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EFFECT OF IODINE SOURCES AND DIETARY ENERGY LEVELS ON PRODUCTIVE, PHYSIOLOGICAL AND IMMUNOLOGICAL PERFORMANCE OF BANDARAH LAYING HENS

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ABSTRACT:A total number of 330 Bandarah chicken (300 females and 30 males) 40-wks-old, were randomly distributed equally into six experimental groups to investigate the effect of supplementing iodine sources (organic and inorganic) with different metabolizable energy levels in 2×3 factorial design on productive, reproductive and immunological traits during the laying period (40-56 wks of age). Laying hens were fed three different metabolizable energy levels being 2606, 2705 and 2803 kcal/kg diet with 0.5 mg iodine from two sources, organic (iodine enriched yeast) and inorganic (Ca (IO3)2·H2O)**.** Results obtained could be summarized as follow: Chickens fed diet containing 2705 kcal of ME /Kg diet and supplemented with organic iodine recorded significantly the highest laying rate and egg mass and the best feed conversation ratio compared with the other experimental groups. The highest ratio of triiodothyronine to thyroxin were recorded for the groups fed diet containing 2606 or 2705 kcal of ME /Kg diet and supplied with organic iodine compared with the other experimental groups. The group fed diet contained 2606 kcal of ME /Kg diet and supplied with organic iodine had significantly an increase in plasma high density lipoprotein and high density lipoprotein to low density lipoprotein ratio compared with the other experimental groups. Results displayed that there was a significant increase in serum total antioxidant capacity when hens fed diet contained 2606 kcal of ME /Kg diet compared with those fed 2705 or 2803 kcal of ME /Kg diet supplemented with both of iodine sources. Feeding laying hen diet containing 2606 kcal of ME /Kg diet supplied with organic iodine showed significantly the highest Immunoglobulin G value compared with the others. It could be concluded that the supplementing diets containing 2705 or 2606 kcal of ME /Kg diet with 0.5 mg iodine enriched yeast/Kg diet is the most successful supplement for enhancing productive, hatchability, immunity, antioxidant status, as well as economical efficiency for Bandarah laying hens.

Key words: Organic iodine, Metabolizable energy, Laying performance, Blood parameters.

INTRODUCTION:

Nutritionists are interested in achieving the most profitable and economical level of dietary energy in laying hens (Harms *et al*., 2000). High feeding efficiency needs scientific and practical feeding methods (Lesson and Summers, 2001). It should be observed that the effective level of dietary energy is different between various breeds (Lippense *et al*., 2002). According to McDonald *et al*. (1995) who found about 2500–2900 Kcal/Kg metabolizable energy (ME) content in the diet for laying hens, is an optimal range of dietary energy. Lower amounts of ME would reduce energy intake which will decrease 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 al*. (2005) showed that there is a wide range of dietary energy levels from 2684 to 2992 kcal of ME/kg currently being used by the egg industry. Kout Elkloub *et al*. (2005) found that the diets containing 2600 kcal ME/kg achieved the best productive and reproductive traits of Mamourah laying hens. While, Hussein *et al*. (2010) reported that the optimal dietary energy levels for Bandarah laying hens is 2750 kcal ME/kg diet to achieve acceptable productive and reproductive **traits during 25 to 49 weeks of age. The amount of feed consumption in poultry depends on the level of energy in the diet; additionally, the balance of nutrients to dietary energy level is an important factor in poultry nutrition (Wu *et al*., 2005). It is well established that laying hens adjust their feed intake according to their energy requirements. Harms *et al*. (2000) displayed that hens received diets containing 2519 kcal of ME/ kg had 8.5% higher feed intake than hens fed diets containing 2798 kcal of ME/kg, and hens received diets containing 3078 kcal of ME/kg had 3.0% lower feed intake than hens fed diets containing 2798 kcal of ME/kg. The results of the effects of energy level in the diet on the laying rate are conflicting. For example, Ciftci *et al*. (2003) reported that reducing the dietary energy content from 2751 to 2641 kcal of ME/kg increased the egg production from 86.44 to 88.27%. While, Mathlouthi *et al.* (2002) observed an improve on laying rate at dietary energy content of 2753 kcal of ME/kg of diet compared with 2653 kcal of ME/kg of diet. Responses of egg weight to changes in dietary energy content are insignificant (Ciftci *et al*., 2003). However, some investigators have reported significant results, although small, increases in egg weight due to increased dietary energy was observed (Marsden *et al*., 1987and Peguri and Coon, 1991).

Iodine is considered as a trace mineral, supplied naturally by water and feed, which is essentially required for birds in small amount for normal production and metabolic function (Sturki, 1986). In birds, an adequate iodine provision is important since T3 and T4 control the heat regulation, growth and body weight, and they regulate the development of secondary sex characteristics and the fertility was important for the lipid metabolism (Ibrahim *et al.* 2015). The organic mineral (chromium) can be absorbed 20-30 times more efficiently than Inorganic forms (Piva *et al.*, 2003). Zelanka *et al.* (1993) and McDowell (1992) reported that the standardized requirement of Iodine is 0.5 mg /kg of diet for hens of heavier laying type and 0.35 mg/kg diet for hens of light laying type. The Gesellschaft für Ernährungsphysiologie (Society for Nutritional Physiology) GFE (1999) suggested an iodine requirement of 0.5 mg iodine/kg feed for broilers and laying hens, while the National Research Council (NRC 1994) proposed 0.35 mg iodine/kg feed for broilers and 0.32- 0.48 mg iodine/kg feed for laying hens. Ayanwale *et al*., (2006) established that I-enriched yeast is the most appropriate form of iodine for use in animal international supplements because of their excellent bioavailability and lower toxicity. Also, Abdallah *et al*. (2009) noted that replacing inorganic minerals with organic sources enhanced immune response of chicks and improved bird's performance. Yalcin *et al.*, (2010) found that organic trace minerals can increase laying rate and enhance egg shell quality and the meat yield provide better response to immune challenge while requiring lower inclusion rates which further decrease the fecal mineral output. Opaliński *et al.*, (2012) supplemented 1and 2 mg of I-enriched yeast/kg of feed in diets fed to laying hens and found that the egg weight and albumen weight were the highest in the group received 2 mg/kg of iodine from I-yeast. Calcium iodide administration to low dietary energy could increase plasma triiodothyronine and thyroxin concentrations when compared with the other thyroidal treatments. This increase was more obvious for triiodothyronine 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). So, the current study was conducted to investigate the effect of two dietary sources of iodine supplementation to Bandarah laying hens diets with different dietary metabolizable energy levels on the productive, physiological and immunological performance of Bandarah laying hens during the laying period 40-56 wks of age.

