



**ROLE OF DIETARY IODINE ON MODULATING PRODUCTIVE,
REPRODUCTIVE, PHYSIOLOGICAL AND IMMUNOLOGICAL
PERFORMANCE FOR LOCAL CHICKENS
2-DURING LAYING PERIOD**

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ABSTRACT: This experiment was conducted for a complex period of 24 wks (each of 12 wks, respectively) to investigate the effect of adding different dietary levels of iodine as calcium iodide (CaI₂) on modulating some productive, reproductive and physiological parameters of Inshas strain (Egyptian developed strain). For this purpose 150 laying hens and 15 males (36 until 48 wks of age) were taken from a large flock in the 2nd period after finishing the 1st period (24-36 wks of age) that used in recording the egg production only and then divided into five equal treatment groups, each of 30 females and 3 males, with three equal replicates nearly similar in live body weight. The 1st group (T1) represented the overall mean of egg production of the flock and fed the basal diet (0.3 mg iodine/kg diet) and served as control 1, the other four groups were having an average egg production less than the overall mean by 20%. Hens were divided as follows, the 2nd group (T2) was fed the basal diet and served as control 2, while the 3rd (T3), the 4th (T4) and the 5th (T5) groups were fed the basal diet plus 1.2, 2.4 and 4.8 mg iodine/kg diet, respectively. Results indicated that iodine supplementation especially at 4.8 followed by 2.4 mg iodine/kg diet non significantly improved feed conversion ratio (g feed/g egg) and egg mass, while shell thickness was significantly ($P \leq 0.05$) improved compared to the control 2 group. Egg number and production percentage were significantly ($P \leq 0.05$) improved by iodine supplementation at 4.8 mg iodine/kg diet (T5 group) compared to the control 2 group. Moreover, significant increases were obtained for red and white blood cells count. As well, plasma total protein, albumin, globulin, T₃ and T₄ hormones, calcium and phosphorus salts and HDL-Ch were elevated significantly ($P \leq 0.05$) at 4.8mg iodine/kg diet. Conversely, additional iodine especially (T5 group) reduced significantly plasma concentration of total lipid, cholesterol, LDL-Ch. On the other hand, T4 and T5 groups recorded the highest values of fertility and hatchability percentage of Inshas hens.

In conclusion, dietary addition of iodine as CaI₂ is a practical application at 4.8mg I/kg diet to Inshas hens and had beneficial effects on productive, reproductive, physiological and hematological parameters and immune status.

Keywords: Iodine, productive, reproductive, physiological, Inshas strain.

INTRODUCTION

Iodine is recognized as one of the essential elements for poultry and is normally provided in the diet in its free form, or as an iodate or iodide, which is essentially required for birds in small amounts for normal production and metabolic functions (Patrick, 2008). It plays a great physiological role as a component of the thyroid hormones (thyroxin and triiodothyronine) which involved in the regulation of both anabolic and catabolic pathways of protein, lipid and carbohydrate metabolism, (Lewis, 2004 and Nima et al., 2012). Calcium iodide is a white crystal line powder with a minimum content of 63% total iodine and 10% calcium, (Eurl, 2012). Rottger et al. (2011) compared various levels of iodine supplementation (0, 1.0, 2.5 and 5.0mg I/kg feed) from two sources (potassium and calcium iodide) and they did not show any adverse effect on chickens performance and thyroid weight of chickens. Saki et al. (2012) concluded that egg production can be obtained by 5 and 10 mg CaI₂/kg diet without any adversely effects. El-Wardany et al. (2011) showed that administration of 1mg CaI₂/kg chickens diet could improve the productive performance compared with the control diet in association with considerable changes in thyroidal hormones (T₃ and T₄) and their ratio. Moreover, their results reflect the beneficial use of CaI₂ as a safe additive without hazards effects on organs histology. Likewise, Abdel-Malak et al. (2012) reported that egg production and feed conversion ratio of Golden Montazah laying hens recorded the best values for hens which fed diet containing 1.2 and 2.4mg I/kg diet, also blood thyroid hormones, calcium and

phosphorus were significantly increased by increasing iodine levels. On the other hand, thyroid hormones are implicated in the reproduction of birds and hyperthyroidism improved hatchability as reported by El-Sebai et al. (2002). Additionally, El-Ansary et al. (1996) reported that administration of KI in drinking water at level of 400ppm increased ($P \leq 0.05$) feed conversion, egg production, weight and mass. Moreover, Ibrahim, et al. (2015) found that performance (egg production and egg mass), hatchability percent, feed conversion ratio improved by increasing iodine level up to 2.4mg iodine/kg diet as compared with control diet in Sinai laying hens. They added that dietary iodine supplementation, up to 2.4mg/kg diet improved blood parameters, hematological traits, T₃ level, and T₃/T₄ ratio without negative effects on liver function and immune responses, interms of ALT, AST activity and WBC's count. Therefore, the objectives of this experiment were to study the influence of varying dietary levels of iodine on some productive, reproductive performance, some physiological and hematological parameters, and immune status of local laying hens (Inshas strain) during the laying period (36-48 wks of age).

