655 kcal/Kg diet respectively. Such finding is to be expected, as hens adjust feed intake when ME content decreasing to achieve a constant energy intake, but this was only up to decreasing dietary energy111Kcal/Kg diet as compared to the control diet in respect of laying performance. These result are consist with Wu *et al*. (2005) who reported that when dietary energy level increased from 2719 to 2956 kcal/kg, hens adjusted feed intake from 107.6 to 101.1 g/hen/day so that the same amount of dietary energy (5.8 kcal) was used to produce one gram egg. In addition, the results is consist with Gunawardana *et al*. (2009a,b) who found that as dietary energy increased feed intake would decrease Also, it seems from the present results that decreasing dietary energy to 2655Kg /Kg diet had no significant effect on feed conversion. However, Wu *et a*l. (2005) reported that as dietary energy content increased from 2719 to 2956 kcal/kg, feed conversion linearly decreased from 2.14 to 1.97 (g feed/g egg), resulting in a net decrease of 7.94%. This difference relating to feed conversion values could be attributed to differences in strain of birds age, amount of decreasing in ME and housing system. According to this study, the economical level of energy depends on the feed intake, feed conversion and cost of feed, and it is different about the recommendation (2750 Kcal/kg) where the results illustrated that 2655 Kcal /Kg diet was the economical level of energy.

Iodine supplementation (1.2 and 2.4 mg/kg diet) resulted in a significant linear feed consumption decreased and hens fed diet contained 1.2 and 2.4 mg iodine/Kg diet produced significantly better feed conversion than control diet. This results is in consist with those reported by Christensen *et al*. (1991) and Yalcin *et al*.(2004) who used high dietary levels of KI 3.5 mg/Kg diet and

Calcium iodide (3, 6, 12 and 14 mg/mg diet) in breeder turkey and laying hens respectively. Those authors illustrated that the KI or Calcium iodide administration could enhance feed conversion ratio. In disagree with Saki *et al*. (2012) who supplemented iodine with 0, 5, 10, 15 and 20 mg/kg dietary calcium iodate to determine the effect of dietary iodine on laying hens' performance. They results found that no significant differences among the treatments in feed consumption and feed conversion ratio, however, they concluded that egg production and better performance can be obtained by 5 and 10 mg/kg of dietary calcium iodate without any adversely effects.

Egg quality parameters:

Data of Table-7 revealed that all egg quality parameters were not significantly affected due to feeding different ME, I levels and their interaction at 50 and 58 wks of age, except HU and shape index which were significantly affected. It is observed that HU was significantly ($P<0.001$) decreased by increasing I level in the diet, whereas, shape index was significantly ($P<0.05$) increased.

These finding agreed those reported by Zanaty (2006), who found that dietary energy levels had no effect on most external and internal egg quality, and that yolk weight percentage and index, were increased with the increase of ME level. Similarly, Ciftci *et al*. (2003) found that shell thickness was not significantly affected by dietary energy level (2650 and 2750 kcal ME/ kg). On the other hand, El-Husseiny *et al*. (2005) and Nahashon *et al*. (2007) found that shell thickness was significantly increased by decreasing ME level in the diet. Improvement of egg shell thickness by feeding diets containing low-ME (2750 kcal ME/ kg) may be due to the calcium losses on the low ME diet which were lower than on the high ME diet. The greater loss of calcium from pullets fed a high ME diet was attributed to calcium combining with the excess of dietary fat to form indigestible soaps (Atteh and Leeson,1985). Also, Gunawardana *et al*. (2009a,b) reported that albumin percent linearly decreased with the ME increase from 2776 to 2908 Kcal/ kg.

In this respect, Yalin *et al*. (2004) indicated that there were no significant differences in egg shell index , egg shell breaking , shell thickness or egg yolk index when SHSY brown layers fed diets supplemented with 0,3,6,12 and 24 mg iodine/ kg diet, however iodine supplementation at levels 12 , 24, mg/ kg diet reduced egg albumen index and Hough units. In addition, Songserm *et al*. (2006) indicated that adding 4000 mg iodine / ton to commercial layer diets did not affect egg quality.

The interactions between varying levels of ME and iodine show that no significant effect exist for all egg quality parameters of Sinai laying hens except shape index which were significantly affected. The best record of shape index (78.62 or 78.07) was occurred by the group fed diet contained 2565 or 2655 Kcal of ME/kg diet and 2.4 or 1.2 mg/ kg of the diet, respectively during the overall experimental period (42-58 wks of age).

7

Fertility and hatchability:

Results of Table-8 showed that all hatchability parameters were not significantly affected due to feeding different ME levels during experimental period, regardless the dietary iodine level which hatchability (%) of all set or fertile eggs insignificantly lower by dietary low ME while either early or late embryonic mortality (EEM or LEM) percentages were insignificantly inecreased as compared to the control (2766 kcal/kg diet). Waldie *et al*., 1991 conducted an experiment in squabbling pigeons, around 3 years old, receiving 3 different energy levels (2650, 2900 and 3150 kcal/kg diet) in isonitrogenous diets (15% CP) and observed that fertility were not influenced by the treatments, whereas hatchability decreased in birds fed with 2650 kcal/kg. Several studies in laying hens have shown that neither energy nor protein levels had affected fertility or hatchability of all set or fertile eggs in Mamourah laying hens (Kout El-kloub *et al*., 2005).

