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PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF LOCAL DOMYATI DUCKS FED DIET ENRICHED WITH ORGANIC ZINC DURING SUMMER SEASON

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ABSTRACT: Heat stress (HS) induced a big economic loss in ducks industry owing to reduce bird's productivity. Nutritional strategy could use to attenuate the negative impacts of HS in poultry, this study purposed to decrease these impacts by organic zinc (oZn) enrichment for ducks diet at summer season on eggs production and quality, physiological and hatching parameters, subsequent growth of hatched ducklings and economic evaluation. Totally, 360 birds of Domyati ducks (300 female and 60 male), aged 25-wks were arranged at four empirical groups (each at five repeats) in a completely randomized design. The first one was considered as control and consumed the basal diet, while the 2nd up to the 4th empirical groups were consumed the basal diet enriched with 40 , 80 and 120 mg oZn /kg respectively, through 25-37 weeks of age under summer season. The results indicated that, ducks fed diet enriched with oZn recorded a significant ($P < 0.001$) increase in egg number (EN), egg weight and mass and improve feed conversion than those fed the control diet through the entire period (25-37 wks-old). Egg quality not significantly affected due to treatments except for Haugh units score. Hatchability (%) of fertile eggs was ($P < 0.01$) improved by oZn enrichment with 80 and 120 mg /kg diet, while total embryonic mortality was decreased in comparison with the control. Both blood hemoglobin content and lymphocytes (L, %) were elevated ($P < 0.001$) by oZn enrichment compared to control group, while heterophils (H, %) and H/L ratio were ($P < 0.001$) decreased. Serum cholesterol and liver enzymes were lowered ($P < 0.001$) by oZn enrichment, while HDL was ($P < 0.001$) elevated. Ducks fed 120 mg oZn/kg diet had a significant improvement in economic evaluation parameters than other groups. Results indicated the possibility of enriching ducks diet with 80 up to 120 mg oZn /kg could be an advantage method to attenuate the negative impacts of heat stress and improve eggs productivity, physiological performance, hatching characteristics and economic evaluation of ducks during Egyptian summer season.

Key words: ducks, egg production, hatching traits, organic zinc.

INTRODUCTION

Perception and controlling environmental conditions is crucial to successful poultry production. Heat stress (HS) causes substantial economic losses for ducks producers, because it induce the most important ecological stressors challenging poultry production worldwide. Prejudicial effects of HS on poultry range from reduced growth and egg production to decreased egg quality and safety. Furthermore, the negative impact of HS on poultry has recently attracted increasing public consciousness and concern. To protect the birds against heat stress, the producers outfit or implement appropriate nutritional strategies or searching for additional cost-effective, prospective solutions, especially under current rearing and feeding conditions turbulent supply and price that heavily impact production cost.

Due to the expansion of duck production the conventional breeding system using grazing could perform to the low nutrient efficiency, high happening of sickness and sharp water contaminating with duck production wastes (Xin et al., 2011). The total slaughter ducks number was estimated by Food and Agriculture Organization of the United Nations throughout 2019, it has reached about 6.42 billion birds in the world, nevertheless, amelioration or modernize of feeding mechanism and nutrition as well as administration system are underdeveloped beyond the increase requests of ducks production (Baeza, 2016). The mineral information of ducks nutrition requirements has been more shortage compared with macronutrients (energy, protein and amino acid). Furthermore, applied mineral requirement for ducks (INRA, 1989 & NRC, 1994) were centered on meat ducks types (Muscovy and Pekin) only. Where, this applied data not suitable for laying ducks because the big variation in growth curve, digestive physiology and nutrient digestibility (Wasilewski et al., 2015).