MATERIALS AND METHODS

Experimental design: The current experimental study was carried out at El–Sabahia Poultry Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. A total number of 330 Bandarah chickens (300 females and 30 males) 40-wks-old were randomly distributed equally in six experimental groups, 55 birds each (50 females and 5 males) in five equal replicates (10 females and one male for each). All birds were housed under similar managerial and hygienic conditions. Throughout the experimental period (40-56 wks of age), feed and fresh water were available ad libitum. The experimental design was in 2×3 factorial design, including three levels of dietary metabolizable energy (ME) (2803 as higher, 2705 as recommended and 2606 as lower kcal of ME/ kg diet) , each with two iodine sources; organic and inorganic ,each at 0.5 mg/kg of basal diet. The organic source of iodine was iodine enriched yeast, supplied by Beijing Alltech Biological Products Co. Ltd., Beijing, China and inorganic iodine source, while the inorganic source was ($Ca(IO_3)_2 \cdot H_2O$), Sigma-Aldrich hemical Co., St. Louis, MO, USA). The basal diets were formulated to meet nutrient requirements of Bandrah laying hens according to Feed Composition Table for Animal and Poultry Feedstuffs in Egypt (2001). The composition and calculated analysis of the experimental diets are shown in Table (1).

Data collected:

Laying performance: Hens body weight was individually weighed (g) at the beginning of the trial and again after four months at the end of the experiment. Laying rate (LR %) and feed consumption (gm) were recorded, while feed conversion ratio (FCR) and egg mass (EM) were calculated through experimental period.

Egg quality traits: At 48 wks of age, (5) eggs from each replicate were randomly taken from the same day of production to investigate some egg quality traits including egg shape index, yolk index according to Sauter et al., (1951), albumen and shell weight were calculated relative weight to egg weight, shell thickness (mm) with membrane and Haugh units according to Williams (1992).

Fertility and hatchability percent: For evaluating fertility and hatchability, three hatches were conducted through the period of experiment. The number of fertile and infertile eggs was 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 eggs, whereas number of hatched chicks per hen was also recorded.

Biochemical blood and hormones assay: At the end of the experiment, (at 09.00 AM), two blood samples (3 ml, each) from one hen / replicate were withdrawn from the brachial vein, (one with anticoagulant to separate plasma and the other one without anticoagulant to separate serum). Samples of serum and plasma were kept at (-20°C) until analysis .Plasma total lipids (TL), triglycerides (TG), cholesterol (Cho), high density lipoprotein (HDL) and low density lipoprotein (LDL) were determined using commercial kits produced by Diamond Diagnostics Company (29 Tahreer St. Dokki Giza Egypt). HDL and LDL ratio was calculated .The activity of serum aspartate amino transferase (AST), and serum alanine amino transferase (ALT), were determined using commercial kits by spectrophotometrically. Serum total antioxidant capacity (TAC) and malondialdehyde (MDA) were colorimetrically determined using commercial Kits. Also, plasma triiodothyronine (T_3), thyroxin (T4) hormones were assayed. T_3/T_4 ratio was calculated and The plasma samples were used to measure the concentrations of immunoglobulin (IgG) and IgM isotypes by using chicken IgG, IgA, and IgM enzyme-linked immunosorbent assay quantification kits, respectively (Bethyl Laboratories, Montgomery, TX, USA)..

Slaughter Traits: At the end of the experimental period, 5 hens per treatment (one from each replicate) were randomly taken; slaughtered and eviscerated then carcass, liver, spleen, and thyroid gland were separated and weighed to the nearest gram, and expressed as the percentage of live body weight.

Economical evaluation: Economical efficiency (EE) was calculated from the input-output analysis which was calculated according to the price of the experimental diets and number of hatched chicks per hen during the year 2019. The values of (EE) were calculated as the net revenue per unit of total cost using the following equation:

1- Cost of birds feeding =Total feed intake (g/h/d) × Feed cost (LE/h/d).

2- Number of hatched chicks per hen= Egg number/hen/period (40-56wk) × hatchability of total egg set.

3- Return of hatched chicks = Number of hatched per hen × price of selling hatched chicks (3 LE/chick).

4- Net return = Return of hatched chicks - cost of feeding the birds.

5- Economical efficiency = net return divided by cost of feeding the birds. **Statistical analysis:** Data obtained were statistically analyzed using the General Linear 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 varianc (in 2×3 factorial design) considering the dietary ME and iodine source as the main effect, using the following model: Yijk = µ +Ei +Tj + (ET) ij+ eijk where: Y ijk =an observation; µ = Overall mean; Ei = effect of dietary ME level (i =1, 2 and 3); Tj = effect of dietary iodine source (j =1 and 2); (ET)ij = interaction between ME level Ei by iodine source Tj and eijk = experimental random error

RESULTS AND DISCUSSION

Productive performance:

Laying rate: Regarding to levels of metabolizable energy (ME), data in Table 2 showed that egg laying rate (LR) showed insignificant differences among the groups fed diets differ on its content of ME. These results are in disagreement with those obtained by Ciftci *et al*. (2003) who noted that reducing the dietary energy content from 2751 to 2641 Kcal of ME/kg increased the egg production from 86.44 to 88.27%. Also, Kout El-kloub *et al.* (2005) displayed that the diets containing 14%CP and 2600 kcal ME/kg improved egg production for Mamourah laying hens. Concerning the source of iodine, LR was significantly improved by 5.1 % for the groups supplemented with dietary Org-I, as compared to those supplemented with dietary Inorg-I. This effect may be due to iodine as a component of T_4 which regulates metabolism and has a strong effect on growth and performance of birds. Moreover, the organic-I may increase body tissue retention of iodine, increasing reserve of I that may be mobilized during time of extra requirement such as laying rate or stress. Deficiency of iodine in feed can cause metabolic disorders, decreased laying rate, and stimulates enlargement of the thyroid gland follicles (Lewis, 2004). On the other hand, organic-I through the function of thyroid hormones tend to stimulate cellular protein synthesis, as observed in our results, which may explain improving egg production level when potassium iodide was supplemented as listed by Hinkle and Kinsella, (1986). Interaction between metabolizable energy and iodine sources in the diet had high significantly effect on LR. The hens fed diet contained 2705 Kcal ME/kg and supplied with Org-I diet recorded the best LR (54.56%) comparing with the other experimental groups. it was also observed that 2606 with Org-I was significantly higher than those contained 2705 and 2803 ME with Inorg-I by 2.36 and 3.97, respectively