On the other hand, feeding different I levels had insignificantly higher fertility percentage and significantly higher hatchability of all set eggs compared to the control (0.3 mg I/ kg). Hatchability (%) of fertile eggs was significantly higher as a result of maternal dietary iodide while LEM (%) were significantly decreased as compared to the control (0.3 mg I/ kg). Maternal dietary iodide depressed maternal thyroid hormones, increased embryonic T4, and improved survival rates of embryos during the latter stages of incubation (Christensen and Davis, 2001). When NRC (1994) requirements levels of iodide seemed adequate to support egg production and the well-being of the hen, but inadequate iodine or hormone was available to sustain embryonic growth and maturation. One critical factor is the onset of thyroid function in the embryo and the initial appearance of the biologically active form of the thyroid hormone, T3 (McNabb *et al*., 1993b). Thyroid hormones of maternal origin are thought to play a role in early embryonic development (Prati *et al*., 1992), but no effects on embryonic mortality during the first wk of incubation were noted. Late maturation of the embryo determines its characteristic stage of development at hatching, and thyroid hormones play major roles in tissue differentiation and in the final maturation of many tissues just prior to hatching (Black, 1978; Mallon and Betz, 1982 and Decuypere *et al*., 1992). An increase of both triiodothyronine (T3) and thyroxin (T4) in plasma was found during the last days of incubation, reaching a maximum the day of piping (Thommes and Hylka, 1977 and Decuypere *et al*., 1979).

Interaction between ME and iodine levels in the diet had high significant effects on hatchability (%) of all set or fertile eggs during the experimental period. Groups fed diet contained 2655 Kcal ME/kg and 2.4 mg I/ kg recorded the best hatchability (%) of all set or fertile eggs of all set or fertile eggs (92.42 and 97.67%, respectively) and less LEM (%) during the overall experimental period.

The iodide or thyroid hormone was assumed to be readily available to the embryo through the yolk. Thus, hormone levels during hatching may be the total combination of T3 and T4 from embryonic synthesis and extra maternal hormone or iodide in excess of the metabolic requirements for maternal maintenance and egg production (Sechman *et al*., 2000).

8

By depositing excess iodide or thyroid hormones in the egg during formation, the hen can ensure not only the maturity of hatchlings but their survival as well. Feeding goitrogens to block maternal T_4 synthesis has been associated with reduced embryonic survival rates and longer incubation periods (Christensen and Donaldson, 1994), and feeding additional iodide had no effect on incubation periods but resulted in improved survival rates. Meanwhile, the increased one-day-old chicks' weights with maternal dietary iodide supplementation can be due to the increased egg weight observed with treatments (Table- 8).

Nutrients digestibility:

The effects of dietary ME, iodine and the interaction between ME and iodine on nutrients digestibility of the experimental diets are presented in Table-9 Results obtained clearly indicated that the digestion coefficient values of dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), nitrogen free extract (NFE) and the total digestibility nutrients (TDN) were nearly similar and no significant influence was observed as a result of decreasing ME content in the layer diet from 2766 to 2655 and 2565 Kcal/Kg diet, while ether extract (EE) and ash retention were significantly increased by decreasing the ME to 2565 Kcal/Kg diet compared to the control diet (2766Kcal/Kg diet).

On the other hand, all values of nutrients digestibility, ash retention and TDN tend to be significantly linear increase for birds fed diets supplemented with 1.2 and 2.4 mg iodine/Kg diet comparing with the control diet (0.3 mg iodine/Kg diet). However, it is clear from the results reported that the digestion coefficient of all nutrients were not affected by the interaction between the varying levels of ME and iodine in the Sinai layer diets.

Generally, results in the current study showed that no alteration among the nutrients digestibility results from the decreasing ME content in the diet, these findings may be due to the feed consumption during the experimental period, where the decreasing ME content from 2766 to 2655 and 2566 Kcal/Kg diet resulted in a significant increase in feed intake/ hen as shown in

Table-6 According to Wu *et al*. (2005) when dietary energy increased from 2,719 to 2,956 kcal of ME/kg, hens adjusted feed intake from 107.6 to 101.1 g/hen per day to achieve a constant energy intake so that the same amount of dietary energy (5.8 kcal) was used to produce 1 g of egg. But in the current study 8.86 and 8.56 Kcal /day was used to produce one gram egg for hens fed diet 2766(control) and 2655 kcal/Kg diet respectively. Also because nutrient contents, except dietary energy level as a main effect in all diets, were the same, nutrient intake such as protein, total sulfur amino acids and lysine linearly increased with decreasing dietary energy. The increase of nutrient intake might explain why decreasing dietary energy levels from 2,765 to 2,655 and 2566 kcal of ME/kg had no effect on nutrients digestibility and supports the hypothesis that this probably is an ideal energy/protein (lysine) ratio for optimal performance. Similarly, Bartov (1989) and Bartov and Plavnik (1998) reported that energy to protein ratio significantly affected feed intake and feed efficiency of broiler chicks and concluded that there was an optimal energy to protein ratio for broilers, which may be below than that reported by Hussein *et al.* (2010) during the period from 25-49 wks of age. In addition, Zhao *et a*l. (2007) reported that amylase, trypsin, and chymotrypsin activity in jejunal fluid of birds adapted to the dietary CP content but not to dietary ME content.

9

On the other hand, significant linear increase in respect of nutrients digestibility by nutritional additive of 1.2 and 2.4 mg iodine/Kg diet. These effects probably due to KI supplementation to low energy diets which may increase plasma T3 concentrations and T3/T4 ratio as shown in Table-12 compared to the control diet (0.3 mg iodine/Kg diet). This increase was for T3 level which may be related to its metabolic activity as the most potent thyroid hormone regulating the metabolism in the living organisms (El-Wardany *et al*., 2011). Also, according to EFSA (2013) the use of potassium iodide as sources of iodine is considered safe for all animal species when used up to the currently authorised maximum content of total iodine in complete feed and the known role of iodine in the metabolism is its incorporation into the thyroid hormones, thyroxine and triiodothyronine as well as the precursor iodotyrosines and both metabolic hormones (T3 and T4) have multiple functions as regulators of cell activity (energy metabolism) and growth.