MATERIALS AND METHODS

This study was carried out at Inshas Poultry Research Station (El-Sharkia Governorate), Animal Production Research Institute, Agricultural Research Center, Egypt.

Chickens and experimental design

A total number of 150 hens and 15 cocks 24 wks old of Inshas strain were used in this experiment up to 48 wks of age through two continuance periods each of 12 wks, the 1st period from 24-36 wks of age was used in recording the

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egg production only and then the birds were individually weighted and divided into 5 equal experimental groups (30 hens and 3 cocks of each) with three replicates (10 hens and 1 cock each) with almost similar average body weight. Replicates were randomly housed in floor pens (280cm long x 220cm wide). The 1st group (T1) represented the overall mean egg production of the hens flock during the periods from 24-36 wks of age and fed the basal diet contained 0.3 mg iodine/kg diet and served as control 1. The other four groups were taken from the same flock with an average egg production less than the overall mean by 20%. Hens were divided on treatments as follows, the 2nd group (T2) was fed the basal diet and served as control 2, while the 3rd (T3), the 4th (T4) and the 5th (T5) groups were fed the basal diet supplemented with CaI₂ to get 1.2, 2.4 and 4.8 mg iodine/kg diet, respectively.

Management and feeding:-

All birds were kept under the same managerial hygienic and environmental conditions in a windowed house with light cycle regimen of 16h light:8h darkness, throughout the experimental period. Feed and fresh water were provided *ad libitum*. The basal experimental diet was formulated to meet the nutrient requirements of Inshas laying hens during laying period according to Feed composition Tables for animal and poultry feed stuffs used in Egypt (2001). The composition and calculated analysis of the experimental basal diet is present in Table 1.

Measurements:-

Productive performance:-

Individual body weights of all birds was recorded two times at 36 and 48 wks of age to the nearest gram. Change in live

body weight was calculated as the difference between the two weights. Feed consumption was recorded weekly for each replicate and treatment group and the average feed consumption/bird/day was calculated. Feed conversion ratio was calculated as gram feed consumed per gram egg production (g feed/g egg). Individual egg weight and egg number were recorded daily, then average egg mass and egg production percentage were calculated for each replicate and treatment. Egg mass was calculate by multiplying egg number by average egg weight.

Egg quality parameters:-

At the last two days of experiment, eight freshly laid eggs per replicate were collected to evaluate external and internal egg quality as egg length and width were measured by a venire caliper to the nearest 0.01 millimeter and egg shape index was estimated. Egg shell quality was assessed where the eggs were weighed individually, broken and egg contents were removed, egg shells with membranes were cleaned and dried. Egg shell weight and percentage of whole egg were determined. Egg shell thickness (mm) was determined also. Records were also taken for albumen weight, height and weight. Also, yolk weight, height, diameter and index were estimated.

Blood biochemical analysis and hematological picture:-

At 48 wks of age two blood samples were collected from each replicate from the wing vein in two heparinized test tubes. Blood of the first tube was used to evaluate the total count of red and white blood cells, and blood smears were done and stained with leishman's stain for the differential counts of

leucocytes. Another blood tube was centrifuged at 3000 rpm for 15 min, so plasma samples were harvested and stored at -20°C until the biochemical analysis was done. Commercial kits were used for calorimetrically determination of the following blood plasma constituents according to the procedure outlined by the manufacturer. Total protein and albumin, calcium and inorganic phosphorus, total lipids, total cholesterol, high density lipoproteins (HDL), low density lipoproteins (LDL), and hepatic enzymes aspartate amino transaminase (AST) and alanine amino transaminase (ALT) were determined. Globulin was calculated by subtraction of plasma albumin from total protein, and albumin/globulin ratio was calculated. Concentration of plasma triiodothyronine (T₃) and thyroxin (T₄) hormones were determined using commercial enzyme immunoassay test kit.