Mineral nutrition plays decisive role for growth and bone mineralization in addition to venereal performance for different ducks types, moreover, it's fundamental to reinforce various enzymatic systems to boost antioxidant and immune capacity (Wang et al., 2020). Zinc is known as one of the essential and pivotal microelements to perform the necessary functions in the animal body (Yu et al., 2020). Many natural feed ingredients are Zn-deficient, so it necessary to added to poultry and other livestock diets, because it required for all living cells and has plays an important role in the immune system (Zaghari et al., 2015). Deficient-Zn in the diet could inhibit egg production, decrease fertility, hatchability, embryo development, and growth, and immune organs, as well as increasing the oxidative damage and the mortality rate in poultry (Zhu et al., 2017). Inorganic zinc is widely used in animal production owing to its low cost, however, organic zinc potentially has more effective than Inorganic either in promoting intestinal health and tissue morphology as well as promote laying performance, improve egg quality, elevate hatchability, and enhance the capabilities to resist diseases and stresses in poultry (Bortoluzzi et al., 2019). An important function of Zn is participation into antioxidant defense system because its decreases oxidative damage of cell membranes caused by free radicals (Prasad et al., 2009). The objective of work trail was to explore the impacts of organic zinc (oZn) enrichment to layer

ducks, egg production, hatching traits, organic zinc.

ducks diet on their productivity, hatching traits and antioxidant capacity at summer circumstances.

MATERIALS AND METHODS

This investigation was done at El – Serw Water Fowl Station, Animal Production Research Institute (APRI), Agric. Res. Center, Ministry of Agric., Egypt. The trial was begun in June 2021. Totally, 360 birds of Domyati ducks (300 female and 60 male), aged 25-wks were arranged at four empirical groups in a completely randomized design, each comprised 90 birds (75 female and 15 male) that then split to five repeats. Ducks were housed as 2.3 ducks /m^2 in a natural house with windows, lighting system contained16 h light and 8 h dark daily. Basal layer diet was enriched with 0.00, 0.235, 0.471 and 0.706 g Availa® Znic (170) per each one kg diet to obtain the four graded levels of organic zinc addition (0, 40, 80 and 120 mg / kg basal diet) and using for ducks feeding in the four groups during the empirical period. Availa-Zn-170 is a complex of amino acid and zinc (17% Zn) that is manufactured by Zinpro Animal Nutrition Corporation, USA. Used layer diet components and contents are present in Table 1.

Collected data and estimated parameters:

1.Daily eggs number and weights as well as weekly feed consumed were recorded for each repeat of all groups, then calculated and denoted per duck / 4 wks meantime the empirical periods 25-29, 29-33, 33-37 and the overall period (25-37 wks -old). Egg mass (EM) and feed conversion (kg feed consumed: kg EM produced) were calculated.

2. Forty eggs (10 eggs / treatment) were taken at one day from the 30^{th} week of age to determine egg quality characteristics.

3. Hatching characteristics were estimated by gathering eggs for 7 days for hatching across three hatches (totaling 1000 egg for each hatch) at the 28^{th} , 32^{th} and 36^{th} wks old through empirical period, eggs of each group arranged into 5 replicates for each hatch .

4.At 32 wks old, fresh blood samples were gathered in tubes containing EDTA from five birds per each group to determine hematological parameters, in terms of hemoglobin (Hb) concentration, RBC and WBC counts, while heterophils (H) and lymphocytes (L) were counted and expressed as percentage of total WBC, and the H: L ratios were calculated**.**

5. At week 35, fresh blood samples were gathered from five birds per group without EDTA and kept at normal room heat for one hour to coagulate, then centrifuged at 3000 rpm for 15 minutes to detach clear serum, after this, separated serum was used for determination of total protein, total cholesterol, triglycerides, HDL and LDL cholesterol and transaminase enzymes activities AST and ALT. Also, the activities of superoxide dismutase (SOD)**,** glutathione (GSH), catalase (CAT), total antioxidant capacity (TAOC) concentration and malondialdehyde (MDA) concentration were determined by using commercial kits.

6. Economic evaluation: obtained data were estimated according to the prices of organic zinc (120 LE/ one kg) , one egg produced (2.25 LE), feed consumed (7.032 LE/kg layer diet) predominant at investigation time (year 2021).