Different response to higher iodine doses is affected by different usability of iodine source (Bobek, 1998) and also in the strain (Rys et al., 1997) and by the presence of antinutritious substance which have an impact on iodine resorption (Garber *et al*., 1993). In addition, previous studies have examined the impact of various factors on T3 and T4 levels in birds, including species (Gonzales *et al*. 1999), energy intake and dietary composition (Swennen *et al*., 2005), Thyroid hormones are involved in the regulation of the basal metabolism of the majority of tissues and consequently in the metabolism of lipids, carbohydrates and proteins (Dias *et al*., 2010). Thyroid hormones also stimulate protein synthesis (Todini, 2007) and enhance the rate of glucose oxidation and intestinal absorption. These metabolic hormones increase glycogenolysis and gluconeogenesis in the liver (Eshkhatkhah *et al*., 2010).

Blood parameters:

a- Serum proteins

The effect of different dietary ME and iodine levels on protein fractions is present in Table-10. It is clear that total protein, albumin, globulin and A/G ratio were significantly higher for the high and middle ME levels compared with the low ME – fed hens. However, iodine effect, regardless ME level, revealed a significantly higher levels of all protein fractions in hens that fed the higher level of iodine (2.4 mg/ kg) followed by those by those at 1.2 mg/ kg compared with the control one (0.3 mg/ kg). This influence may be due to the ability of iodine to stimulate protein synthesis and / or nitrogen retention. Of interest, the interaction between the two variables was not significant. This may reflect different mechanism of action of iodine in response to dietary ME levels. In this respect, El-Gendi (1997); Hamdy and Abd El-Latif (1999); and Markovic, *et al*. (2011) have reported that the lower blood proteins concentrations in the low ME diets could be explained by the fact that when ME is reduced, there were a rapid turnover of plasma total proteins to the skeletal muscles to compensate for the low energy levels or may be due to the higher utilization under the influence of iodine supplements. This in turn stimulates thyroid gland activity, which in close agreement with the present results.

10

b – Serum Lipids

Results of serum lipids profile of Sinai laying hens as influenced by dietary Me and iodine levels are shown in Table –11. It is clear from these results that the ME level had significant on all Lipid fraction except for the serum triglycerides, which was not influenced by ME level. The higher levels were observed for serum total lipids, cholesterol and LDL in the ME of the basal diet (control). However, HDL concentration and HDL/LDL ratio significantly higher in the low ME – fed hens compared with the other groups. This revealed a beneficial effect of low ME on the birds health status and immune responses. The same trend was also observed when dietary iodine level is considered, irrespective of ME levels, which reflect better lipid profiles with the high iodine level (2.4 mg/ kg). This effect is supported by the significant reduction in LDL concentration in both low ME and iodine level diets. Also, the interaction effect between ME and iodine level was significant with the lowest values recorded for the low ME × high iodine fed hens (42.93 mg/ dl) followed by the median ME × high iodine fed hens (46.17 mg/ dl).

The previous results confirm the concept of the relationship between thyroid gland activity and lipid metabolism, especially in the low ME diets. The decreased levels of total lipids, triglycerides, cholesterol and LDL may be explained as a consequence of low dietary ME and or the high iodine level which could stimulate hyperthyroidism status. These results are in agreement with those reported by McNabb and king (1993a); El-Gendi (1997); Lichovinikova, *et al*. (2003); Bobiniene, *et al*. (2010) and El-Wardandy, *et al*. (2011) who mentioned that thyroid hormones level and dietary ME content are the main factors affecting lipid metabolism in laying hens.

C – Thyroid hormones levels:

Results in Table-12 showed significant reduction in serum T_4 level due to deceasing dietary energy level. However, the opposite trend was recorded for T_3 concentration-although insignificant- and the T_3/T_4 ratio which was significantly increased in response to low dietary energy level. Interestingly, the effect of iodine levels regardless ME levels, where the high and median iodine levels increased significantly T_3 level compared with the control group. The same was also observed with T_3/T_4 ratio, but T_4 level was significantly decreased.

Moreover, the interaction between ME and iodine levels showed insignificant effects, although there is an obvious increases in T_3 level and decreases in T_4 levels due to the combined effect of low ME × high iodine level and high ME × low iodine level, respectively. Also, the T_3/T_4 ratio was significantly increased by low ME × high or median iodine levels.

It is likely that when iodine was supplemented to the low energy diet, it could increase blood T_3 and the T_3/T_4 ratio in a dose-dependent manner. This is a good physiological response as T_3 was the most potent thyroid hormone in regulating all metabolic processes in living mammals and birds. Moreover, the enhanced T_3/T_4 ratio reflects an increase in the peripheral turnover of T_4 to T_3 via deiodination process in the presence of excess dietary iodine.

11

12

These effects may explain the improvements in egg production and egg quality traits of the aged-hens that used in the present study. Our results are in agreement with many studies dealing with the novel iodine, thyroid and energy levels, all of these studies support the present findings (Darrad, *et al*., 2000; Lichovnikova, *et al*., 2003; Moravec, *et al*., 2006; Song, *et al*., 2006; Bobiniene,*et al*., 2010; Miskiniene, *et al*., 2010; El-Wardany, *et al*., 2011 and many others).

d-Some blood minerals and enzymes activity:

Table-12 declared that dietary energy level had no significant influence on serum Calcium (Ca) and phosphorus (P) levels of laying Sinai hens. This was also noticed for AST and ALT activity (Table-13), while alkaline phosphatase activity was significantly increased (Table-12). However, data showed that dietary iodine levels had highly significant effects on all measurements. But the interactions effects were not significant (Table-12, 13).