Fertility and hatchability:

At 48 weeks of age, each treatment contained 3 replicates, each replicate contains of 10 hens and 1 cock. The cocks and hens were placed on the floor and supplied with the same treatments. Eggs from each treatment were daily collected for two weeks, and then incubated to determine fertility percentage and hatchability was calculated as a percentage of fertile eggs or of total eggs set.

Statistical analysis:

Data were subjected to one-way analysis of variance using general linear models (GLM) procedure of SAS, Institute (2001). Means were separated by using Duncan's multiple range test (Duncan, 1955). The percentage values were

transferred to percentage angle using arcsine equation before subjected to statistical analysis, and then actual means are presented.

The following model was used:

$$Y_{ij} = G + T_i + e_{ij}.$$

Where, Y_{ij} = observation for each dependent variable; G = General mean; T_i = Treatment effects ($i = 1, 2, \dots$ and 5); e_{ij} = Random error.

RESULTS AND DISCUSSION

Productive performance traits:

Body weight and body weight gain:

Results obtained from Table 2 indicated that the dietary inclusion of iodine as CaI₂ improved the final body weight and body weight gain at the end of the experimental period compared with the control 2 group (T₂) especially hens fed on T₄ or T₅ group. These results are in full agreement with those reported by Hassaan et al. (2015) who found that values of body weight and body weight gain were improved significantly ($P \leq 0.01$) due to iodine supplementation especially at 4.8 followed by 2.4mg iodine/kg diet compared with control group. Similar to results of the current study, Ibrahim et al. (2015) reported that body weight and body weight gain were significantly improved by increasing iodine level at 2.4mg I/kg diet compared with the control diet in Sinai laying hens. Likewise, these results are in agreement with those reported in foreign chicken by El-Ansary et al. (1996) who demonstrated that addition of KI to the diet increased ($P \leq 0.05$) the body weight and body weight gain of the hens comparing to control group. Also, El-Wardany et al. (2011) in broilers, Soliman et al. (2008) and Abdel-Malak et al. (2012) in local chickens found an improvement body weight and body weight gain using

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graded levels of dietary iodine. The increase in final body weight and body weight gain of Inshas laying hens during the experimental period especially T5 group may be due to the increase in thyroid hormones (T_3 and T_4) which are needed for normal growth and development as reported here in Table 6. Thyroid hormones are necessary with growth hormone for growth and development, which involved in the insulin-like growth factor (IGF1) production, stimulating cellular protein synthesis in almost every tissue of body throughout the life of chickens (Tsukada et al., 1995).

Laying performance:

Data concerning laying performance in Table 2 showed a non-significant differences among iodine treatment groups for feed intake values but feed conversion ratio (g feed/g egg) was slightly improved by the diet containing 4.8mg I/kg diet (T5 group) as compared to the control 2 group. On the other hand, laying performance parameters (egg number, production% and mass) were significantly improved in the hens fed diet contains 4.8 and 2.4mg CaI_2 /kg diet respectively compared with those in the control 2 group. These findings are consistent with the findings of El-Ansary et al. (1996) in chicken and Hamdy and Abdel-Latif (1999) in Japanese quail, who reported an improvement in feed conversion ratio due to dietary or drinking water supplemented with KI. Also, El-Wardany et al. (2011) in broiler, Soliman et al. (2008), Abdel-Malak et al. (2012) and Ibrahim et al. (2015) in local chickens reported that, addition of 1mg CaI_2 or 0.80 mm or 1.2 and 2.4mg I/kg diet respectively improved the feed conversion ratio as well as improved significantly egg number, mass and

production% compared with the control group. The influence of iodine on feed utilization may be due to an alteration of the microflora of the gut, consequently, more nutrients are available for better growth performance of chicks (Stanley and Bailey, 1989). It's worthy to note that the better FCR may be due to the increase in body weight gain that achieved during the whole experiment period. The improvement in the egg production performance may be associated with better metabolizability of nutrients by CaI_2 supplementation. The beneficial effect of dietary CaI_2 on egg production parameters is due to its role on modulating the rate of intestinal calcium absorption, therefore saving more calcium for egg production (Abdel-Hamid et al., 2000).