7.Statistical analysis: Data were analyzed by the analysis of variance according to SPSS (2008) and significant differences among means were detected by the Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Laying performance:-

Enriching ducks diet with organic zinc (oZn) resulted in a significant improvement in egg production parameters (Table 2). Egg number (EN), weight (EW) and mass (EM) were increased ($P < 0.001$) with feeding on diet enriched with varied oZn levels than those fed the control diet throughout all empirical intervals. Generally, EN per duck was elevated ($P < 0.001$) by 8.92, 11.54 and 17.63% for ducks fed 40, 80 and 120 mg oZn / kg diet, respectively than those fed un-supplemented diet (control) through the whole empirical period (25-37 wks). Moreover, ducks fed 120 mg oZn /kg diet recorded ($P < 0.001$) higher EN than other oZn groups. Also, egg weight ($P < 0.001$) improved due to adding various oZn levels to ducks diet as compared to the control during all periods, but, ducks fed 80 and 120 mg oZn / kg diet produced the heavier egg weight during 25-37 wks-old. Egg mass (EM) took the same trend with EN production, it was ($P < 0.001$) augmented for ducks fed differ oZn diets during all investigation periods (Table 2). Egg mass improved ($P < 0.001$) by 10.61 , 13.85 and 19.85 %, respectively for ducks fed diet enriched with 40 , 80 and 120 mg oZn / kg compared to those fed unenriched diet through the entire empirical period (25-37 weeks-old).

The above findings could indicate that enrichment ducks diet with organic zinc (oZn) could help to improve the productive performance of ducks, because the current investigation carried out through summer season, so, oZn could act some roles in reducing oxidative stress (Sahin et al., 2009). Or, oZn could ameliorate the epithelium quality via which elevating the protein synthesis and sedimentation at eggs albumen that reflect on EN, EW and EM improvement (Nys et al., 2004). Another explanation of improved egg production could related with the more Zn bioavailability in OZn form, which is needed for elevated progesterone synthesis that decrease the secretion of prolactin hormone and their effect on brooding and stopping egg productivity (Park et al., 2004), or the interaction among Zn with venereal hormones secretion which elevated LH and FSH hormones concentricity in blood that increases egg formation (Amen and Al-Daraji , 2011).

Our findings are consistent with Gheisari et al. (2011); Yang et al. (2012) who observed egg production improvement of laying hens with using dietary organic Zn addition. Also, some recent trails demonstrated a positive effects of dietary Zn addition (30 : 160 mg /kg diet) on laying productivity of laying hens (Abd El-Hack et al., 2018), ducks (Chen et al., 2017), and Japanese quails (Aghaei et al., 2017) . Abd El-Hack et al. (2018) confirmed that the 100 mg Zn-Met enrichment diet resulted more egg production compared to 50 mg Zn-Met /kg of laying hens. Also, Korenekova et al. (2007) found that daily Zn addition (4 mg/bird) increases the egg mass for quails, while Torki et al. (2015) demonstrated that adding 40 mg Zn/kg to the layer diet increased egg number and weight and improved feed efficiency of laying hens. Moreover, Abedini et al., (2018) explained that dietary organic Zn sources addition of laying hens leads to improve egg production in comparison with inorganic sources. Huang et al.

(2020) reported that egg weight, laying rate, egg mass were increased by increasing dietary Zn addition ($P < 0.04$) of duck breeders. But some studies confirmed that dietary Zn addition had no positive effects on egg productivity for laying or broiler hens (Tabatabaie et al., 2007, Liao et al., 2018). Zhang et al. (2017) confirmed that different dietary Zn level or source not influence on egg production through 63 - 68 wks of age for laying hens.

