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Effects of adding high levels of Organic Zinc to the diets of Japanese quail females on some serum blood hormones

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ABSTRACT

The current study was carried out at AL-Anbar University's College of Agriculture. Quail field to study the following traits: growth hormone, T3, T4, and T.S.H. 180 female Japanese quail, aged 90 days and raised in cages, were randomly distributed across 4 nutritional treatments in a completely randomized design. Each treatment included 45 females, with three replicates per treatment, and each replicate contained 15 females, which were raised separately. The (females) quail were fed four types of diets representing the experimental treatments as follows: T1: the basal diet without added zinc, T2: the basal diet with the addition of 25 mg/ kg of zinc, T3: the basal diet with the addition of 50 mg/ kg of zinc, and T4: the basal diet with the addition of 75 mg/ kg of zinc. The results indicated a significant increase at the ($P \leq 0.01$) level in the concentration of Growth Hormone (GH) in the blood serum at the 25 and 50 mg/ kg zinc levels At 25 and 50 mg/kg levels, a significant increase ($P \leq 0.0002$) in triiodothyronine (T3) concentration was observed. Additionally, the results showed a significant increase at the ($P \leq 0.0025$) level in the concentration of Tetraiodothyronine (T4) at the 25 mg/ kg zinc level. There was also a significant increase at the ($P \leq 0.0001$) level in the concentration of Thyroid-Stimulating Hormone (TSH) at the 25 and 50 mg/ kg zinc levels compared to the control group.

KEY WORDS:
Zinc, endocrine system, Growth hormones, Japanese quail

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تأثير اضافة مستويات مرتفعة من الزنك العضوي في عليقة إناث السمان الياباني على بعض هرمونات مصل الدم

الخلاصة

أجريت هذه التجربة في كلية الزراعة (جامعة الانبار) في القاعة المخصصة لتربية السمان التابعة لحقول تربية الدواجن لقسم الانتاج الحيواني بهدف دراسة الصفات الاتية (هرمون النمو، T3، T4، T.S.H). استخدم 180 أنثى من طائر السمان الياباني المربى في الاقفاص بعمر 32 يوم، ووزعت بشكل عشوائي على 4 معاملات تغذوية بتصميم تام العشوائية. احتوت كل معاملة على 45 أنثى، بواقع ثلاث مكررات لكل معاملة، وكل مكرر احتوى 15 اناث، وربيت بشكل منفصل. غذيت الطيور (الإناث) بأربع أنواع من العلائق مثلت المعاملات التجريبية على النحو الآتي، T1: مثلت عليقة الأساس غير المحتوية على الزنك المعدني، T2: عليقة الأساس مع إضافة 25 ملغم / كغم زنك معدني، T3: عليقة الأساس مع إضافة 50 ملغم / كغم زنك معدني، T4: عليقة الأساس مع إضافة 75 ملغم / كغم زنك معدني. بينت النتائج الى ان التغذية بعلائق أضيف اليها الزنك المعدني الى وجود ارتفاع معنوي عند مستوى المعنوية (P≤0.0001) في تركيز Growth hormone (GH) في مصل الدم في المستوى 25 و50 ملغم كغم علف زنك معدني. كما يلاحظ وجود ارتفاع معنوي عند مستوى (P≤0.0002) في تركيز هرمون Triiodothyronine (T3) في المستوى 25 و50 ملغم كغم علف زنك معدني. كما تشير النتائج الى وجود ارتفاع معنوي عند مستوى (P≤0.0025) في تركيز هرمون Tetraiodothyronine (T4) في المستوى 25 ملغم كغم علف زنك معدني. وكذلك يلاحظ ايضا وجود ارتفاع معنوي عند مستوى (P≤0.0001) في تركيز هرمون Thyroid (TSH) stimulating hormone في المستوى 25 و50 ملغم كغم علف زنك معدني مقارنة مع مجموعة السيطرة.