It is clear from these results that iodine enhances egg production which increased the physiological demands for Ca and P need for egg shell formation which explain the low Ca level in blood and the higher level of alkaline phosphatase activity. This may be a consequence of the higher laying rates of hens in the high iodine group. Results showed also, that the higher level of iodine has no deleterious effect on liver function as indicated by the insignificant change in ALT and AST activities. These results are, in general, in close agreement with those observed by Mallon and Bet 2 (1982); McNab and king (1993); Bobiniene, *et al*. (2010) and Abdel-Malak, *et al*., (2012).

e- Blood hematology:

Results in Table-13 showed that the dietary energy level has insignificant effect on blood hemoglobin, WBC′s count, and lymphocytes (%) while heterophils (%) and H/L ratio were significantly influenced (Table-13). On the other hand, dietary iodine level significantly affected hemoglobin; heterophils (%); lymphocytes (%) and H/L ratio without significant effects on WBC′s count. Moreover, the interaction effect for all hematological traits was not significant. These results reflect the productive status of hens and support the concept that dietary iodine, in excess, could improve the productivity of laying hens at late phase of production via different magnitudes, including thyroid gland activity, increasing hemoglobin concentration and enhancing immune responses (WBC′s count, H/L ratio). These results are in close agreement with by Williams and Njoya (1998); Islam *et al*. (2004) and Song *et al*. (2006).

Economic efficiency (EE):

Results concerning the EE of egg production as influenced by different dietary ME, iodine nutrition and their interaction are shown in Table-14.

13

14

It is noticed that decreasing dietary ME content in Sinai layer diet from 2766 to 2655 Kcal/Kg diet resulted in no significant effect in EE, but the decreasing up to 2565 Kcal/Kg diet had significantly lower economic efficiency values than control diet. The most remarkable is a linear improved in EE as dietary iodine level increased where supplemented diet with the high level of iodine (2.4 mg/Kg diet) produced significantly higher EE than control diet (0.3 mg iodine /Kg diet) followed by the diet contained 1.2 mg iodine/Kg diet.

In respect of the interaction between energy and iodine, the results indicated that the high level of iodine (2.4mg/Kg diet) with decreasing ME from 2766 to 2655 Kcal/Kg diet resulted in significantly higher EE than all other treatments followed by the diet contained 2766 Kcal/Kg diet + 2.4 mg iodine / Kg diet and the contained 2655 Kcal/Kg diet + 1.2 mg iodine / Kg diet respectively, with no significant differences between them. On the other hand, decreasing ME to 2566 Kcal/Kg diet with 0.3 or 1.2 mg iodine /Kg diet produced the lowest values of EE than achieved by the other treatments.

CONCLUSION

Under the experimental conditions of this study the results demonstrate that the adequate level of ME for Sinai laying hens was 2655 Kcal/Kg diet to maximize the productive performance under the condition of this study, however the combination of the same level of ME (2655 Kcal/Kg diet) and 2.4 mg iodine/Kg diet is the most successful supplement for improving laying performance, fertility and hatchability performance for Sinai laying hens during the late stage of laying period (42- 58 wks of age).

REFERENCES

Abdel-Malak, N. Y; Sahar, M. N. Osman; A.S. A. Bahakaim; Amal, S. Omar and Ramadan, A. Nehad (2012). Effect of using different levels of iodine in layer's diets on egg iodine enrichment. Egypt. Poult. Sci. Vol (32) (IV): 851-864.

Abou- Raya, A. K. and A. Gh. Galal (1971). Evaluation of poultry feeds in digestion trails with reference to some factors involved. U.A.R. (Egypt), Anim. Prod. , 11: 207 – 221.

AOAC. (1995). Official Methods of Analysis. 16th ed. Assoc. Off. Anal. Chem., Washington, DC.

Atteh, j.O. and S. Leeson (1985). Response of laying hens to dietary saturated and unsaturated fatty acids in the presence of varying dietary calcium levels. Poultry Sci., 64: 520–528.

Balnave D. and D. Robinson (2000).Energy requirements of imported Brown layer strains. A report for the rural industries research and development corporation. RIRDC Publication No 00/179

Barov, I. and I. Plavnik. (1998). Moderate excess of dietary proteinincreases breast meat yield of broiler chicks. Poult. Sci.77:680–688.

Bartov, I. (1989). Lack of interactive effect of nicarbazin and di-etary energy-to-protein ratio on performance and abdominalfat pad weight of broiler chicks. Poult. Sci. 68:1535–1539.

Black, B. L. (1978). Morphological development of the epithelium of the embryonic chick intestine in culture: influence of thyroxine and hydrocortisone. Am. J. Anat. 153:573–600.

Bobek,S.(1998).Profylaktyka jodowau zwierzat.Medicine Veterinary 54:80-86.

Bobiniene, R.; D. Gudavicute and M. Miskiniene (2010). The impact of iodine on biochemical blood parameterters in laying hens. Vet. Med. Zootech., 51 (73): 3-9.

Brand Z, T. S. Brand and C. R. Brown (2003). The effect of dietary energy and protein levels on production in breeding female ostriches. Birt. Poult. Sci., 44: 598-606.

Bucolo, G. and H. David (1973). Quantitative determination of serum triglycerides by the use of the enzyme .Clin.Chem., 19:475.

Campbell, T.W. (1995). Avian Hematology and Cytology, Iowa State University Press, Ames, Iowa, USA. pp: 3-19.

Christensen, V.L and G.S. Davis (2001). Maternal Dietary Iodide Influences Turkey Embryonic Thyroid Function. Poultry Sci. Association, Inc.

Christensen, V.L. and W.E. Donaldson (1994). Effect of maternal thyroid status on embryo physiology and hatchability of commercial turkey eggs. Poultry Science 73: 236-244.

Christensen, V.L.; W.E. Donaldson and J.F. Hazelwood (1991). The effect of dietary iodine on hatchability of eggs from two commercial strains of turkeys. Poultry Science 70:2529-2536.

Ciftci, I.; E. Yenice; D. Gokceyrek and E. Ozturk (2003). Effects of energy level and enzyme supplementation in wheat-based layer diets on hen performance and egg quality. Acta Agric. Scand. Sect. A Anim. Sci. 53:113–119.

Darras, V.M. ; S.V. derGeyten and E.r. Kühn (2000). Thyroid hormone metabolism in Poultry. Biotechnol. Agron. Soc. Environ., 4: 13-20.

Decuypere, E., E. Dewil and E. R. Kuhn (1992). The hatching process and the role of hormones. Pages 239–255 In: Avian Incubation, S. G. Tullett, ed., Butterworth-Heinemann, London.