Egg quality:

Concerning external and internal egg quality traits, Table 3 showed that hens fed on diets provided with 4.8 and 2.4mg I/kg diet respectively slightly improved egg length and width, albumen height, albumen (%), yolk height and yolk diameter. As well as improved significantly ($P \leq 0.05$) shell thickness as compared with the hens in the control 2 group. These results agreed with the findings of Soliman et al. (2008), Madian (2008), and Ibrahim et al. (2015) who reported that external egg quality especially shell thickness and internal egg quality especially albumen and yolk height were significantly improved when they supplementation iodine from 0.48mg to 2.4mg I/kg diet for local chickens. Abdel-Hamid et al. (2000) reported that the beneficial effect of dietary CaI_2 on external egg quality is due to its role on enhance Ca absorption through the gut, therefore saving more Ca for egg production and external egg quality.

Hemato-biochemical parameters:

Hematological characteristics:

The results showed that iodine treated had significantly ($P \leq 0.01$) high Red blood cells (RBC's) number and White blood cells count (WBC's) especially T5 and T4 that fed 4.8 or 2.4mg I/kg diet respectively (Table 4). These results comes in agreement with the previous findings of El-Nagar et al. (2001) on broiler chicken, Abaza et al. (2003) on Alexandria cockerels, Ibrahim et al. (2015) and Hassaan et al. (2015) on local chicken, they reported that RBC's number was significantly increased with dietary iodine supplementation from 2.4 to 4.8mg I/kg diet (hyperthyroidism), which was accompanied by a significant increase in hemoglobin and hematocrite concentration. As well as WBC's count was significantly increased ($P \leq 0.05$) in chicken fed diet containing 2.4 or 4.8mg I/kg diet compared with the control 1 group. This mainly, due to an increase in the lymphocyte percentage. In spite of, the absence of significance among treatments respecting the H/L ratio, it is observable that the CaI₂ groups had numerically low values compared with the non supplemented ones, indicating better immune responses. This comes in good agreement with the findings of Abaza et al. (2003) who stated a positive correlation between thyroxin levels and number of circulating lymphocytes.

Biochemical characteristics:

Data of some blood plasma constituent of Inshas laying hens at 48 wks of age as affected by fed diets containing varying levels of iodine (CaI₂) are presented in Table 5. Plasma total protein, albumin, globulin and albumin/ globulin ratio, it is evidently shown that dietary supplementation of iodine has been increased ($P \leq 0.05$) the average values of

both plasma total protein, albumin and globulin levels especially for T5 and T4 groups, respectively. These results are in close agreement with those reported by Hassaan et al. (2015) and Ibrahim et al. (2015) in local laying hens they revealed a significant high levels of all protein fractions in hens that fed the higher level of iodine 4.8 followed by 2.4mg I/kg diet compared with the control one (0.3mg/kg). This influence may be due to the ability of iodine to stimulate protein synthesis and or nitrogen retention. Of interest, the albumin/ globulin ratio has been well known as an indicator for the immune resistance, was the highest in the untreated hens T1 and T2 controls indicating the worst immune status. Where the low albumin/ globulin ratio indicate more disease resistance and immune response (Lee et al., 2003). It is clear that the effect of iodine supplementation was more pronounced in laying hens received the high level of iodine (4.8mg I/kg diet), thus plasma total lipids concentration was decreased significantly. Moreover, plasma cholesterol, triglycerides and LDL followed the same trend as plasma total lipids. On the contrary, plasma level of HDL was significantly ($P \leq 0.05$) high for the iodine supplemented groups comparable to the control groups. These results are in agreement with the finding of El-Nagar et al. (2001), El-Sebai et al. (2002), Hassaan et al. (2015) and Ibrahim et al. (2015) who reported that plasma total lipids, triglycerides and cholesterol were significantly decreased under hyperthyroidism status or addition of CaI₂ by 4.8 or 2.4mg/kg diet, respectively. The previous results confirm the concept of the relationship between thyroid gland activity and lipid metabolism. These results may be due to the role of thyroid

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hormones or iodine dietary levels which considered the main factors affecting lipid metabolism in laying hens as reported by McNabb and King (1993), Bobiniene et al. (2010) and El-Wardany et al. (2011).

Respecting the influence of supplemental dietary iodine on plasma concentration of calcium and phosphorus, results shown in Table 5 revealed that, non supplemented control groups had significantly the lowest plasma concentration of both minerals (Ca and P) when compared to the other supplemented ones. Besides, calcium and phosphorus levels were increased in plasma of lying hens whose fed diet contained the high level of iodine (T5 group) followed by those in T4 and T3 groups respectively. These results are in harmony with El-Sebai et al. (2002), Soliman et al. (2008), and Hassaan et al. (2015) who reported that both plasma Ca and P concentrations increased under hyperthyroidism or adding high levels of iodine as CaI_2 at levels from 0.80 to 4.8mg/kg diet. This may be attributed to the differences in Ca and P regulation and absorption among the experimental groups. As well, thyroid hormones increased the total Ca and P absorption efficiency (Abdel-Hamid et al., 2000).