Feed consumption (FC) not significantly affected through the 1st and 2nd empirical periods while it affected at the 3rd and the whole period due to oZn treatment (Table 2). The consumed FC amount tend to decrease by increased the level of OZn addition in comparison to the control. Feed consumed ($P < 0.050$) decreased by 1.41 and 2.39 % for birds fed diet enriched by 80 and 120 mg oZn / kg than the control at the overall period (25-37 wks), respectively. Feed conversion ratio (FCR) was ($P < 0.001$) affected among treatment (Table 2). It was improved by adding different oZn levels throughout the varied studied periods. Ducks fed diet enriched with 120 mg oZn / kg recorded the best FCR value than the control and other oZn groups at 25-37 wks-old. The FCR improvement is not due to a decrease in FC amount only, but could related to the increase in eggs number then egg mass produced when oZn added compared to the control group. Moreover, oZn addition could resulted in more efficient in nutrient absorption owing to its positive effect on villus extent and crypt profundity and their ratio between them as well as revamp the lining epithelium cells of enteric lumen (Zhang et al., 2015). Improving villus extent is correlated with the elevation of nutrients digestion and absorption as well as an augmented of brush boundary enzymes and alimentary transport systems (Awad et al., 2017). Or, organic Zn forms could provide safeguard against of the creation non-digestible congregations with the intestinal anti-nutritive components and considered more effectively absorbed than inorganic Zn sources (Swiatkiewicz eta al., 2014). Our results are similar with Sahin and Kucuk (2003) who noticed an improvement in feed efficiency by ZnSo4 addition to quail grow under heat stress. Huang et al., (2020) found that feed efficiency ratio (egg to feed) was improved ($P < 0.04$) by dietary Zn of duck breeders. However, Tabatabaie et al. (2007) stated that feed efficiency (feed: egg) of laying hens not affected by both Zn sources and levels. Also, Zhang et al. (2017) established that consumed feed and feed efficiency were not changed by supplemental Zn level or source during 63 - 68 weeks of age for laying hens.

Egg quality traits:-

Non-significant differences were noticed amongst treatments in studied egg quality characteristic except for Haugh units (Table 3). Haugh unit was ($P < 0.040$) better by using diet enriched with various oZn levels compared to the control diet. Although, relative egg shell and albumin weights for eggs produced from oZn groups were numerically similar with the control group, but tend to increase. Generally, Zn plays an important role of numerous enzymes, and it is required for the carbonic anhydrase enzyme, which is crucial for supplying the carbonate ions during eggshell formation, lowering it levels may resulted in a deficient of bicarbonate ion secretion, then consequently, extremely minimized eggshell weight (Nys et al., 2004). The shortage effect of dietary Zn in the current study is consistent with Tabatabaie et al. (2007) who confirmed that shell thickness and weight were not (P> 0·11) affected by varied Zn sources or levels of laying hens. Chen et al. (2017) illustrated that dietary Zn addition didn't effect on egg shape index, the relative weights of yolk, albumen and egg shell as well as shell thickness of laying ducks. Liao et al. (2018) discussed the interaction among environmental temperature and dietary Zn addition which didn't effect (P> 0.05) on eggshell thickness and weight of broiler breeders at 42-wks-old. Also, Huang et al. (2020) reported that shell weight and shell strength of duck breeders were not changed by dietary Zn addition. However, Gheisari et al. (2011) found that dietary Zn methionine addition improved eggshell weight, whereas organic forms of Zn increased eggshell thickness for lying hens. On the other hand, Huang et al. (2020) recorded an improvement (P < 0.05) in haugh unit and shell thickness with dietary Zn addition of duck breeders.