Decuypere, E.; E. J. Nouwen; E. R. Kuhn; R. Geers and H. Michels (1979). Iodohormones in the serum of chick embryos and posthatching chickens as influenced by incubation temperature. Relationship with the hatching process and thermogenesis. Ann. Biol. Anim. Biochem. Biophs. 19: 1713-1723.

Dias, I.R.; C.A. Viegas; A.M. Silva; H.F. Pereira; C.P. Sousa; P.P. Carvalho; A.S. Cabrita; P.J. Fontes; S.R. Silva and J.M.T. Azevedo (2010). Haematological and biochemical parameters in churra-da-terra-quente ewes from the north east of Portugal. Arq, Bras, Med. Vet. Zoot., 62(2) Belo Horizonte.

Duncan, D.B. (1955). Multiple ranges and multiple f-test, Biometries 11: 1-42.
EFSA (European Food Safety Authority) (2013). Scientific Opinion on the safety and efficacy of iodine compounds (E2) as feed additives for all animal species: calcium iodate anhydrous and potassium iodide. EFSA Journal 11(2):3099
El-Gendi, G.M (1997). Effects of experimental hypo and hyper-thyroid function on some metabolic and productive parameters in Rhode Island Red, Fayoumi and Dandarawi hens. 2 nd Hungararian Egyptian Poult. Conf. 16-19 sept. Godollo, Hungary.
El-Husseiny, O.M., A.Z., Soliman; M.O., Abd-Elsamee and I.I., Omara (2005). Effect of dietary energy, methionine, choline and folic acid levels on layers performance. Egypt Poult. Sci. 25: 931-956.
Ellefson, R. D. and W.T. Caraway (1976). Fundamental of clinical chemistry .Ed Tietz NW, p 506.
El-Wardany I.; Eman F. El-Daly; A.H. Abd El-Gawad; A.E.A. Hemid and Nafisa A. Abd El-Azeem (2011). Effect of thyroid activity modulation on some histological and biochemical aspects in broiler chicks. American-Eurasian J. Agric. & Environ. Sci., 11 (6): 893-902.
Eshkhatkhah, B.; M. Sadaghian; S. Eshkhatkhah; S. Pourabi and K. Najafian (2010). Relationship between the blood thyroid hormones and lipid profile in Moghani sheep, influence of age and sex. Comp. Clin. Path., 19: 15-20.
EURL (2012). Report on Potassium iodide and calcium iodate anhydrous. European commission, feed additives. No.454413
Feed Composition Tables for Animals and Poultry Feedstuffs Used in Egypt (2001). Technical Bulletin No., 1, Central Lab. For Food and Feeds (CLFF) Ministry of Agric. Res. Cent. Egypt.
Garber, D.W., Henkin, Y., Osterlund, L.C., Wolley, T.W. and Segrest, J.P. (1993). Thyroid function and other clinical chemistry parameters in subjects eating iodine enriched eggs. Food Chemistry Toxicology 31: 247-251.
Gonzales, E.; J. Buyse, J. Sartori; M. Loddi and E. Decuypere (1999). Metabolic disturbances in male broilers of differents strains. 2. Relationship between the thyroid and somatotropic axes with growth rate and mortality. Poultry Science. 78: 516- 521.
Grobas, S.; J. Mendez; C. Deblas and G. G. Mateos (1999). Laying hen productivity as affected by energy, supplemental fat, and linoleic acid of the diet. Poultry Sci. 78:1542-1551.
Gross, W.B. and P.B. Siegel (1986). Effects of initial and second periods of fasting on heterophil/lymphocyte ratios and body weight. Av. Dis., 30:345 346.

Gunawardana P.; G. Wu, Kun Yuan; M.M. Bryant and D.A. Roland (2009a). Effect of Dietary Protein and Peptide in Corn-Soy Diets on Hen Performance, Egg Solids, Egg Composition and Egg Quality of Hy-Line W- 36 Hens During Second Cycle Phase Three. International Journal of Poultry Science 8: 317-322

Gunawardana, P.; D. A. Roland, Sr., and M. M. Bryant. (2009b). Effect of dietary energy, protein, and a versatile enzyme on hen performance, egg solids, egg composition, and egg quality of Hy-Line W-36 hens during second cycle, phase two. J. Appl. Poult. Res. 18:43-53.

Hamdy, A.M.M., and S.A. Abdel-Latif (1999). Effect of iodinated water on some productive and metabolic parameters of Japanese quail hens. Egyptian J. Nutrition and Feeds(special issue) 2: 703-709.

Hansborough, L. A. and M. Khan (1951). The initial function of the chick thyroid gland with the use of radioiodine 131I. J. Exp. Zool., 116, 447.

Harms, H.R., B.G. Russell and D.R. Sloan, (2000).Performance of four strains of commercial layerswith major change in dietary energy. J. of Appl.Poult. Res., 9: 535-541.

Hazelwood, R. L. (2000). Pancreas. Pp. 539-555. In: Sturkie's Avian Physiology, 5th ed. G Causey Whittow, ed. Academic Press. CA.

Hinkle, P.M. and P.A. Kinsella (1986). Thyroid hormone indication of an endocrine growth factor by pituitary tumor cell. Science 234:1549.

Hussein, M. A. A; Kout El-kloub, M.El. Moustafa; M. K. Gad El-hak and A. M. Abbas (2010). Optimal metabolizable energy and crude protein levels for Sinai laying hens. Egypt. Poult. Sci. Vol (30) (IV): 1073-1095.

Islam, M.S.; N.S. Lucky; A. Ahad; M.M. Rahman and M.S. Siddiui (2004). Haematological parameters of Fayoumi, Assil and local chickens reared in Sylhet region in Bangladesh. Int. J. Poult. Sci., 3(2): 144-147.

Jakobsen , P.E.; S. G. Kirston and H. Nielsen (1960). Digestibility trails with poultry. 322 bretning fra foprsgs labratriet udgivest statens .Husdybug sudvalg kobenhann.