Egg weight: Data presented in Table 2 showed that there were significant differences among the experimental groups in egg weight (EW) per hen, due to different ME levels. Egg weight was significantly enhanced for the hens fed diets containing 2803 or 2705 Kcal ME/kg diet compared to the group fed 2606 Kcal ME/kg. In contrast, Wu *et al.* (2005) stated that, increasing only dietary energy without the increase of other nutrients (protein and amino acid) levels did not increase egg weight, and both protein (amino acids) and dietary energy are important to increase egg weight. The current study, observed that the high ME level had significantly higher EW as compared to low ME level in the diet. These results are in disagreement with Jalal *et al.* (2006) who found that egg weight was not affected by dietary energy. Regarding to iodine sources, the different sources of iodine had no significant effect on EW. Groups fed Org-I diet had significantly heavier egg weight than those fed the Inorg-I. The interactions between different levels of ME and iodine sources display that the group fed diet containing 2803 and supplied with Org-I produced the highest EW compared to other groups, while those fed diet containing 2606 supplied with Inorg-I produced the lowest EW. However, the groups fed diets contained 2606, 2705 and 2803 and supplied with Org-I produced higher EW compared with the corresponding groups fed with Inorg-I diet.

Egg mass: Data presented in Table 2 showed that significant differences were noted among the experimental groups in egg mass (EM) due to either varying ME or iodine sources in the diet. Egg mass per hen for group received 2803 Kcal of ME/kg diet was numerically lower as compared to group received 2705 Kcal ME/kg. These results are not agree with Nahashon et al. (2007) who indicated that EM was higher ($P \leq 0.05$) for hens receiving diet with 2803 Kcal ME/kg than those fed diet containing 2900 Kcal of ME /kg diet during 26 - 50 wks of age. Egg mass was affected significantly ($P \leq 0.001$) by iodine source supplementation, the hens fed diet supplemented with Org-I exhibited significantly higher EM than those fed the Inorg-I diet by 8.31%, (Table 2). These results may be due to increasing of T3 and T3/T4 ratio detected for the groups supplied with organic iodine (Table 5). Results obtained confirmed those observed by Samar et al. (2005) who reported that, with a mild hyperthyroidism, egg mass increased significantly by 6.07 and 14.81% in Silver and Gimmizah local strains, respectively compared to control after peak of egg production. The interaction between ME levels and iodine sources indicated that there were significant interaction among them (Table 2). The best record of EM per hen per day (30.01g) was occurred by the group fed diet contained 2705 Kcal of ME/kg diet with Org-I diet, while the worst was occurred by group fed diet contained 2606ME with Inorg-I diet.

Feed consumption, energy intake and feed conversion ratio: Daily feed intake (FI, g/hen/d), energy intake (EI, kcal/hen/d) and feed conversion ratio (FCR, g feed/g egg mass) are presented in Table 2. It is clear that the mean values of FI and FCR had the same trend, since the lowest FI and the best FCR were recorded for the group fed diet containing 2803 Kcal ME/Kg diet. According to these results, the feed consumption was increased by decreasing ME content, since with decreasing dietary energy levels from 2803 to 2705 and 2606 Kcal/Kg diet, FI linearly increased from 120.9 to 125.7 and 131.9 g/hen/day respectively. Therefore, an increase of 100 kcal/kg dietary energy decreased FI by 1.37 %. The same results were reported by Grobas *et al.*(1999) who indicated that an increase of 33 kcal/kg dietary energy decreased feed intake by 1%, which was agree with result in the current study. In addition, results obtained confirmed those of Harms *et al.* (2000) who concluded that hens fed diets containing 2519 kcal/kg had 8.5% more feed intake than hens fed diets containing 2798 kcal/kg. Wu et al. (2005) reported that as dietary energy content increased from 2719 to 2956 kcal/kg, feed intake decreased and feed conversion linearly improved from 2.14 to 1.97 (g feed/g egg), resulting in a net improve of 7.94%. This difference relating to feed conversion values could be attributed to differences in strain of bird's age, amount of decreasing in ME and housing system. Also, the results are consisting with Gunawardana *et al.* (2009a, b) who found that as dietary energy increased feed intake would decrease. While EI not affected by dietary energy. Concerning to the iodine sources, the lowest FI, EI and the best FCR were recorded for the groups supplied with organic sources of iodine. Nollet *et al.* (2007) determined that feeding organic minerals replacing inorganic sources may have benefits in FCR in young broilers. The interaction between ME and iodine in FI and FCR illustrated that the groups fed diet containing 2705 Kcal ME/Kg diet with organic iodine or fed diet containing 2803 Kcal ME/Kg diet with inorganic or organic iodine consumed significantly the lowest amount of feed compared with the other groups, while highest EI and best FCR was recorded for the group fed diet containing 2705Kcal ME/Kg diet with organic iodine.

Body weight and body weight change: As shown in Table 3, the average initial live body weight (BW) values of laying hens with different treatments at the beginning of the experiment (40 weeks of age) were, nearly similar, with no significant differences among them. This may create a suitable condition to appraise the effect of dietary treatments during the subsequent periods. Regarding to the effect of ME and regardless of iodine sources, increasing ME content on Bandarah layer diets from 2606 to 2803 kcal/kg diet significantly increased the final BW and BW change at the end of the experimental period. These results are compatible with the results 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 low 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 (Piliang *et al*., 1982). Balnave and Robinson (2000) observed that body weight gain increased with increasing dietary ME level (2500, 2705 and 2900 kcal ME/kg) for Brown layer strains. Generally, hens fed diet supplemented with Org-I had significantly higher BW change at the end of the experimental period comparing with the Inorg-I groups. Body weight change was significantly affected due to the interaction between ME and I sources. BW change was significantly increased in hen fed diet contained 2803, 2705 or 2606 Kcal ME/ kg with Org-I compared to those contained 2705 or 2606 ME with Inorg-I followed by those fed 2606 Kcal ME/ kg and Inorg-I. This increment in BW change may be attributed to the hyperthyroid status induced by using Org-I which may be considered the best source of iodine.