Hatching characteristics:-

Fertility (%) was improved (P>0.05) of produced eggs by feeding oZn diets compared to the control (Table 4). Hatchability (%) of fertile eggs was (P < 0.01) enhanced by adding both 80 and 120 mg oZn /kg diet by about 7.31 and 7.03%, respectively as compared to the control, while using 40 mg oZn /kg diet recorded insignificant improvement (3.05 %) (Table 4). On the other hand, early and late embryonic mortality (%) were significantly lower by adding 80 and 120 mg oZn /kg diet when compared to control, moreover, total embryonic mortality (%) was took the same trend, it was attenuated by 23.35 and 22.43% for eggs produced from ducks fed 80 and 120 mg oZn /kg diet than those fed un-supplemented diet (Table 4). Hatched duckling weight (g) was superior for oZn groups compared to the control. These findings could indicat that Zinc is commonly supplemental source to the diets to improve hatchability and embryonic development of layer and breeding birds (Park et al., 2004). Or, nearly 86% of the Zn primarily precipitated in the impregnate egg is transmitted to the embryo (Richards, 1997), so, Zn deficit in breeders diet firstly lowering it in eggs contents , then prevent the embryonic growth and evolution owing to impair skeletal development. Current results are in agreement with Zhu et al. (2017) who found that organic Zn supplementation to maternal broilers diet produced a superior hatchability percentage than the inorganic Zn addition. Sun et al. (2018) concluded that in-ovo injection with Zn into egg yolk of Zn-deprived broiler breeders attenuated embryonic mortality and elevated hatchability (%) as well as improved healthy chicks. Khoobbakht et al. (2018) reported that ZnMet addition enhanced fertility and hatchability (%) and hatched chick's weight of Japanese quail. However, Kidd et al. (1992) stated that adding 80 mg/kg from Zn-Met or ZnO to layer diet (72 mg Zn/kg) didn't effect on reproductive productivity of broiler breeders.

The subsequent live body weight and weight gain was hiked (P < 0.001) for ducklings hatched from eggs produced from breeder ducks fed diet enriched with 40 mg oZn /kg, only than the control and other oZn groups through the period from hatch up to 21 d-old, while feed consumption and conversion were not affected among treatment (Table 4). This results explained that the use of OZn addition to laying ducks could be enriched

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the eggs yolk with Zn (Zhu et al. , 2017), that effect on subsequently hatching weight and duckling's body weight at 21-d-old, although total amount of feed consumption not changed compared with the control. These findings are agreed with Saenmahayak et al. (2010) who stated that using organic Zn instead of inorganic form capable to ameliorate weight gain and feed efficiency. Jahanian and Rasouli (2015) confirmed that dietary addition of Zn-Meth enhanced broilers productivity.

Hematology and serum constituents:-

All studied hematological parameters were significantly affected among treatments except of red and white blood cells count (Table 5). Blood hemoglobin content and lymphocytes cells (L, %) were elevated ($P < 0.001$) for ducks fed different oZn /kg diets compared to control group, while heterophils cells (H, %) and H/L ratio were ($P < 0.001$) attenuated. The group fed diet enriched with 40 mg oZn /kg recorded the higher value of L % and the lower H and H/L ratio than the control and other groups. In general, the H/L ratio is an indicator of stress in birds (Ebrahimzadeh et al., 2012). The doses and different forms of zinc reduced the H/L ratio, moreover, organic and inorganic Zn had a similar impact on the H/L ratio, because Zn is necessity to create lymphocytes naturally during evolution; consequently, Zn scarcity could result to peripheral T cells numbers depression, then diminution T supporter cell function and diminished thymocytes in thymus (Kidd et al., 1992). Also, increased lymphocyte percent and decreased the H/L could attributed to the decrease of glucocorticoid secretion (Ebrahimzadeh et al., 2012). So, dietary Zn addition could increase thymulin efficacy, which produce to the more appropriate maturation and leverage of T lymphocytes. Our findings are similar with Hidayat et al (2020) who stated that the heterophil and the ratio between heterophil/lymphocyte (H/L) decreased ($p<0.05$) with Zn level addition increased to broilers diet. In contrary, Mayer et al. (2019) reported that dietary Zn supplementation didn't impact on blood hematocrit and hemoglobin ($P > 0.05$).