Jalal, M. A.; S. E. Scheideler and D. Marx (2006). Effect of bird cage space and dietary metabolizable energy level on production parameters in laying hens. Poult. Sci., 85: 306-311.

Kaufmann, S.; G. Wolfram ; F. Delange and W.A. Rambeck (1998). Iodine supplementation of laying hen feed: A supplementary measure to eliminate iodine deficiency in humans? Zeitschrift für Ernährungswissenschaft 37: 288–293.

Kout EL-Kloub, M.El. Moustafa; M. A. A. Hussein and M.K. Gad El-hak. (2005). A study on the energy and protein requirements of Mamourah local strain chickens during laying period. Egypt Poult. Sci., Vol (25)(111): (637-651)

Kühn, E.R., V.M. Darras; C. Gysemans; E. Decuypere; L. Berghman and J. Buyse (1996). The use of intermittent lighting in broiler raising. 2. Effect on the somatotrophic and thyroid axes and on plasma testosterone levels. Poult. Sci., 75: 595-600.

Lesson, S. and J.D. Summers (2001). Scott′s Nutrition of the chicken. University book. Guelph, Canada.

Lewis, P.D. (2004). Responses of domestic fowl to excess iodine: A review. Br. J. Nutr. 91:29-39

Lichovnikova, M.; L. Zeman and M. Cermaknova (2003). The long-term effect of using a higher amount of iodine supplement on the efficiency of laying hens. Br. Poult. Sci., 44 (5):732-736.

Lippense, M.; G. Huy ghbaert and G. Degroote (2002). The efficiency of nitrogen retention during compensatory growth of food-restricted broilers. British Poultry Science Journal, 43: 669- 676.

Liu Y.Q. and Z. Han (1998). Effects of daidzein on egg laying performance and blood hormone levels in laying hens. Chinese Journal of Animal Science 34(3): 9-10.

Mallon, D. L. and T. W. Betz (1982). The effects of hydrocortisone and thyroxine treatments on duodenal morphology, alkaline phosphatase and sugar transport in chicken (Gallusgallus) embryos. Can. J. Zool. 60:3447–3455.

Marsden, A.; T. R. Morris, and A. S. Cromarty (1987). Effects of constant environmental temperatures on the performance of laying pullets. Br. Poult. Sci. 28:361–380.

Mathlouthi, N.; M. Larbier; M. A. Mohamed and M. Lessire (2002). Performance of laying hens fed wheat, wheat-barley or wheat-barley-wheat bran based diets supplemented with xylanase. Can. J. Anim. Sci. 82:193–199.

McDonald, P.; R.A. Edwards; J.F.D. Greenhelgh and Morgan, C.A. (1995). Animal nutrition, 5th (ed.) Longman. Pp: 359- 362.

McDowell, L.R. (1992). Minerals in Animal and Human Nutrition. Academic Press Inc. Harcourt Brace java-novich. pp524.

McNabb, F. M. A.; E. A. Dunnington; P. B. Siegel and S. Su-varna (1993b). Perinatal thyroid hormones and hepatic 5′ deio-dinase in relation to hatching time in weight-selected linesof chickens. Poultry Sci. 72:1764–1771.

McNabb, F.M. A. and D.B. King (1993a). Thyroid hormone effects on growth, development and metabolism. In: Pang, P.K.T. Scanes, C.Cr. and Schreibman, (eds). The Endocrinology of growth in Vertebrates.A cademic press, Ny pp. 393-417.

Miskiniene, M; K. Inga; B. Rasa; D. Gudavicute and J. Eider (2010).Application of “JODIS” as a stable source of iodine in the nutrition of laying hens. Bull. Vet. Inst. Pulawy, 54: 389-392

Moravec, J.H.; H. Khazali; M. Shivazad and H.M. Yeganeh (2006). Plasma cocentrations of thyroid hormone and growth hormone of Lohman male broiler breeders fed different dietary energy and protein levels. Inter. J. Poult. Sci., 5 : 457-462.

Nahashon, S.N.; N.A. Adefope; A. Amenyenu and D. Wright (2007). Effect of varying concentrations of dietary crude protein and metabolizable energy on laying performance of Pearl Grey guinea fowl hens. Poult. Sci., 86(8): 1793-9.

NRC (1994). National Research Council. Nutrient Requirement for Poultry. Ninth Revised Ed. National Academy Press, USA.

Nuovo J.A. and L. Wartofsky (1995). Adverse effects of Iodine. In: Becker kL, ed., Principles and Practice of Endocrinology and Metabolism. Second edition. Philadelphia: J.B. Lippincott Co. pages 332-338.

Peguri, A., and C. Coon. (1991). Effect of temperature and dietary energy on layer performance. Poult. Sci. 70:126–138.

Peters, T. (1968). Determination of total protein in serum. Clinical Chemistry, 14:1147.

Piliang, W.G.; H.R. Bird; M.L. Sunde and D.J. Primgle, (1982). Rice bran as major energy source for laying hens. Poultry Sci., 61: 357 – 363.

Prati, M.; R. Calvo and G. M. Escobar (1992). L-thyroxine and 3, 5, 3′-triiodothyronine concentrations in the chicken egg and in the embryo before and after the onset of thyroid function. Endocrinol. 130:2651–2659.

Reitman, S. and S. Frankel (1957). Coloric determination of GOT or GPT activity. Am. J. Clin. Path., 28-56.

Rezvani, M.R.; A. Golian; F.E. Shahroudi and H.N. Maghaddam (2000). Effects of pullet nutritionand dietary energy and fat of layer rations on the performance of Hy-line layers. J. of Science and Technology of Agriculture and Natural Resources, 4: 81-91.

Ritchie, B. W.; J. G. Harrison, and R. L. Harrison (1994). Avian Medicine. Winger's Publishing Inc, Florida, USA, pp. 176-198.