Fertility and hatchability: Results of Table 3 showed that fertility was not significantly affected due to feeding different ME levels, iodine sources and their interaction, while dietary ME significantly affected the hatchability (%)

of total set eggs and number hatched per hen (NHPH) which were significantly higher by dietary 2705 kcal/kg diet and lower in 2803 kcal/kg while 2606 group was intermediate. Several studies with laying hens have shown that neither energy nor protein levels affected the fertility or hatchability of total set or fertile eggs in Mamourah laying hens (Kout El-kloub *et al*., 2005). Concerning the source of iodine, the layer group fed Org-I diet, was significantly higher in both of hatchability % and number of baby hatched per hen compared to the Inorg-I diet. Interaction between varying levels of ME and iodine sources showed significantly better values of hatchability % and number hatched per hen for the groups fed diet containing 2606 or 2705 kcl ME/kg diet and supplied with organic iodine.

Egg quality traits: Egg shape index, yolk, albumin and shell percentages, yolk index, shell thickness and Haugh unit (HU) are presented in Table 4. Data obtained revealed that all egg quality traits were not significantly affected due to feeding different ME, I sources and their interaction, except the HU score and shell weight % which were significantly increased with feeding diets containing 2705 or 2803 kcl ME/kg, compared with those fed 2606 ME. These finding are in agreement with observation of Zanaty (2006) who found that dietary energy levels had no effect on most external and internal egg quality traits, however, only the 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. Concerning to iodine sources, it was observed that HU and shell weight % were significantly improved when laying hens fed Org-I diet compared to inorganic iodine diet. The interactions between varying levels of ME and iodine sources show that no significant effect exist for all egg quality traits of Bandarah laying hens except shell weight % and HU which were significantly affected. The lowest record was occurred by the group fed diet contained 2606 Kcal ME/kg diet supplemented with Inorg-I compared to other groups.

Blood parameters:

Immune indices: Data of blood immunoglobulin, liver function and thyroid activity of Bandarah laying hens as affected by feeding diet containing varying levels of ME and I sources are presented in Table 5. Results showed significant increase of serum immunoglobulin G (IgG) and serum Immunoglobulin G (IgM). When laying hens fed diet contained 2606 or 2705 Kcal ME/kg diet compared to the high ME group (2803 Kcal ME/kg diet). Concerning iodine sources, the groups of laying hens fed diet supplemented with Org-I significantly had higher serum (IgG) and (IgM) than those fed diet supplemented with Inorg-I diet by 12.32 and 45.45 %, respectively. The interaction between dietary ME and iodine sources was significantly differ in serum (IgG) and (IgM), whereas feeding laying hen 2606 Kcal ME/kg diet with Org-I showed the highest IgG value compared with others, in addition, groups fed diets contained 2606 or 2705 Kcal ME/kg diet with Org-I had significantly higher IgM compared with those fed diets contained 2606 and 2803 Kcal ME/kg diet with Inorg-I by 40.98% and 115% respectively, while the other groups exhibited intermediate IgM values.

Indices of Liver enzymes activity: Results of Table 5 declared that different dietary energy levels, iodine sources and their interaction did not significantly affect on serum AST and ALT activities. Only, AST activity showed significant improvement for the groups fed diets supplied with Org-I compared with those fed diet supplied with inorganic iodine. This indicated that iodine has no deleterious effect on liver function. These results are in close agreement with the observation reported by Bobiniene *et al*. (2010) and Abdel-Malak *et al.*, (2012).

Plasma thyroid hormones: Regarding thyroid hormones, results in Table 5 showed significant effect in the T3/T4 ratio due to dietary energy level so; the T3/T4 ratio was significantly increased in response to feeding diets containing 2606 and 2705 Kcal ME/kg compared to the groups fed diet containing 2803 Kcal ME/kg by 11.11 and 9.94 %, respectively. Regarding to the effect of iodine sources, results indicated that supplementation of dietary Org-I increased significantly plasmaT3 and T3/T4 ratio compared with the values for the groups supplied with Inorg-I by 19.17 and 28.75 %, respectively. The interaction between ME and iodine sources showed significant effects, whereas laying hens fed diet contained 2606 and 2705 Kcal ME/kg with Org-I exhibited significantly an increasing on T3/T4 compared with other groups which had the same ratio. This result reflects on egg production, immunity, antioxidant status and hatchability. This is a good physiological response as T3 was the most potent thyroid hormone in regulating all metabolic processes in living mammals and birds. Moreover, the enhanced T3/T4 ratio reflects an increase in the peripheral turnover of T4 to T3 via deionization process in the presence of excess dietary Org-I. These effects are in agreement with Miskiniene *et al*. (2010), El-Wardany *et al*. (2011) and Ibrahim *et al.* (2015) who observed an improvement in egg production and egg quality traits of the aged-hens. Also, Todini (2007) and Dias *et al*. (2010) reported that 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 and enhance the rate of glucose oxidation and intestinal absorption. These metabolic hormones increase glycogenolysis and gluconeogenesis in the liver (Eshkhatkhah *et al*., 2010).

Plasma lipid profile: Results of plasma lipids profile of Bandarah laying hens as influenced by dietary ME and iodine sources are shown in Table 6. It is clear from these results that the ME level, iodine source or their interaction had significant effect for all lipid fractions except for the total lipids and triglycerides, which were not influenced. Since, the highest levels of plasma cholesterol and LDL were observed for groups fed diet containing 2803Kcal ME/kg. However, HDL concentration and HDL/LDL ratio were significantly higher for the groups fed the low and mid ME diet. Concerning the iodine sources, Org-I displayed significant increase in plasma total cholesterol, HDL and HDL/LDL ratio compared with those fed diet contained InorgI, while the opposite was true with plasma LDL. This result reflects on better lipid profiles with Org-I diet. The interaction effect between ME and iodine sources were significant. Table (6) showed that group which fed diet contained 2606 ME with OrgI had significantly an increase in plasma HDL and HDL/LDL ratio compared to other group. However, the highest plasma LDL was due to feeding laying hen diet contained 2803 ME with Inorg-I. The previous results confirm the concept of the relationship between thyroid gland activity and lipid metabolism, especially in the low ME diets. These results are in agreement with those reported by Bobiniene, *et al*. (2010) who mentioned that thyroid hormones level and dietary ME content are the main factors affecting lipid metabolism in laying hens.