Studied serum constituents were ($P < 0.001$) affected among treatments except for total protein, albumin and triglycerides (Table 5). Although, triglycerides not significantly affected due to oZn addition but it decreased in ducks blood which fed varied oZn levels. Serum cholesterol and LDLc were lowered ($P < 0.001$) for ducks fed various oZn /kg diets compared to control group, while HDL-cholesterol was ($P < 0.001$) elevated. Also, liver enzymes (AST & ALT) were significantly decreased by oZn treatments as compared with the control. Current results could attributed to the altitude bioavailability of organic zinc, which produce to higher fat metabolism in the liver, likewise controlling the leverage and gene expressions of lipogenic enzymes (Liu et al., 2015). The obtained results are agreed with Abd El-Hack et al. 2018) who reported that serum triglyceride and LDLc were attenuated by dietary Zn-Met addition of laying hens. However, Lu and Combs (1988) found that adding Zn to chickens diet didn't effect on serum cholesterol. Furthermore, Amen and Al-Daraji (2011) ; Abd El-Hack et al. 2018) stated that Zn addition to broiler breeder diets with 50 up to 100 mg/kg produced to an increase ($P<0.05$) of plasma total cholesterol.

Antioxidants status

Adding organic zinc (oZn) to breeder ducks diet had no significant effects on blood antioxidants and oxidative status except of total antioxidants capacity (Table 6). Total antioxidants capacity was significantly boosted by enrich ducks diet with oZn during the laying period. Although, glutathione (GSH), superoxide dismutase (SOD) and catalase (CAT) were not (P > 0.05) affected, but they tend to numerically increase owing to oZn addition as compared to control group. However, oxidative stress like malondialdehyde (MDA) tend to decrease (P > 0.05) due to oZn addition. Generally, heat stress could lead to produce ROS that induce oxidative harm in poultry (Lin et al., 2008). Synthesized antioxidant enzymes, like SOD and glutathione peroxidase and CAT, that plays a major roles of anti-stress of heat stress for animals because they are the first line of antioxidants defense, moreover , these anti-stress will be effective only if co-factors such Se , Zn, Cu and Mn are available (Sahin et al., 2009). So, increased MDA concentricity is a paramount indicator of lipid peroxidation and absent antioxidant enzymes, that reducing MDA content and helpful to improve antioxidant capacity in the body (Nielsen et al., 1997). Moreover, Zn shortage result to a decrease of SOD activity, producing an increase of tissue sensitivity to oxidation owing the impairment of the antioxidant system, one of the suggested mechanisms of action for Zn, it is capacity to supplant transition metals (Fe and Cu) from binding sites. Zn can engage with iron and copper to bind to the cell membrane and prevent the production of free radicals, thus employ as a direct antioxidant action (Prasad, 2014).

The above findings shows that oZn could increase SOD, CAT and GSH activities, as well as reducing the MDA content, it plays a major role in free radicals suppression and oxidative damage reduction as well as heat stress resistance improvement, because Zn is a cofactor of the main antioxidant enzymes like SOD, that is necessity component of it which plays a fundamental role in the detoxification of superoxide free radicals and protection the cells against oxidative stress (Yuan et al., 2011) and inhibits lipid peroxidation (Prasad and Kucuk, 2002). Some studies were noted that the antioxidant capability in both blood and liver enhanced owing to dietary Zn addition for hens (Liao et al., 2018) and ducks (Chen et al., 2017). The current results are similar with Bun et al. (2011) who found that SOD increased in broilers plasma and liver by increasing organic Zn levels addition. Sun et al., (2012) confirmed that dietary organic minerals (Cu, Mn, Zn) addition for laying hens increased SOD activity compared to inorganic sources. Chen et al. (2017) explained that plasma reduced glutathione (GSH) concentrations not effected by Zn addition of laying ducks. Abedini et al. (2018) established that SOD activity tend to increase by dietary 80 mg Zn-Met/kg addition of laying hens, while Zhang et al. (2020) found that Zn addition didn’t effect on plasma TAOC content but did influence SOD and GSH activities and MDA; where SOD and GSH activities were increased by increasing dietary Zn levels addition but MDA decreased. Also, Chang et al. (2022) found that SOD, CAT and GSH were increased, while MDA was attenuated by dietary Zn-Met addition. Otherwise, Liao et al. (2018) illustrated that dietary Zn addition had not significantly affected on SOD and MDA regularizing of broiler breeders bodies. Abd El-Hack et al. (2018) established that dietary Zn-Met addition not affected on

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antioxidant indices in blood serum of laying hens.