Thyroid activity and liver functions:

Data presented in Table 6, illustrate the effect of dietary iodine supplementation on thyroid gland activity and liver functions of Inshas laying hens. Plasma concentrations of thyroid hormones (T_3 and T_4), as an indication of thyroid activity, were significantly increased ($P \leq 0.05$) by increasing dietary iodine levels compared with the control groups (T1 and T2), which recorded the lowest levels of both hormones. These results agreed with El-Wardany et al. (2011) in broilers, Hassaan et al. (2015) in local

cockerels, Soliman et al. (2008), Abdel-Malak et al. (2012) and Ibrahim et al. (2015) in local laying hens by adding CaI_2 1mg/kg diet or different levels of iodine (0.6, 0.8, 1.2, 2.4 and 4.8) mg/kg diet respectively. They showed that thyroid hormones were significantly increased by increasing iodine levels. The current results showed that plasma concentration of T_3 hormone was significantly elevated in the heavy and high production group compared to the light and low ones. It is likely that when iodine was supplemented to the diet, it could increase blood plasma 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. These effects may explain the improvements in egg production and quality traits of the laying hens in the present study. This suggestion was supported by the previous findings of several studies conducted by Hayashi et al. (1992), El-Husseiny et al. (2000), Bobiniene et al. (2010) and Miskiniene et al. (2010).

It is clearly observed that, dietary addition of iodine levels, (Table 6) could significantly affect the hepatic enzymes activities. Where, Inshas laying hens of control groups recorded the highest values of both aspartate amino transaminase (AST) and alanine amino transaminase (ALT) enzymes comparable to laying hens of the other supplemented groups. These results indicated that supplemental iodine had no deleterious effect on liver functions and may protect the hepatocytes of Inshas laying hens

from being destroyed and that is meant a better liver function associated with iodine supplementation. The current results are in harmony with El-Nagar et al. (2001) in broiler chicks, El-Sebai et al. (2002) in Japanese quail, Hassaan et al. (2015) in local cockerels and Ibrahim et al. (2015) in local laying hens. They found that serum AST and ALT concentration were significantly decreased with hyperthyroidism or addition of dietary iodine. Therefore, the results indicated that the heavy body weight and high egg production treated laying hens had a better liver functions than the light and low ones. These results are in harmony with those of Hassaan et al. (2009) who reported that light weight and low production chicks on the average produce the lowest meat and egg mass, because this class would include mainly more unhealthy chicks than the heavy and high production birds, which confirm the results of the present study.

Fertility and hatchability:-

All the dietary iodine supplementations significantly ($P \leq 0.05$) improved the fertility and hatchability of fertile eggs percentages compared with those of control groups (Table 7). Moreover, the best significant ($P \leq 0.05$) result of hatchability of all eggs recorded by Inshas laying hens fed diet supplemented with 4.8mg I/kg diet compared with

control 1 group. The improvement in hatchability percentages could be attributed to the improvement in egg shell quality in quail (Mostafa and Abdel-Mageed, 2006). These results agreed with El-Sebaie et al. (2002) in Japanese quail, Soliman et al. (2008) and Ibrahim et al. (2015) in local laying hens by feeding laying hens on diets containing iodine salts as calcium iodine at levels (0.48, 0.80 and 2.4mg/kg diet) improved percentage of fertility, hatchability of total and fertile eggs and shell thickness compared to the control groups. This finding is in good agreement with the findings of McNabb et al. (1985) who reported that in Japanese quail, maternal diets containing 150 μg I/kg diet can improve hatchability by providing sufficient egg I for the thyroid function of embryos and hatchlings.

IN CONCLUSION,

the present study indicated that supplemental iodine especially at level 4.8mg I/kg diet as CaI_2 to Inshas laying hens of -20% from the overall mean egg production, could improve productive and reproductive performance, as well as physiological, hematological and immunological parameters for attaining the goal of improvement of egg production in local and developed Egyptian laying hens.

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Table (1): The composition of the experimental basal diets.