Serum antioxidant and lipid peroxidation status: Data for the biochemical constituents of serum antioxidant (total antioxidant capacity (TAC) and lipid peroxidation status {malondialdehyde (MAD) of Bandarah laying hens are presented in Table 6. Regarding to the effect of metabolizable energy, results displayed that there was significant increase in serum TAC when hens fed diet contained 2606 ME than those fed 2705 or 2803 ME by 25.2 and 27.4%, respectably while the later groups exhibited no significant difference between them. On the other hand, serum MDA significantly recoded highest value when laying hen fed diet contained 2803 ME compared with those fed 2606 or 2705 ME. Concerning the effect of iodine sources, TAC was significantly increased for the groups supplied with organic iodine compared with those fed inorganic iodine, while MAD had the opposite trend. The interaction results indicated that there was significant interaction among different groups. The group which fed diet contained 2606ME with Org-I showed significantly higher serum TAC compared with those fed diet contained 2606, 2705 and 2803 ME with Inorg-I and statistically equal to the group fed diet containing2606ME with Inorg-I. The groups fed diet contained Org-I showed a numerical lower MDA compared with those fed diet contained Inorg-I. Additionally, the group which fed diet contained 2705 ME with org-I recorded significantly the lowest value (1.73) compared with the other experimental groups.

Carcass characteristics: Results in Table 7 showed significant effect in the thyroid gland weight due to dietary energy level. Thyroid gland weight % was significantly increased in response to feeding diets containing 2606 and 2705 Kcal ME/kg compared to the group fed diet containing 2803 Kcal ME/kg by 11.11 and 9.94 %, respectively. Also, the relative weight of spleen, liver and pancreas were significantly increased by increasing the ME content of the diet. Regarding to the effect of iodine sources, results indicated that supplementation of dietary Org-I increased significantly spleen, liver, pancreas and thyroid gland relative weight compared with the values for the groups supplied with Inorg-I. The interaction between ME and iodine sources showed significant effects on some of carcass organs. The relative weight of spleen and liver for the group supplied with 2803 Kcal ME/kg with Org-I were significantly higher compared with the values for the other groups. The hens fed diet contained 2606 and 2705 Kcal ME/kg with Org-I indicated that thyroid gland weights were statistically equal for all groups except the group fed diet containing 2803 Kcal ME/kg diet and supplied with inorganic iodine, which had significantly the lowest weight comparing to the other experimental groups.

Economical efficiency (EE): Results concerning the EE of hatched chick as influenced by different dietary ME levels and iodine sources are shown in Table (8). It is noticed that decreasing dietary ME content in Bandarah layer diet from 2803 to 2705 Kcal ME/Kg diet with Org-I achieved the best EE , compared to the other groups.

CONCLUSION

Under the experimental conditions of this study, the results demonstrate that the adequate level of ME for Bandarah laying hens was 2705 or 2606 Kcal/Kg diet to maximize the productive performance, however the combination of the same level of ME (2705 and 2606 Kcal/Kg diet) with 0.5 mg iodine enriched yeast/Kg diet is the most successful supplement for improving egg production, hatchability, immunity, antioxidant status, and economical efficiency for Bandarah laying hens during the laying period (40- 56 wks of age).

Table (1): Composition and calculated analysis of the experimental diets

Ingredients (%)	**Energy levels (kcal /kg diet)**		
	2606	**2705**	**2803**
Yellow corn	576	597	602
Soybean meal (44%CP)	250	260	264
Wheat bran	60	23	3
Soya oil	3	9	20
Calcium diphosphate	17	17	17
Limestone	86	86	86
Sodium chloride	3.7	3.7	3.7
Vit. and Min. Premix1	3	3	3
DL-Methionine	1.3	1.3	1.3
Total	1000	1000	1000
***Calculated analysis*[2]**			
Crude protein, %	16.5	16.5	16.5
ME (kcal /kg diet)	2606	2705	2803
C/P ratio	157.9	163.9	169.9
Ether extract, %	30.1	35.5	46.0
Crude fiber, %	32.5	29.8	28.2
Calcium, %	33.3	33.3	33.3
Phosphorus available, %	4.69	4.49	4.44
Methionine, %	3.76	3.77	3.75
Cystine,%	2.88	2.86	2.84
Lysine, (%)	8.36	8.44	8.44
Arginine, %	10.6	10.6	10.6

[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).

Table (2): Effect of dietary energy levels and iodine sources on performance of Bandarah laying hens

Traits / Treatments	Laying rate (%)	Egg weight (g)	Egg mass (g/h/d)	Feed intake (g/h/d)	Feed conversion (g feed/g egg)	Energy intake (kcal /h/d)
Dietary energy(kcal of ME/kg diet)						
2606	51.26	53.20^{b}	27.29^{b}	131.9^{a}	4.85^{a}	342.9
2705	52.87	54.55^{a}	28.85^{a}	125.7^{b}	4.38^{b}	339.4
2803	51.45	55.09^{a}	28.30^{a}	120.9^{c}	4.27^{c}	338.5
SEM	0.42	0.21	0.32	1.45	0.08	3.77
P value	NS	**	**	**	**	NS
Iodine source						
Inorg-I	50.57^{b}	53.45^{a}	27.03^{b}	128.7^{a}	4.77^{a}	347.1^{a}
Org-I	53.15^{a}	55.11^{b}	29.25^{a}	123.7^{b}	4.23^{b}	333.4^{b}
SEM	0.28	0.22	0.27	1.39	0.08	2.9
P value	**	*	**	**	**	**
Dietary energy× Iodine source						
2606× Inorg-I	50.13^{d}	51.72^{e}	25.93^{d}	132.8^{a}	5.12^{a}	345.2^{b}
2606× Org-I	52.39^{b}	54.68^{c}	28.65^{b}	131.2^{a}	4.58^{b}	341.1^{b}
2705× Inorg-I	51.18^{c}	54.09^{d}	27.68^{bc}	132.2^{a}	4.78^{b}	356.9^{a}
2705× Org-I	54.56^{a}	55.01^{b}	30.01^{a}	119.3^{b}	3.97^{c}	322.1^{c}
2803× Inorg-I	50.39^{d}	54.54^{c}	27.48^{bc}	121.2^{b}	4.41^{b}	339.3^{b}
2803× Org-I	52.50^{b}	55.64^{a}	29.11^{b}	120.6^{b}	4.13^{bc}	337.6^{b}
SEM	0.41	0.21	0.25	1.66	0.07	4.33
P value	0.0002	0.0001	0.001	0.001	0.0002	0.001

a, b.. Means within a column within each factor with different superscripts are significantly different ($P \leq 0.05$), *= ($P \leq 0.05$) **= ($P \leq 0.01$), NS= Not significant. SEM= Standard error of means, P value= Probability level, Inorg-I = 0.5mg inorganic iodine kg diet (as control), Org-I = 0.5 mg organic/kg diet.