Economic evaluation:

Data of Table 7 shows that ducks fed diet enriched with 120 mg oZn/kg led to a significant increases in totals eggs selling, net revenue and economic efficiency comparing with ducks in control and other ZN treatments throughout the studied period (25-37 wks-old). These increases could related to the decrease in the amount feed consumed which decreased feed consumed cost, as well as the increase of egg number produced per duck which improved total eggs selling that recorded a positive on net revenue. Current findings are agreed with Ibrahim et al. (2021) who found that feeding organic Zn diet increased the net revenue per hen over than the Nano zinc and un-supplemented group

CONCLUSION

The obtained data indicated, the possibility of enriching ducks diet with organic zinc by 80 or 120 mg per kg during summer conditions could be an advantage method to attenuate the negative impacts of heat stress of Domyati ducks and improve the laying productivity, physiological performance and hatching characteristics for produced eggs as well as economic efficiency.

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

Ingredients , %	**Used diets**	
	Starter	**Layer**
Yellow corn	61.10	65.90
Soy bean meal (44 %)	32.55	22.30
Corn gluten (60 %)	0.00	2.50
Wheat bran	2.55	0.00
Di-cal. Phos.	1.60	1.85
Limest.	1.45	6.65
Vit & Min. premix [1]	0.30	0.30
NaCl	0.35	0.40
DL- Meth (99%)	0.10	0.10
Total	100.0	100
Calculated Analysis [2]		
Crud protein %	20.01	17.01
Metabolizable energy (Kcal / kg)	2807	2801
Crud fiber %	3.90	3.06
Calcium. %	1.01	3.01
Available Phosphorus %	0.44	0.46
Lysine (%)	1.05	0.80
Methionine (%)	0.42	0.39
Meth. + Cyst. (%)	0.76	0.69
Sodium . %	0.16	0.18
Zinc, mg/kg	78.15	73.45
Price , (LE/kg) [3]	7.400	7.032

1- Each 3kg contains 100 mill IUVit A;2 mill IU Vit.D3;10 g Vit.E; 1 g Vit.K_3 ; 1 g Vit B1; 5 g Vit B2 ;10 mg Vit.B12 ; 1.5 g Vit B6; 30 g Niac ;10 g Panto.c acid ;1g Fol. acid;50 mg Biot; 300 g Chol chlor; 50 g Zn; 4 g Co; 0.3 g I ; 30 g Ir; 0.1 g Se; 60g Man ;0.1 g Cob; and carrier $CaCO_3$ to 3000 g .

2- According to Feed Comp Tables for anim. and poult. Feed-stuffs used in Egypt (2001).

3- one kg (LE) of yellow corn ,5.7 ; Soy bean meal, 9.80 ; Corn gluten, 12.60; wheat bran, 3.8 ; Di-calcium,28.0 ; limestone, 0.50 ; Vit&Min.,45.0 ; Nacl,1.0 and Meth.,85.0

Table (2): Effect of enriching ducks diet with organic zinc (oZn) during summer season on laying performance.