الكلمات المفتاحية: الزنك، الغدد الصماء، هرمون النمو، طائر السمان

INTROUCTION

Zinc is an essential mineral element because it is indispensable for the growth and development of all living organisms. The physiological functions of zinc are numerous and important, as it maintains the function and structure of more than 300 enzymes and a large number of proteins (Sahraei *et al*., 2014). Feng *et al*. (2010) indicated that zinc is a vital trace element involved in cell growth, cellular homeostasis, protein and carbohydrate metabolism and DNA and RNA. Synthesis. it's crucial for vital functions, including the enhancement of reproduction and immune function (Prasad, 2002). Furthermore, zinc increases the activity of several hormones, including sex hormones, insulin, and glucagon., and also plays an important role in growth and the immune system (Chand *et al*., 2014). It has been shown that adding zinc to diets has significant effects in reducing oxidative damage to cells caused by free radicals (Tupe *et al*., 2010). Adequate levels of nutrients in the diet, including zinc and other elements, can enhance broiler hens' ability to reproduce. (Zhandi *et al*., 2016).

Also, it's one of the essential micronutrients that play a fundamental role in numerous body enzymes (McCall *et al*., 2000; Jarosz *et al*., 2017). The insulin-like growth factor (IGF-1) in poultry is a hormone that resembles insulin in its molecular structure and plays a crucial role in growth development, physiological characteristics, and reproductive functions (Kaiya *et al*., 2007). Zinc addition to the poultry diets under stress conditions can compensate for or maintain its normal blood levels which enhances thyroid gland function in secreting hormones. T3 and T4. according to that, promotes the synthesis of erythropoietin and increases the formation of red blood cells, hemoglobin (Hb) and packed cell volume (PCV) (Scanes, 2020). Zinc deficiency affects many vital functions in organisms, including thyroid activity and the secretion of hormones Triiodothyronine (T3) and Tetraiodothyronine (T4) (Iqbal *et al*., 1990). According to Morley et al.

(1980), an impairment in serum zinc levels is linked to a decrease in pituitary-derived thyroid-stimulating hormone (TSH), and subsequently, a reduction in thyroid hormones T3 and T4. T4 plays an important role in red blood cell formation by increasing the gene expression rate for erythropoietin synthesis, a glycoprotein that directly affects the division of erythroid progenitor cells and their maturation into hemoglobin-containing red cell precursors (Gunga *et al*., 1994). Growth hormone actively promotes body growth by inducing the liver and other specialized tissues to generate IGF-1, which is necessary for the formation of bone, cartilage, and ligaments. Growth is a complicated process that involves several organs. (Buonomo *et al*., 1991; Phillips *et al*., 1990). Thus, the purpose of the study was to find out how adding varying amounts of zinc to the diet affected the stimulation of the secretion of growth hormone (GH), triiodothyronine (T3), tetraiodothyronine (T4), and thyroid-stimulating hormone (TSH).

MATERIAL AND METHODS

Location of the Experiment:

This study was carried out at a quail field at the University of Anbar's College of Agriculture. to examine the effect of adding different levels of zinc to diet and its impact on the concentrations of the hormones TSH, T3, T4, and GH. 180 female Japanese quails, Females were 90 days old and were randomly divided into 4 treatments with 3 replicates, each containing 15 females. Birds raised in floor cages 50 × 60 × 67 cm. diameters treatments distributed randomly as follows: T1 - females fed a diet without zinc addition (control diet), T2 - addition of zinc 25 mg/kg of zinc (ZN), T3 - addition of zinc at a rate of 50 mg/kg of zinc (ZN), and T4 - addition of zinc at a rate of 75 mg/kg of zinc (ZN).

The birds were fed a well-balanced diet that met all of their nutritional requirements. Following the National Research Council's guidelines, the flock was fed a balanced female quail producti on diet. (NRC, 1994) as shown in Table 1.

Studied Traits:

Blood samples were collected to obtain serum from three birds randomly selected from each replicate, totaling fifteen birds per treatment. Axillary venous blood was used from the flank and placed in gel tubes without the use of anticoagulants.. The concentration of Growth Hormone (GH) was measured using an Elisa kit manufactured by USA BIO, following the instructions provided with the kit. The concentrations of Thyroid-Stimulating Hormone (TSH), Triiodothyronine (T3), and Tetraiodothyronine (T4) were measured using specialized kits for these hormones in poultry, provided by Mybiosource, UK according to the instructions included with the kits.