Table (3): Effect of dietary energy level and iodine sources on body weight and hatching traits of Bandarah laying hen

Traits / Treatments	Initial BW (40 wk) (g)	Final BW (56 wk) (g)	BW Change 40-56wk (g)	Fertility (%)	Hatchability of total eggs (%)	No. hatched per hen (chick)
Dietary energy(kcal of ME/kg diet)						
2606	1776.15	1899.5	123.35 [b]	94.61	82.11 [ab]	42.17 [ab]
2705	1773.15	1901.8	128.65 [b]	94.61	84.55 [a]	44.68 [a]
2803	1771.85	1937.3	165.45 [a]	95.31	78.055 [b]	40.24 [b]
SEM	30.11	32.02	10.14	0.89	1.69	1.28
P value	NS	NS	**	NS	**	**
Iodine source						
Inorg-I	1772.9	1897.1	124.17 [b]	95.73	79.50 [b]	40.17 [b]
Org-I	1774.5	1928.7	154.13 [a]	93.96	83.63 [a]	44.54 [a]
SEM	24.72	25.31	5.04	0.63	1.19	0.91
P value	NS	NS	**	NS	**	**
Dietary energy× Iodine source						
2606× Inorg-I	1774.7	1881.3	106.6 [c]	95.4	78.10 [b]	39.15 [c]
2606× Org-I	1777.6	1917.7	140.1 [ab]	93.82	86.11 [a]	45.18 [a]
2705× Inorg-I	1772	1871.6	99.6 [c]	94.99	82.43 [ab]	42.07 [ab]
2705× Org-I	1774.3	1932	157.7 [a]	94.23	86.66 [a]	47.28 [a]
2803× Inorg-I	1772	1938.3	166.3 [a]	96.8	77.98 [b]	39.3 [c]
2803× Org-I	1771.7	1936.3	164.6 [a]	93.82	78.13 [b]	41.17 [ab]
SEM	34.95	42.14	6.07	1.26	2.39	1.81
P value	NS	NS	**	NS	*	**

a, b.. Means within a column within each factor with different superscripts are significantly different (P≤0.05), *= (P≤0.05) **= (P≤0.01), NS= Not significant. SEM= Standard error of means, P value= Probability level, Inorg-I = 0.5mg inorganic iodine kg diet (as control), Org-I = 0.5 mg organic/kg diet.

Table (4): Effect of dietary energy level and iodine sources on some egg quality traits of Bandarah laying hens

Traits / Treatments	Egg shape Index (%)	Yolk Weight (%)	Albumen Weight (%)	Shell Weight (%)	Yolk Index (%)	Shell thickness (mm)	Haugh unit Score
Dietary energy kcal of ME/kg diet)							
2606	72.33	31.63	56.32	10.88 [b]	42.42	0.39	80.32 [b]
2705	72.90	33.09	55.51	11.69 [a]	41.82	0.40	86.73 [a]
2803	74.85	33.31	55.76	11.82 [a]	41.32	0.41	86.24 [a]
SEM	0.82	0.82	0.88	0.32	0.77	0.08	1.73
P value	NS	NS	NS	*	NS	NS	**
Iodine source							
Inorg-I	73.1	32.5	55.9	11.12 [b]	41.70	0.39	81.37 [b]
Org-I	73.6	32.9	55.8	11.80 [a]	42.00	0.40	87.49 [a]
SEM	0.73	0.68	0.72	0.27	0.63	0.07	1.73
P value	NS	NS	NS	*	NS	NS	**
Dietary energy× Iodine source							
2606× Inorg-I	71.86	31.48	56.63	10.44 [b]	41.48	0.38	78.60 [c]
2606× Org-I	72.79	31.78	56.01	11.31 [ab]	43.36	0.4	82.04 [bc]
2705× Inorg-I	73.02	32.78	55.73	11.49 [ab]	41.14	0.4	85.56 [bc]
2705× Org-I	72.77	33.4	55.28	11.89 [a]	42.5	0.39	87.9 [ab]
2803× Inorg-I	74.33	33.17	55.39	11.44 [ab]	42.49	0.4	79.94 [bc]
2803× Org-I	75.37	33.44	56.12	12.20 [a]	40.15	0.41	92.54 [a]
SEM	1.38	1.14	1.23	0.39	1.08	0.11	2.69
P value	NS	NS	NS	*	NS	NS	**

a, b.. Means within a column within each factor with different superscripts are significantly different ($P \leq 0.05$), *= ($P \leq 0.05$) **= ($P \leq 0.01$), NS= Not significant SEM= Standard error of means, P value= Probability level, Inorg-I = 0.5mg inorganic iodine kg diet (as control), Org-I = 0.5 mg organic/kg diet.

Table (5): Effect of dietary energy level and iodine sources on serum immunoglobulin (Ig), liver functions and thyroid activity of Bandarah laying hens

Traits / Treatments	IgG (mg/dl)	IgM (mg/dl)	AST (U/L)	ALT (U/L)	T_3 (ng/ml)	T_4 (ng/ml)	T_3/T_4 ratio
Dietary energy (kcal of ME/kg diet)							
2606	1.81 ^{a}	0.74 ^{a}	97.30	34.70	1.817 ^{a}	9.675 ^{a}	0.190 ^{a}
2705	1.58 ^{b}	0.76 ^{a}	88.50	34.42	1.637 ^{b}	8.725 ^{b}	0.188 ^{a}
2803	1.02 ^{bc}	0.54 ^{b}	85.80	34.20	1.862 ^{a}	10.910 ^{a}	0.171 ^{b}
SEM	0.084	0.058	9.28	0.443	0.088	0.22	0.01
P value	**	**	NS	NS	*	**	**
Iodine source							
Inorg-I	1.38 ^{b}	0.55 ^{b}	96.53 ^{a}	34.83	1.617 ^{b}	9.950 ^{a}	0.160 ^{b}
Org-I	1.55 ^{a}	0.80 ^{a}	84.53 ^{b}	34.05	1.927 ^{a}	9.590 ^{b}	0.206 ^{a}
SEM	0.094	0.046	7.552	0.359	0.079	0.210	0.009
P value	**	*	**	NS	**	**	**
Dietary energy× Iodine source							
2606× Inorg-I	1.47 ^{b}	0.61 ^{bc}	96.8	35.12	1.602 ^{bc}	10.120 ^{bc}	0.156 ^{b}
2606× Org-I	2.14 ^{a}	0.86 ^{a}	97.8	34.28	2.032 ^{a}	9.230 ^{cd}	0.224 ^{a}
2705× Inorg-I	1.73 ^{b}	0.65 ^{ab}	97.6	34.62	1.394 ^{c}	8.520 ^{d}	0.160 ^{b}
2705× Org-I	1.42 ^{b}	0.86 ^{a}	79.4	34.22	1.880 ^{ab}	8.930 ^{d}	0.216 ^{a}
2803× Inorg-I	0.95 ^{c}	0.40 ^{c}	95.2	34.74	1.854 ^{ab}	11.210 ^{a}	0.164 ^{b}
2803× Org-I	1.09 ^{c}	0.67 ^{ab}	76.4	33.66	1.870 ^{ab}	10.610 ^{ab}	0.178 ^{b}
SEM	0.096	0.068	7.829	0.573	0.082	0.271	0.012
P value	**	**	NS	NS	*	*	**