Röttger A.S.; I. Halle; H. Wagner; G. Breves and G. Flachowsky, (2011). The effect of various iodine supplementation and two different iodine sources on performance and iodine concentrations in different tissues of broilers. British Poultry Science, 52, 115–123.

Rys, R., Wir-Konas, E., Pyska, H., Kuchta, M. and Pietras, M. (1997). Changes in egg iodine concentration in three hen strains in relation to iodine level in diets. Roczniki Naukowe Zootechniki 24: 229-242.

Saki, A.A.; M. Aslani Farisar, H. Aliarabi, P. Zamani and M. Abbasinezhad (2012). Iodine-enriched egg production in response to dietary iodine in laying hens. Journal of Agricultural Technology Vol. 8(4): 1255-1267

Samar A. Elnagar; Hanaa M. Khalil; Maysa M. Hanafy and A.M.H. El-Sheikh (2005). Thyroid hormone and hens reproductive performance of two local strains. Egyp. Poul. Sci.. Vol 25(I); 147-165.

Sechman, A. and S. Bobek (1988). Presence of iodohormones in the yolk of the hens egg. Gen. Comp. Endocrinol., 69: 99-105.

Sechman, A.; J. Rzasa and H. Paczoska-Eliasiewicz (2000). Thyroid hormones (T_4, T_3, rT_3) concentrations in chicken ovarian follicles during sexual maturation and egg lay. Abstracts and Proceedings of XXI World's Poultry Congress, Montreal, Canada, August 20-24.

Sechman, A. and S. Bobek (1988). Presence of iodohormones in the yolk of the hens egg. Gen. Comp. Endocrinol., 69: 99-105.

Siedel, J. (1983). Test combination of cholesterol. Clin. Chem. 29: 1075.

Song, z.; Y. Guo and J. Yuan (2006). Effect of dietary iodine and selenium on the activities of blood lymphocytes in laying hens. Asian-Aust. J. Anim Sci., 19 (5): 713-719.

Songserm, O.; S. Chaunchom; S. Sanguanphan; O. Triwutanon and A. Plaiboon (2006). Iodine supplementation in layer diets for commercial production of Iodine- enriched egg Animals Vet. Medicine, 55: 257 – 264.

SPSS. (2008). SPSS User´s Guide Statistics. Ver. 17. Copyright SPSS Inc., USA.

Stilborn, H.L. and P.W. Waldroup (1990). Anevaluation of low-energy feedstuffs in diets forlaying hens. Animal Feed Science and Technology,27: 327-339.

Stoll, R. and P. Blanquet (1953). Sur l' activite des thyroided de l' embryon du poulet, provenant d'oeufs ˝marques˝ par l'administration de 131I a la poule. Ann. Endocrinol., 14, 1.

Sturki, P. D. (1986). Avian physiology 4th ed (omstock Associate, Ny, USA).

Swennen, Q., G. Janssens, S. Millet, G. Vansant, E. Decuypere and J. Buyse, (2005). Effects of substitution between fat and protein on feed intake and its regulatory mechanisms in broiler chickens: Endocrine functionning and intermediary metabolism. Poultry Science. 84: 1051-1057.

Thommes, R. C. and V. W. Hylka (1977). Plasma iodothyronines in the embryonic and immediate posthatch chick. Gen. Comp. Endocrinol. 32: 417-422.

Todini, L., (2007). Thyroid hormones in small ruminants: effects of endogenous, environmental and the nutritional factors. Animal., 1(7): 997-1008.

Waldie, G.A.; T.M. OLOMU; K.M. CHENG and J. SIM (1991). Effect of two feeding systems, two protein levels, and different dietary energy sources and levels on performance of squabbling pigeons. Poult. Sci., 1991, 70, 1206-1212.

Williams, J. and J. Njoya, (1998). Plasma concentration of thyroid hormones in growing pullets and laying hens reared under two tropical climates and fed on diets with different energy concentrations. Br. Poult. Sci., 39: 579-582.

World Health organization (1990). Animal Feeding society (in Czech). introductory workshop on Iodine deficiency disorders control, Islamic Republic of Iran. 54pp.

Wu, M.; M. Brynt; R.A. Voilet and D.A. Roland D.A. (2005). Effect of dietary energy on performance and egg composition of bovans white and dekalb whit hens during phase I. Poultry Science Journal, 84: 1610- 1615.

Yalcin, S.; Z. Kahrama, S. Yalcin; S,S. Yalcin and H.E. Dedeoglue (2004). Effects of supplementary iodine on the performance and egg traits of laying hens. British Poultry Science 45(4): 499-503.

Zanaty, G. A. (2006). Optimum dietary protein and energy levels for Norfa hens during the laying period. Egypt. Poult. Sci., 26: 207-220.

Zelanka, J.; L. Zeman; S. Koci and Z. Kocova (1993). Nutrition requirements and poultry feed value- table. Animal Feeding Society (in Czech). 54pp

Zhao, F; S. S. Hou, H. F. Zhang, and Z. Y. Zhang (2007). Effects of dietary metabolizable energy and crude protein content on the activities of digestive enzymes in jejunal fluid of Pekin ducks. Poult. Sci., 86:1690–1695.