Table (1) shows the proportions and components of the feed ingredients included in the diet and the calculated chemical composition.

Feed Ingredients	Percentage of Feed Ingredients
Yellow Corn	%55
Soybean Meal	% 27.4
Wheat	% 6
Wafi Egg Protein	% 5
Dicalcium Phosphate	% 1
Limestone	% 6.5
Table Salt	% 0.1
Total	%100
Calculated Chemical Composition	
% CP	20.5
Energy kcal/ kg	2810.3
%Methionine + Cystine	0.8
% Lysine	1.2
% Fat	2.8
% Fiber	2.6
%Calcium	2.6
%P	0.8
%PAVIA	0.5

Wafi protein concentrate used in this diet, 40% crude protein, 5% crude fat, 2% crude fiber, 5.6% calcium, 4% phosphorus, 85.3% available lysine, 70.3% methionine, 4% methionine + cystine, 3.2% sodium, and 2100 kcal/kg of metabolizable energy. It also includes a blend of vitamins and trace minerals to meet the birds' needs. Phytase enzyme is provided at 15,000 enzyme units/kg of concentrate, and choline chloride is included at 5,000 mg/kg of concentrate**.**

Statistical Analysis:

SAS statistical software was used to evaluate the data (2001 or 2012). Completely Randomized Design (CRD) used in this study. Differences between treatments were tested using Duncan's multiple-range test (1955). The following statistical model was applied:

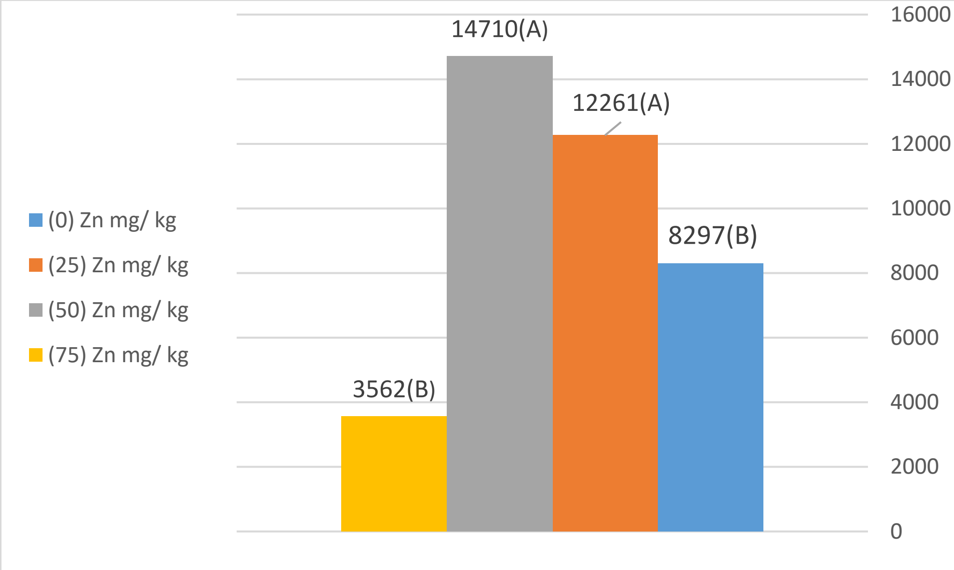
$$\mathbf{Y_{ij} = \mu + T_i + e_{ij}}$$

Where:

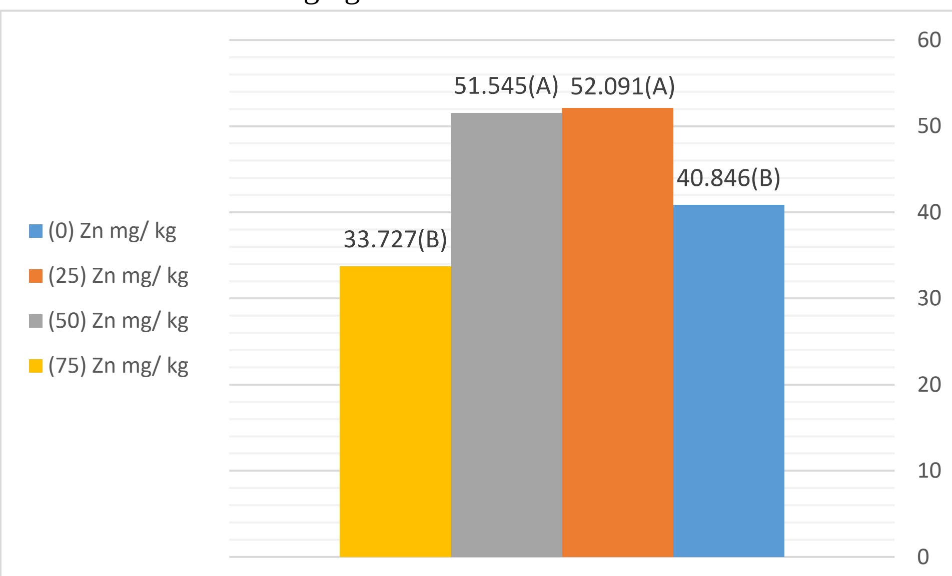
- Y_{ij} = Observed value for the studied trait
- μ = mean
- T_i= Treatment effect (the study included four treatments)
- e_{ij}= Random error, which is normally distributed with a mean of zero and variance of δe2\delta for each trait.

RESULTS AND DISCUSSION

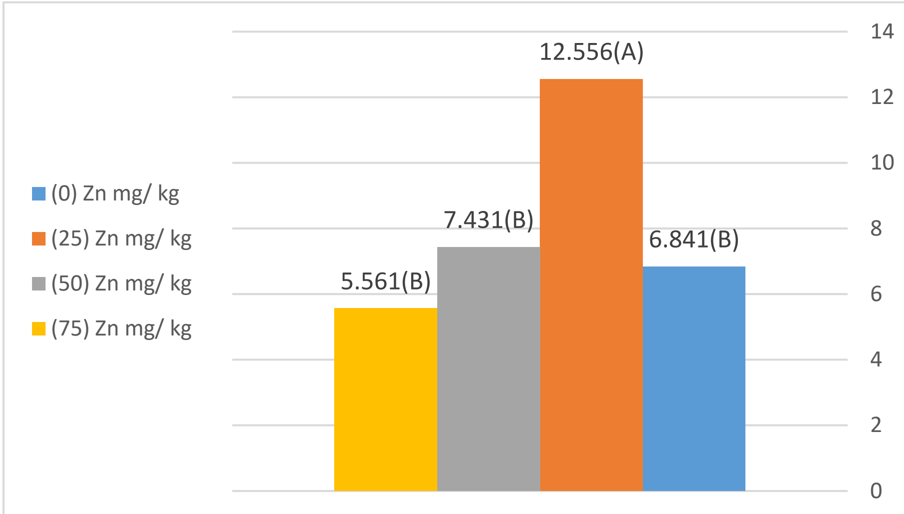
In comparison to the control group, Figure 1 demonstrates a substantial rise ($P \leq 0.0001$) in the concentration of Growth Hormone (GH) in blood serum during the second treatment, which involved 25 mg/kg of zinc, and the third treatment, which involved 50 mg/kg of zinc. Furthermore, as compared to the control group, the fourth treatment with 75 mg/kg of zinc shows a substantial drop in GH levels. 75 mg/kg of zinc when compared to the control group.