a, b.. Means within a column within each factor with different superscripts are significantly different (P≤0.05), *= (P≤0.05) **= (P≤0.01), NS= Not significant. SEM= Standard error of means, P value= Probability level, Inorg-I = 0.5mg inorganic iodine kg diet (as control), Org-I = 0.5 mg organic/kg diet.

Table (6): Effect of dietary energy level and iodine sources on plasma lipid profile, serum antioxidant and lipid peroxidation status of Bandarah laying hens

Traits / Treatments	Total lipids (g/dl)	Triglycerides (mg/dl)	Cholesterol (mg/dl)	LDL (mg/dl)	HDL (mg/dl)	HDL/LDL ratio	TAC (mg/dl)	MAD (mg/dl)
Dietary energy (kcal of ME/kg diet)								
2606	5.94	180.65	89.10 [b]	49.63 [b]	33.12 [a]	0.70 [a]	493.45 [a]	1.94 [b]
2705	7.02	172.50	92.90 [b]	53.61 [b]	28.82 [b]	0.57 [b]	414.30 [b]	1.94 [b]
2803	6.81	168.80	99.90 [a]	61.06 [a]	22.82 [c]	0.38 [c]	417.90 [b]	2.28 [a]
SEM	0.299	3.541	4.447	4.777	2.11	0.075	14.62	0.063
P value	NS	NS	*	**	**	**	**	**
Iodine source								
Inorg-I	6.74	181.77	83.80 [b]	61.41 [a]	23.267 [b]	0.38 [b]	428.87 [b]	2.21 [a]
Org-I	6.43	166.20	104.13 [a]	48.12 [b]	33.240 [a]	0.71 [a]	454.90 [a]	1.89 [b]
SEM	0.253	2.461	3.117	3.817	2.145	0.064	13.95	0.058
P value	NS	NS	**	**	**	*	*	**
Dietary energy× Iodine source								
2606× Inorg-I	6.29	192.8	78.00 [d]	56.48 [b]	26.52 [bc]	0.47 [c]	472.6 [ab]	2.00 [bc]
2606× Org-I	5.59	168.5	100.20 [b]	42.78 [c]	39.72 [a]	0.93 [a]	514.3 [a]	1.87 [c]
2705× Inorg-I	7.09	181.2	86.20 [cd]	62.48 [ab]	24.36 [cd]	0.39 [d]	410.8 [bc]	2.15 [b]
2705× Org-I	6.95	163.8	99.60 [bc]	44.74 [bc]	33.28 [b]	0.74 [b]	417.8 [bc]	1.73 [d]
2803× Inorg-I	6.85	171.3	87.20 [cd]	65.28 [a]	18.92 [d]	0.29 [d]	403.2 [c]	2.49 [a]
2803× Org-I	6.76	166.3	112.6 [a]	56.84 [b]	26.72 [bc]	0.47 [c]	432.6 [bc]	2.07 [bc]
SEM	0.377	4.527	5.073	5.752	2.696	0.07	19.66	0.077
P value	NS	NS	*	*	**	**	*	**

a, b.. Means within a column within each factor with different superscripts are significantly different (P≤0.05), *= (P≤0.05) **= (P≤0.01), NS= Not significant. SEM= Standard error of means, P value= Probability level, Inorg-I = 0.5mg inorganic iodine kg diet (as control), Org-I = 0.5 mg organic/kg diet.

Table (7): Effect of dietary energy level and iodine sources on relative weight of some of carcass traits of Bandarah laying hens

Treatments \ Traits	Spleen (%)	Liver (%)	Abdominal fat (%)	Pancreas (%)	Thyroid gland (%)
Dietary energy (kcal of ME/kg diet)					
2606	0.132^{b}	1.977^{b}	3.10^{c}	0.233^{b}	0.0083^{a}
2705	0.137^{b}	2.025^{b}	4.82^{b}	0.267^{a}	0.0082^{a}
2803	0.163^{a}	2.497^{a}	5.67^{a}	0.292^{a}	0.0065^{b}
SEM	0.014	0.08	0.30	0.013	0.00006
P value	*	**	**	**	*
Iodine source					
Inorg-I	0.119^{b}	2.072b	4.55	0.248^{b}	0.0049^{b}
Org-I	0.169^{a}	2.260a	4.46	0.280^{a}	0.0083^{a}
SEM	0.011	0.09	0.29	0.013	0.00001
P value	**	*	NS	*	**
Dietary energy× Iodine source					
2606× Inorg-I	0.113^{c}	1.960^{b}	3.07^{b}	0.223^{c}	0.0079^{a}
2606× Org-I	0.150^{bc}	1.993^{b}	3.03^{b}	0.243^{bc}	0.0086^{a}
2705× Inorg-I	0.103^{c}	1.987^{b}	4.75^{a}	0.257^{bc}	0.0081^{a}
2705× Org-I	0.170^{b}	2.063^{b}	4.883^{a}	0.277^{b}	0.0079^{a}
2803× Inorg-I	0.140^{bc}	2.270^{b}	5.823^{a}	0.360^{a}	0.0044^{b}
2803× Org-I	0.187^{a}	2.723^{a}	5.510^{a}	0.223^{c}	0.0081^{a}
SEM	0.016	0.330	0.320	0.013	0.00003
P value	*	*	**	**	**

a, b.. Means within a column within each factor with different superscripts are significantly different ($P\leq0.05$), *= ($P\leq0.05$) **= ($P\leq0.01$), NS= Not significant SEM= Standard error of means, P value= Probability level, Inorg-I = 0.5mg inorganic iodine kg diet (as control), Org-I = 0.5 mg organic/kg diet.