Ingredients	Percentage (%)
Yellow corn	61.57
Soya bean 44%	17.00
Wheat bran	6.70
Corn gluten 60%	4.50
Di Ca P	1.39
Lime stone	8.16
Salt	0.37
Premix*	0.30
L Methionine	0.01
Total	100.00
Calculated values (%)**	
Protein	16.5
Metabolizable energy	2699
Crude fiber	3.468
Ether extract	2.964
Calcium	3.399
Available Phosphorous	0.397
Total Phosphorous	0.610
Sodium	0.164
Arginine	1.28
Lysine	0.730
Methionine	0.335
Methionine & cysteine	0.619

*Premix added to the 1 kg of diet including Vit.A 10000 I.U; Vit. D₃ 2000 I.U; Vit. E 15 mg; Vit. K₃ 1 mg; Vit. B₁ 1mg; Vit. B₂ 5 mg; Vit. B₁₂ 10 µg; Vit B₆ 1.5mg; Niacin 30mg; Pantothenic acid 10mg; folic acid 1mg; Biotin 50 µg; choline 300 mg; zinc 50mg; copper 4mg; iodine 0.3 mg; iron 30mg; selenium 0.1mg; manganese 60mg; cobalt 0.1mg and carrier CaCO₃ up to 1kg.

**According to Feed composition tables for Animal & Poultry feedstuffs used in Egypt (2001).

Table (2): Effect of dietary iodine supplementation on the performance of Inshas laying hens during the experimental period.

Item	T1	T2	T3	T4	T5	SE
Initial body weight (g)	1352	1341	1338	11341	1338	9.002
Final body weight (g)	1477	1459	1456	472	1475	10.675
Change in body weight (g)	125	118	118	131	137	12.818
Feed intake (g/hen/day)	97.30	97.88	98.12	96.80	97.60	0.459
Total feed intake (g/hen/period)	8173.20	8221.92	8242.08	8131.20	8198.40	38.582
Feed conversion (g feed/g egg)	3.31 ^b	3.88 ^a	3.79 ^a	3.63 ^{ab}	3.52 ^{ab}	0.112
Egg number (egg)	49.58 ^a	41.43 ^c	42.99 ^{bc}	44.85 ^{abc}	46.86 ^{ab}	1.491
Egg production (%)	59.02 ^a	49.32 ^c	51.17 ^{bc}	53.39 ^{abc}	55.79 ^{ab}	1.776
Egg weight (g)	49.93	51.11	50.60	50.34	49.71	0.618
Egg mass (g)	2476.03 ^a	2117.19 ^b	2173.89 ^b	2257.75 ^{ab}	2328.86 ^{ab}	75.291

^{a, b, ...} Means within each row have no similar letter(s) are significantly different ($P \leq 0.05$)

T1=Control 1 group, T2=Control 2 group, T3=Fed the basal diet + 1.2 mg iodine/kg diet, T4=Fed the basal diet + 2.4 mg iodine/kg diet, T5=Fed the basal diet + 4.8 mg iodine/kg diet.

Table (3): Effect of dietary iodine supplementation on external and internal egg quality of Inshas laying hens at 48 weeks of age.

Item	T1	T2	T3	T4	T5	SE
External egg quality						
Egg length (mm)	53.69 ^a	52.03 ^{ab}	51.96 ^b	52.51 ^{ab}	53.29 ^{ab}	0.543
Egg width (mm)	41.30	41.19	40.37	40.90	41.14	0.382
Shell thickness (mm)	0.371 ^b	0.368 ^b	0.372 ^{ab}	0.374 ^a	0.377 ^a	0.003
Shell weight (%)	13.06	14.25	13.68	14.25	13.39	0.596
Egg shape index	76.97	79.21	77.74	77.92	77.24	0.742
Internal egg quality						
Albumen height (mm)	6.89	7.04	7.04	6.58	7.14	0.541
Albumen (%)	56.29	53.42	54.48	54.22	55.20	0.987
Yolk height (mm)	17.06	17.08	16.41	16.70	16.96	0.308
Yolk diameter	39.15	38.52	38.81	38.66	39.76	0.524
Yolk (%)	30.66	32.33	31.84	31.53	31.42	0.686
Yolk index	43.65	44.39	42.37	43.26	42.75	0.963

^{a, b, ...} Means within each row have no similar letter(s) are significantly different ($P \leq 0.05$)

Table (4): Effect of dietary iodine supplementation on hematological picture of Inshas laying hens at 48 weeks of age.