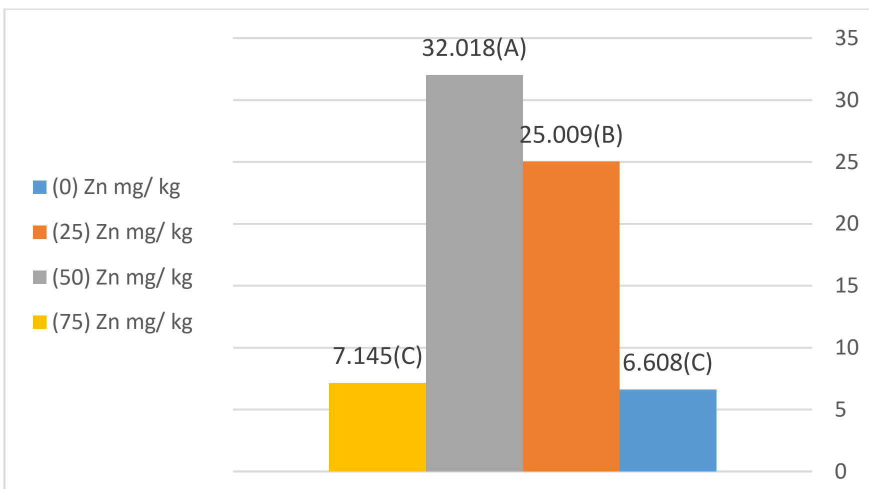
In contrast to the control group, Figure 2 reveals a substantial rise ($P \leq 0.0002$) in the blood serum concentration of Triiodothyronine (T3) for the second treatment with 25 mg/kg of zinc and the third treatment with 50 mg/kg of zinc. likewise, as compared to the control group, the fourth treatment with 75 mg/kg of zinc exhibits a substantial decrease in T3 concentration.



When comparing the blood serum concentration of Tetraiodothyronine (T4) during the second treatment with 25 mg/kg of zinc to the control group, Figure 3 indicates a substantial rise ($p \leq 0.0025$). While the fourth treatment, which contained 75 mg/kg of zinc, illustrated a substantial decrease in comparison to the control group, the third treatment, which contained 50 mg/kg of zinc, did not exhibit any discernible change.



Comparing the second treatment with 25 mg/kg of zinc and the third treatment with 50 mg/kg of zinc to the control group, Figure 4 demonstrates a substantial increase ($p \leq 0.0001$) in the concentration of Thyroid-Stimulating Hormone (TSH) in blood serum. When comparing the fourth treatment with 75 mg/kg of zinc to the control group, no discernible difference was found. difference was found.



The significant increase in Growth Hormone (GH) aligns with findings by Phillips *et al*. (1990) who noted the direct effect of GH on its specific receptors in target cells, leading to an increased utilization of amino acids or the conversion of fats into fatty acids. GH has an indirect effect on body cells, and zinc enhances the genetic expression of Insulin-like Growth Factor 1 (IGF-1). This genetic expression of IGF-1 contributes to cellular processes within the body by stimulating GH secretion, which in turn increases the cells' permeability to amino acids. This results in a higher concentration of amino acids within the cells, partially contributing to increased protein synthesis while reducing their concentration in blood plasma, as these are considered outcomes of gene expression (Aequaah, 2009).

IGF-1 plays a crucial role in anabolic processes and growth promotion, functions typically associated with Growth Hormone (GH). It has an insulin-like effect on the body and also possesses anti-inflammatory and antioxidant properties. IGF-1 concentrations decrease with aging (Fredrickson *et al*., 1967). Studies have shown that the IGF-1 gene is highly effective in enhancing growth and regulating cellular activities. It acts as a growth-promoting gene and is involved in metabolic processes such as cellular proliferation and differentiation (M.A. Egom *et al*., 2019). According to Stefanidou et al. (2006) and Chand et al. (2014), zinc becomes an essential substance that promotes growth in the body, regulator, structural component and cofactor. It aids in the metabolism of nutrients such as carbohydrates and proteins, thereby enhancing growth and reproduction.

The significant increase in T3, T4, and TSH hormones aligns with the findings of Duntas *et al*. (2013) and Carmona *et al*. (2014). They noted that adding zinc to the diet of Japanese quail interacts with thyroid hormones, as these hormones require the involvement of nutrients, including zinc. Zinc plays a role in regulating the function and mechanism of these hormones by highlighting its regulatory effects. Thyroid hormones are essential for maintaining body balance by facilitating the metabolism of fats and glucose (Gereben *et al*., 2008; Larsen *et al*., 2013).
Our research confirms the findings of Marques et al. (2006) and Baltaci et al. (2013), which demonstrated that zinc is crucial during thyroid hormone metabolism. Thyrotropin-releasing hormone (TRH), which can be made by the hypothalamus, is manufactured by deiodinase enzymes, and its activity operates by zinc.