Table (8): Effect of dietary energy level and iodine sources on economical evaluation of Bandarah laying hens during 40-56 weeks of age.

Traits / Treatments	2606 Kcal ME /kg diet + Inorg-I	2606 Kcal ME /kg diet + Org-I	2705 Kcal ME /kg diet + Inorg-I	2705 Kcal ME /kg diet + Org-I	2803 Kcal ME /kg diet + Inorg-I	2803 Kcal ME /kg diet + Org-I
Average feed consumption kg per hen during 40-56 weeks of age	15.936	15.744	15.864	14.316	14.544	14.472
Cost /kg feed, L.E[1]	4.03	4.28	4.36	4.61	4.61	4.86
Total feed cost, L.E[2]	64.19	67.35	69.17	66.00	67.09	70.38
Number of chick produced / hen	39.15	45.28	44.07	47.28	40.81	44.69
Price of one chick, L.E[3]	3	3	3	3	3	3
Total return / hen, LE	117.45	135.33	126.56	141.84	117.88	123.01
Net return / hen, LE[4]	53.26	67.98	57.39	75.84	50.79	52.63
Economic efficiency[5]	0.83	1.01	0.83	1.15	0.76	0.75

Inorg-I = 0.5mg inorganic iodine kg diet (as control), Org-I = 0.5 mg organic/kg diet. 1-Price of one Kg iodine enriched yeast=250 LE. L.E = Egyptian pound. 2- According to price of different ingredients available in Egypt at the experimental time. 3- According to local price at the experimental time. Chick Price= 3 LE 4-Net Revenue (LE) = Differences between Chick Price and Feed cost. 5-Economic efficiency = (Net return LE / Total feed cost LE)

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الملخص العربى

تأثير مصادر اليود ومستوى طاقة الغذاء على الاداء الانتاجي والفسيولوجي والمناعى فى دجاج البندرة البياض

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أجريت هذه الدراسة لمعرفة مدى تأثير مصادر اليود ومستوى طاقة الغذاء على تحسين أداء دجاجات البندرة المستنبطة محليا و بعض الصفات الفسيولوجية و المناعية ، استخدم في هذه الدراسة عدد ٣٣٠ طائر(٣٠٠ دجاجة و ٣٠ ديك)عمر ٤٠ أسبوع. تم وزن الطيور فردياً و قسمت عشوائياً إلى ستة مجموعات كل مجموعة تتكون من خمسة مكررات فى تصميم عاملى ٢×٣ خلال فترة الانتاج من ٤٠-٥٦ اسبوع من العمر. تم تكوين العلائق بحيث تحتوى على ٣ مستويات من الطاقة هى ٢٦٠٦ ،٢٧٠٥ و٢٨٠٣ كيلوكالورى طاقة ممثلة لكل كيلو جرام عليقة وتم اضافة اليود بمستوى ٠.٥ملجم لكل كجم عليقة الى كل مستوى على هيئة مصدرين الاول عبارة عن المصدر المعدنى(يوديد الكالسيوم) اما المصدر الثاني كان المصدر العضوى (خميرة غنية باليود). ويمكن ان تتلخص أهم النتائج المتحصل عليها فيما يلى:

١- ادت تغذية الدجاج على عليقة تحتوي على ٢٧٠٥ كيلوكالورى من الطاقة الممثلة ومضاف اليها يود فى صورته العضوية الى زيادة معنوية فى معدل انتاج البيض وكتلة البيض وافضل معدل تحويل غذائى مقارنة بباقى المجاميع التجريبية.

٢- نتج عن تغذية الدجاج على عليقة محتوية على طاقة ممثلة ٢٦٠٦ أو ٢٧٠٥ كيلوكالورى والمضاف اليها يود فى صورته العضوية أكثر عدد كتاكيت فاقسة لكل دجاجة ام

٣- لوحظ أعلى نسبة بين هرمون التراى ايودوثيرونين وهرمون الثيروكسين عند تغذية الدجاج على عليقة محتوية على ٢٦٠٦ أو ٢٧٠٥ كيلوكالورى من الطاقة الممثلة والمضاف اليها يود فى صورته العضوية مقارنة بالمجاميع الاخرى.

٤- نتج عن اضافة اليود العضوى الى العليقة منخفضة الطاقة زيادة معنوية فى مستوى كل من البروتينات عالية الكثافة فى بلازما الدم وكذلك النسبة بين البروتينات عالية الكثافة الى البروتينات منخفضة الكثافة مقارنة بباقى المجاميع.

٥- ادت تغذية الدجاج على عليقة تحتوى على٢٦٠٦ كيلوكالورى من الطاقة الممثلة والمضاف اليها يود فى صورته العضوية زيادة معنوية فى مستوى مضادات الاكسدة الكلية فى سيرم الدم مقارنة بتلك المغذاة على عليقة تحتوى على ٢٧٠٥ أو ٢٨٠٣ كيلوكالورى من الطاقة الممثلة والمضاف اليها يود عضوى أو معدنى.

٦- أدت التغذية على عليقة تحتوى على طاقة ممثلة ٢٦٠٦كيلوكالورى/كجم مع اليود العضوى الى زيادة معنوية فى مستوى الجلوبيولين المناعى من نوع G مقارنة بالمعاملات الاخرى، كذلك حدث زيادة معنوية فى مستوى الجلوبيولين المناعى من نوع M فى مستوى سيرم الدم للدجاج المغذى على عليقة تحتوى على طاقة ممثلة ٢٦٠٦ أو ٢٧٠٥ كيلوكالورى والمضاف اليها يود فى صورته العضوية

وقد خلصت الدراسة الى ان اضافة اليود فى صورته العضوية الى العلائق محتوية على طاقة ممثلة سواء ٢٦٠٦ او٢٧٠٥ كيلو كالورى/كجم عليقة أدى إلى تحسن فى الصفات الانتاجية و التناسلية و المناعية لدجاج البندرة البياض خلال فترة الانتاج من ٤٠-٥٦ اسبوع من العمر، فضلا عن تحسن الكفاءة الاقتصادية.