Item	T1	T2	T3	T4	T5	SE
Red blood cells ($\times 10^6/\text{ul}$)	2.910 ^d	3.110 ^{cd}	3.232 ^{bc}	3.352 ^{ab}	3.494 ^a	0.069
White blood cells ($\times 10^3/\text{ul}$)	26.896 ^c	29.566 ^{bc}	32.132 ^{ab}	35.006 ^a	35.490 ^a	1.170
Heterophil (%)	29.066	28.552	28.484	26.882	27.282	1.845
Lymphocyte (%)	60.196	63.412	63.562	62.588	63.704	1.390
Heterophil/Lymphocyte ratio	0.486	0.451	0.449	0.430	0.429	0.030

^{a, b, ...} Means within each row have no similar letter(s) are significantly different ($P \leq 0.05$)

Table (5): Effect of dietary iodine supplementation on blood plasma proteins, lipids and minerals concentrations of Inshas laying hens at 48 weeks of ages.

Item	T1	T2	T3	T4	T5	SE
Plasma proteins:						
Total protein (g/dl)	4.78 ^c	5.22 ^{bc}	5.17 ^{bc}	5.65 ^{ab}	5.85 ^a	0.169
Albumin (Al) (g/dl)	2.74 ^b	3.05 ^a	2.93 ^{ab}	3.14 ^a	3.18 ^a	0.079
Globulin (Gl) (g/dl)	2.04 ^c	2.18 ^{bc}	2.24 ^{abc}	2.51 ^{ab}	2.67 ^a	0.139
Al/Gl Ratio	1.354	1.414	1.328	1.276	1.214	0.083
Plasma lipids:						
Total lipids (mg/dl)	418.27 ^a	389.37 ^{ab}	387.16 ^{ab}	356.40 ^b	347.14 ^b	13.796
Total cholesterol (mg/dl)	182.01 ^a	158.89 ^{ab}	140.14 ^{bc}	133.28 ^{bc}	123.69 ^c	10.131
Triglycerides (mg/dl)	96.10 ^a	82.75 ^b	76.44 ^{bc}	72.00 ^{bc}	66.97 ^c	4.209
HDL-ch (mg/dl)	62.67 ^c	71.03 ^b	75.20 ^{ab}	79.40 ^{ab}	83.39 ^a	2.743
LDL-ch (mg/dl)	100.11 ^a	71.31 ^{ab}	49.65 ^{bc}	39.47 ^{bc}	26.91 ^c	11.141
Plasma minerals:						
Calcium (mg/dl)	9.02 ^c	9.90 ^{bc}	10.98 ^{ab}	11.36 ^{ab}	11.64 ^a	0.493
Phosphorus (mg/dl)	4.77 ^d	5.05 ^d	6.03 ^c	7.16 ^b	7.80 ^a	0.237

^{a, b, ...} Means within each row have no similar letter(s) are significantly different ($P \leq 0.05$)

Table (6): Effect of dietary iodine supplementation on thyroid activity and liver functions of Inshas laying hens at 48 weeks of ages.

Item	T1	T2	T3	T4	T5	SE
Thyroid activity:						
T3 (ng/ml)	2.372 ^c	2.724 ^{bc}	3.074 ^{ab}	3.238 ^a	3.400 ^a	0.162
T4 (ng/ml)	14.850 ^c	15.266 ^c	15.802 ^{bc}	17.198 ^{ab}	18.292 ^a	0.583
T3/T4 ratio	0.162	0.179	0.196	0.188	0.188	0.013
Liver functions:						
AST (U/L)	51.05	50.43	48.79	49.34	50.62	1.616
ALT (U/L)	24.91	23.98	24.71	23.82	23.00	1.761

^{a, b, ...} Means within each row have no similar letter(s) are significantly different ($P \leq 0.05$)

Table (7): Effect of dietary iodine supplementation on fertility and hatchability percentages of Inshas laying hens at 48 weeks of ages.