The thyroid gland releases far more T3 and T4 hormones when TRH promotes the release of thyroid-stimulating hormone (TSH). Thyroid gland disorders can affect all body tissues because many tissues contain receptors for thyroid hormones, which are essential for maintaining healthy cell function. The proper functioning of target tissues requires adequate levels of these hormones (Fernández-Real *et al*., 2013; Reinehr, 2010).

These results are also consistent with previous studies that highlight the role of zinc, which plays a crucial role in binding TRH (Thyrotropin-releasing hormone). Zinc is essential for the synthesis of thyrotropin in the pituitary gland, acting as either an inhibitor or a cofactor for TSH (Thyroid-stimulating hormone). Therefore, by affecting the processes that control thyroid hormone metabolism, zinc aids in the production of thyroid-stimulating hormones. (Baltaci *et al*., 2013; Marques *et al*., 2006).

CONCLOSION

In conclusion zinc addition Japanese quail female rations led to improvement in growth hormone. This is evident through zinc's role as a growth stimulant, regulator, and cofactor by metabolizing nutrients such as carbohydrates and proteins, which enhances growth and reproduction and improves the characteristics of growth hormone., It also improvem thyroid hormones (T3, T4, and TSH). It was shown because zinc is essential for thyroid hormone metabolism in reaction to the hormonal and metabolic changes that occur in the body as a result of zinc treatment.

REFRANCES

Babaei, H., Derakhshanfar, A., Kheradmand, A., & BAZI, J. (2007). Zinc modulates heat-induced degenerative effects in mice testes. IJVR 8, 298–303.

Chand, N., Naz, S., Khan, A., Khan, S., & Khan, R. U. (2014). Performance traits and immune response of broiler chicks treated with zinc and ascorbic acid supplementation during cyclic heat stress. International Journal of Biometeorology, 58(10), 2153-2157.

Jarosz, Ł., Marek, A., Grądzki, Z., Kwiecień, M., & Kalinowski, M. (2017). The effect of feed supplementation with zinc chelate and zinc sulphate on selected humoral and cell-mediated immune parameters and cytokine concentration in broiler chickens. Research in veterinary science, 112, 59-65.

McCall, K. A., Huang, C. C., & Fierke, C. A. (2000). Function and mechanism of Zinc metalloenzymes. J. Nutr, *130*, 1437-1446.

Prasad AS, Kucuk O. (2002) Zinc in cancer prevention. Nutr Cancer21:291-295 Balch J (2007) Vitamins for a low sperm Accessed 3 Oct 2017. count.

Sahraei, M., & Janmohammadi, H. (2014). Relative bioavailability of different zinc sources based on tissue zinc concentration in broiler chickens. Iranian Journal of Applied Animal Science, 4(4), 817-825.

SAS. 2001. SAS/TAT user's Guide Version 6.4th ed. SAS Institute Inc. Gary, NC.

Tupe, R. S., Tupe, S. G., Tarwadi, K. V., & Agte, V. V. (2010). Effect of different dietary zinc levels on hepatic antioxidant and micronutrients indices under oxidative stress conditions. Metabolism, 59(11), 1603-1611.

Xu, X., Chen, X., Hu, H., Dailey, A. B., & Taylor, B. D. (2015). Current opinion on the role of testosterone in the development of prostate cancer: a dynamic model. BMC cancer, 15(1), 1-8.

Zhandi, M., Sharideh, H., Zaghari, M., & Akhlaghi, A. (2016). Dietary zinc oxide and 6-phytase effects on fertility rate in old broiler breeder hens. *Journal of Agricultural Science and Technology*, *18*(2), 327-336.

Acquaah, G. (2009). *Principles of plant genetics and breeding*. John Wiley & Sons.

Buonomo, F. C., & Baile, C. A. (1991). Influence of nutritional deprivation on insulin-like growth factor I, somatotropin, and metabolic hormones in swine. *Journal of Animal Science*, *69*(2), 755-760.

Gunga, H. C., Kirsch, K. A. R. L., Rocker, L. O. T. H. A. R., & Schobersberger, W. O. L. F. G. A. N. G. (1994). Time course of erythropoietin, triiodothyronine, thyroxine, and thyroid-stimulating hormone at 2,315 m. *Journal of Applied Physiology*, *76*(3), 1068-1072.