تأثير إضافة اليود إلى العلائق منخفضة الطاقة علي الأداء الإنتاجي والتناسلي في الدجاجات البياضة لسلالة سيناء المحلية

أحمد فرج إبراهيم, ملاك منصور بشارة و حنان صابر محمد

معهد بحوث الإنتاج الحيواني- مركز البحوث الزراعية- الدقي- الجيزة

استخدم في هذا البحث عدد ٢٩٧ طائر دجاج السينا المحلي (٢٧٠ انثى +٢٧ ذكر) عمر ٤٢ أسبوع تم وزنهم وتقسيمهم الى تسعة مجاميع تجريبية وبكل مجموعة ثلاثة مكررات وذلك لدراسة تاثير اضافة اليود الي العلائق البياض المنخفضة في الطاقة الممثلة في تصميم عاملى ٣×٣ خلال المرحلة المتأخرة من إنتاج البيض من ٤٢- ٥٨ أسبوع من العمر علي اداء إنتاج البيض و مقاييس جودة البيض و الأداء التناسلي و معاملات هضم العناصر الغذائية و أيضا علي بعض مكونات الدم. تم تكوين العلائق التجريبية بحيث تحتوى عل ثلاث مستويات من الطاقة (٢٧٦٦ ، ٢٦٥٥ ، ٢٥٦٥ كيلو كالوري طاقة ممثلة / كيلو جرام عليقة) وبكل مستوى منها ثلاث مستويات من اليود (٠.٣ ، ١.٢ ، ٢.٤ مليجرام يود / كجم عليقة). ويمكن تلخيص النتائج المتحصل عليها فيما يلي:

١- انخفض وزن الجسم النهائى ووزن الجسم المكتسب معنويا بخفض مستوي الطاقة الممثلة في العليقة البياض لدجاج السينا المحلي بينما زاد وزن الجسم المكتسب بإضاقة ٢.٤مليجرام يود /كجم عليقة وكذلك تأثر معنويا بالتداخل بين اليود ومستوي الطاثة في العليقة.

٢- انخفض معدل انتاج البيض وكتلة البيض / دجاجة بخفض مستوي الطاقة في العليقة الي ٢٥٦٥ كيلوكالوري/كجم بينما ادي اضافة اليود بمستوي ١.٢ و٢.٤ مليجرام /كجم الي تحسن معنوي للأداء الإنتاجي وكذلك سجلت الدجاجات المغذاة علي عليقة تحتوي طاقة ممثلة ٢٦٥٥ كيلوكالوري /كجم مضاف اليها ٢.٤ يود/ كجم الي أحسن اداء انتاجي.

٣- لم يتأثر الأداءالتناسلي معنويا بالمستويات المختلفة من الطاقة الممثلة في العليقة لكن تحسنت نسبة الفقس معنويا بإضافة ١.٢ و٢.٤ مليجرام / كجم عليقة وكذلك أدي التداخل بين ٢٦٥٥ كيلوجرام /كجم و ٢.٤ مليجرام/ كجم عليقة الي افضل قيمة مسجلة لنسبة الفقس.

٤- زاد معنويا استهلاك العلف خطيا بخفض مستوي طاقة العليقة البياض لدجاجات السينا من ٢٧٦٦ الي٢٦٥٥ و٢٥٦٥ كيلو كالورى/كجم عليقة.لكن انخفاض مستوي الطاقة إلي ٢٥٦٥ كيلو كالورى/كجم أدي إلي انخفاض معنوي معدل التحويل الغذائي.

٥- تحسن معدل التحويل الغذائي معنويا بإضافة اليود للعليقة بمستوي ١.٢ و٢.٤ مليجرام/كجم عليقة إلي انخفاض معنوي في العليقة المستهلكة.

٦- تحسن معنويا معدل التحويل الغذائي بخفض مستوي الطاقة إلي ٢٦٥٥كيلو كالورى/كجم مع إضافة ٢.٤ يود مليجرام وبلغت تلك الزيادة حوالي ١٥.٥% مقارنة بعليقة المقارنة.

٧- زاد معنويا معامل هضم المستخلص الإيثيري والرماد المحتجز بخفض مستوي الطاقة إلي ٢٥٦٥ كيلو كالورى/كجم عليقة . أيضا تحسن معامل هضم كل العناصر الغذائية بإضافة ١.٢ و ٢.٤ يود إلي العليقة البياض مقارنة بالعليقة المحتوية علي ٠.٣ مليجرام يود/كجم.

٨- المستويات المختلفة من الطاقة أثرت معنويا علي قياسات الدم الخاصة بالتمثيل الغذائي فيما عدا الجليسيريات الثلاثية وأيضا تحسن معنويا تركيز الليبوبروتين عالي الكثافة ومستوى السيروكسين خاصة مع المستوي المنخفض والعالي من الطاقة.

٩- أضافة اليود حتي مستوي ٢.٤ مجم /كجم عليقة حسن من تقديرات الدم والقياسات الخاصة بالمناعة ومستوي الترای أيودوثيرونين والنسبة بين الترای أيودوثيرونين والثيروكسين دون أي تأثير سلبى علي وظائف الكبد والإستجابة المناعية و ذلك فيما يتعلق بنشاط إنزيمات وظائف الكبد و محتوي الدم من كرات الدم البيضاء.

١٠- اوضحت النتائج أن التداخل بين المستوى المنخفض والمتوسط من الطاقة مع المستوي العالي من اليود حقق أفضل نتائج من الناحية الإنتاجية والفسيولوجية.

١١- لم تتأثر الكفاءة الاقتصادية معنويا بانخفاض الطاقة الممثلة من ٢٧٦٦ إلي ٢٦٥٥ كيلو كالورى/كجم عليقة ومن ناحية أخري تحسنت الكفاءة الاقتصادية بإضافة ٢.٤ مليجرام يود/كجم من العليقة المحتوية على ٢٦٥٥ كيلوجرام/كجم عليقة.

أوضحت نتائج تلك الدراسة أن المستوي الكافى من الطاقة الممثلة لدجاج السينا المحلي هو ٢٦٥٥ كيلوكالوري /كجم عليقة للحصول علي افضل اداء انتاجي تحت ظروف التجربة الحالية ومع ذلك فإن التداخل بين نفس المستوي من الطاقة (٢٦٥٥ كيلوكالوري /كجم عليقة) مع اضافة ٢.٤ مليجرام يود / كجم عليقة يعتبر أفضل احتياج لتحسين الأداء الإنتاجي و التناسلي لدجاجات السينا المحلية خلال المرحلة المتأخرة من إنتاج البيض من ٤٢- ٥٨ أسبوع من العمر.

99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 134 135

99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 134 135

99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 134 135