Item	T1	T2	T3	T4	T5	SE
Fertility (%)	84.54 ^c	85.94 ^{bc}	90.62 ^a	93.00 ^a	92.04 ^a	1.349
Hatchability of all eggs (%)	80.30 ^b	82.91 ^{ab}	82.83 ^{ab}	83.67 ^{ab}	85.00 ^a	1.325
Hatchability of fertile eggs (%)	83.17 ^b	84.21 ^b	88.19 ^a	91.15 ^a	90.33 ^a	1.809

^{a, b, ...} Means within each row have no similar letter(s) are significantly different ($P \leq 0.05$)

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Iodine, productive, reproductive, physiological, Inshas strain

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الملخص العربي

دور أيودين الغذاء في تحسين الأداء الإنتاجي والتناسلي والفيسيولوجي والمناعي للدجاج المحلي

2- أثناء فترة وضع البيض

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1- قسم بحوث تربية الدواجن 2- قسم بحوث تغذية الدواجن

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

أجريت هذه الدراسة لدورة مركبة مدتها 24 أسبوع (كل دورة 12 أسبوع على التوالي) لبحث تأثير إضافة مستويات مختلفة من الأيودين في صورة يوديد الكالسيوم للعليقة على تحسين بعض الخصائص الإنتاجية والتناسلية وبعض المقاييس الفسيولوجية والهيماطولوجية والنسبة المئوية لإنتاج البيض وكتلة البيض وجودة البيض الخارجية والداخلية وكذلك الحالة المناعية لدجاج سلالة أنشاص (سلالة مستنبطة مصرية). ولهذا الغرض تم أخذ عدد 150 دجاجة بياضة و 15 ديك (من عمر 36 حتى 48 أسبوع) من قطيع أكبر وذلك في الفترة الثانية من التجربة بعد إنتهاء الفترة الأولى (من عمر 24 حتى 36 أسبوع) والتي إستخدمت في تسجيل إنتاج البيض فقط لا غير. تم تقسيم الدجاج إلى 5 مجاميع تجريبية متساوية بكل منها 30 دجاجة و 3 ديوك وكل مجموعة قسمت إلى 3 مكررات متساوية العدد وكذلك متوسط وزن جسم متساوى تقريبا.

- المجموعة الأولى (T1) تمثل المتوسط العام لإنتاج البيض لقطيع الدجاجات ككل وغذيت على العليقة الأساسية التي تحتوى على 0.3 ملجم أيودين/كجم عليقة وحفظت على أساس (كنترول 1)، الأربع مجاميع الأخرى والتي أخذت من نفس القطيع بمتوسط إنتاج للبيض اقل من المتوسط العام بنحو 20% وقسمت على المعاملات كالتالي :-
- المجموعة الثانية (T2) غذيت على العليقة الأساسية وحفظت على أساس (كنترول 2) ، بينما المجموعة الثالثة (T3) والرابعة (T4) والخامسة (T5) غذيت على العليقة الأساسية مضافا إليها 1.2 و 2.4 و 4.8 ملجم أيودين/كجم عليقة على التوالي.

وأوضحت النتائج المتحصل عليها مايلى:

-أدت إضافة الأيودين خاصة بمستوى 4.8 متبوعا بمستوى 2.4 ملجم أيودين/كجم عليقة لتحسين غير معنوى فى معدل تحويل الغذاء (جم غذاء/جم بيض) وعدد البيض بينما أدت لزيادة معنوية فى سمك قشرة البيض كما أدت إضافة الأيودين بمستوى 4.8 ملجم أيودين/كجم عليقة لتحسين معنوى فى عدد البيض والنسبة المئوية لإنتاج البيض مقارنة بالمجموعة التجريبية الثانية (كنترول 2) ، كذلك أدت لزياده معنوية فى عدد كرات الدم الحمراء والبيضاء خاصة الخلايا الليمفاوية وبالمثل مستويات البروتين الكلية والألبومين والجلوبيولين وهرمونات T₃, T₄ وأيضا مستويات الكالسيوم والفسفور وكذلك مستوى الكوليسترول عالى الكثافة إرتفعت معنويا عند مستوى 4.8 ملجم أيودين /كجم عليقة (T5)، وعلى العكس أدت هذه الإضافة لخفض معنوى لتركيزات البلازما من الليبيدات الكلية والكوليسترول الكلى، والكوليسترول منخفض الكثافة وعلى الجانب الأخر لوحظ فى دجاجات أنشاص فى المعاملتين الرابعة (T4) والخامسة (T5) أنها سجلت أعلى قيم من نسبة الخصوبة والفقس.

نستخلص من هذه الدراسة أن الإمداد الغذائي من الأيودين فى صورة يوديد الكالسيوم هو تطبيق عملي خاصة بمستوى 4.8 ملجم أيودين/كجم عليقة لدجاجات سلالة أنشاص لما له من تأثيرات مفيدة على الخصائص الإنتاجية والتناسلية والمقاييس الفسيولوجية والهيماطولوجية وكذلك حاله المناعيه.