Iqbal, A., Decuypere, E., Abd El Azim, A., & Kühn, E. R. (1990). Pre-and post-hatch high temperature exposure affects the thyroid hormones and corticosterone response to acute heat stress in growing chicken (Gallus domesticus). *Journal of Thermal Biology*, *15*(2), 149-153.

Kaiya, H., Darras, V. M., & Kangawa, K. (2007). Ghrelin in birds: its structure, distribution and function. The Journal of Poultry Science, 44(1), 1-18.

Egom, M. A., Ndofor-Foleng, H. M., Iloghalu, O. G., Ikeh, N. E., Onodugo, M. O., Okenyi, N., & Agu, C. I. (2019). Original Research Article Bioinformatic Analysis of Insulin-Like Growth Factor-1 Gene of Three Avian Species. Journal of Agriculture and Food Environment, 6(1), 10-18.

Morley, J. E., J. Gordone and J. M Hershman. (1980). zinc deficiency chronic starvation and hypo ethylic-pituitary- thyroid function. A. J. Clin. Nutr. 33: 1767-1770

Phillips, L. S., Harp, J. B., Goldstein, S., Klein, J., & Pao, C. I. (1990). Regulation and action of insulin-like growth factors at the cellular level. *Proceedings of the Nutrition Society*, *49*(3), 451-458.

Scanes, C. G. (2020). Avian physiology: are birds simply feathered mammals. *Frontiers in Physiology*, *11*, 542466.

Fredrickson, D. S., Levy, R. I., & Lees, R. S. (1967). Fat transport in lipoproteins—an integrated approach to mechanisms and disorders. *New England Journal of Medicine*, *276*(3), 148-156.

Feng J, Ma WQ, Niu HH, Wu XM, Wang Y, Feng J (2010) Effects of zinc glycine chelate on growthhaematological, and immunological characteristics in broilers. Biol Trace Elem_ Res 133:203.211.

Stefanidou, M., Maravelias, C., Dona, A., & Spiliopoulou, C. (2006). Zinc: a multipurpose trace element. Archives of toxicology, 80, 1-9.

Chand, N., Naz, S., Khan, A., Khan, S., & Khan, R. U. (2014). Performance traits and immune response of broiler chicks treated with zinc and ascorbic acid supplementation during cyclic heat stress. *International Journal of Biometeorology*, *58*, 2153-2157.

Baltaci, A. K., Mogulkoc, R., & Belviranli, M. (2013). Serum levels of calcium, selenium, magnesium, phosphorus, chromium, copper and iron--their relation to zinc in rats with induced hypothyroidism. *Acta Clin Croat*, *52*(2), 151-156.

Marques, R. C., & Marreiro, D. N. (2006). Metabolic and functional aspects of zinc in Down syndrome. Rev Nutr, *19*, 501-10.

Fernández-Real, J. M., Corella, D., Goumidi, L., Mercader, J. M., Valdés, S., Rojo Martínez, G., ... & Estruch, R. (2013). Thyroid hormone receptor alpha gene variants increase the risk of developing obesity and show gene–diet interactions. *International journal of obesity*, *37*(11), 1499-1505.

Reinehr, T. (2010). Obesity and thyroid function. Molecular and cellular endocrinology, 316(2), 165-171.

Carmona, Y. V., Coria, M. J., Oliveros, L. B., & Gimenez, M. S. (2014). Hypothyroidism and oxidative stress: differential effect on the heart of virgin and pregnant rats. *Hormone and Metabolic Research*, *46*(01), 14-20.

Duntas, L. H., & Biondi, B. (2013). The interconnections between obesity, thyroid function, and autoimmunity: the multifold role of leptin. *Thyroid*, *23*(6), 646-653.

Gereben, B., Zavacki, A. M., Ribich, S., Kim, B. W., Huang, S. A., Simonides, W. S., ... & Bianco, A. C. (2008). Cellular and molecular basis of deiodinase-regulated thyroid hormone signaling. *Endocrine reviews*, *29*(7), 898-938.

Larsen, P. R., & Zavacki, A. M. (2013). Role of the iodothyronine deiodinases in the physiology and pathophysiology of thyroid hormone action. *European thyroid journal*, *1*(4), 232-242.