Age , wks	Organic zinc, mg/kg				MSE*	P-value
	0	40	80	120		
Egg number per duck / 4 wks						
25 – 29	15.23 c	16.26 b	16.04 b	18.31 a	0.274	0.001
29 - 33	16.98 b	17.02 b	18.49 a	18.89 a	0.250	0.001
33 - 37	10.96 b	13.74 a	13.62 a	13.58 a	0.291	0.008
25 - 37	43.17 c	47.02 b	48.15 b	50.78 a	0.678	0.001
Egg weight , g						
25 – 29	70.33 a	69.42 b	70.98 a	70.41 a	0.175	0.005
29 - 33	72.73 b	75.20 a	74.71 a	74.70 a	0.250	0.001
33 - 37	74.23 b	75.72 a	75.58 a	76.42 a	0.253	0.001
25 - 37	72.27 b	73.36 a	73.73 a	73.61 a	0.156	0.001
Egg mass (EM) per duck / 4 wks , g						
25 – 29	1071.24 c	1128.73 b	1138.35 b	1289.18 a	19.69	0.001
29 - 33	1234.38 b	1280.27 b	1382.65 a	1411.22 a	20.43	0.001
33 - 37	813.49 b	1041.12 a	1030.02 a	1037.86 a	24.19	0.001
25 - 37	3119.12 c	3450.12 b	3551.02 b	3738.27 a	55.30	0.001
Feed consumption (FC) per duck/ 4 wks, g						
25 – 29	3799.95	3774.50	3749.40	3726.00	11.618	0.121
29 - 33	4236.15	4205.15	4184.50	4136.40	19.822	0.363
33 - 37	4655.85 a	4596.55 ab	4579.60 ab	4527.15 b	16.361	0.032
25 - 37	12691.95 a	12576.20 ab	12513.5 bc	12389.55 c	34.144	0.050
Feed conver. ratio (g FC/ g EM)						
25 – 29	3.551 a	3.346 b	3.296 b	2.893 c	0.057	0.001
29 - 33	3.434 a	3.285 a	3.045 b	2.933 b	0.051	0.001
33 - 37	5.745 a	4.437 b	4.454 b	4.367 b	0.142	0.001
25 - 37	4.073 a	3.648 b	3.531 b	3.315 c	0.067	0.001

Means bearing different superscripts letter (s) in the same row are significantly different at $P \leq 0.05$.

*MSE: standard error mean

Table (3): Effect of enriching ducks diet with organic zinc (oZn) during summer season on egg quality parameters.

Parameters	**Organic zinc, mg/kg**				**MSE***	**P-value**
	0	**40**	**80**	**120**		
Shell egg wt,%	10.70	10.95	10.93	11.29	0.13	0.462
Egg Yolk wt, %	32.46	32.13	32.04	31.61	0.29	0.782
Egg albumin wt, %	56.84	56.92	57.03	57.10	0.28	0.989
Shape Index	74.77	75.02	74.15	74.80	0.40	0.895
Egg yolk index	0.42	0.43	0.43	0.42	0.003	0.286
Shell thickness, mm	0.32	0.32	0.32	0.32	0.003	0.607
Haugh unit	90.04 ^{b}	93.07 ^{a}	94.86 ^{a}	93.70 ^{a}	0.61	0.040

Means bearing different superscripts letter (s) in the same row are significantly different at P≤ 0.05.
*MSE: standard error mean

Table (4): Effect of enriching ducks diet with organic zinc (oZn) during summer season on hatching traits and subsequent growth performance of hatched ducklings up to 21 d-old .

Parameters*	**Organic zinc, mg/kg**				**MSE***	**P-value**
	0	**40**	**80**	**120**		
Fertility , %	86.06	87.93	88.62	88.39	0.70	0.595
Hatchability, %	76.15 ^{b}	78.47 ^{ab}	81.72 ^{a}	81.50 ^{a}	0.75	0.010
Early Embryonic mortality, %	9.28 ^{a}	8.51 ^{ab}	7.24 ^{b}	7.06 ^{b}	0.32	0.024
Late Embryonic mortality, %	14.57 ^{a}	13.02 ^{ab}	11.04 ^{b}	11.44 ^{b}	0.47	0.018
Total Embryonic mortality, %	23.85 ^{a}	21.53 ^{ab}	18.28 ^{b}	18.50 ^{b}	0.75	0.010
Duckling weight at hatch	40.77	41.15	41.71	40.78	0.22	0.421
Subsequent growth performance from hatch up to 21 d-old						
Final LBW, g at 21d-old	603.0 ^{b}	676.6 ^{a}	609.4 ^{b}	602.0 ^{b}	7.81	0.001
BWG , g (1-21 d)	562.2 ^{b}	635.5 ^{a}	567.7 ^{b}	561.2 ^{b}	7.84	0.001
FC , g (1-21 d/duckling)	1000.3	1028.7	997.8	999.8	14.19	0.869
FCR (g feed / g BWG)	1.779	1.621	1.760	1.782	0.030	0.178

Means bearing different superscripts letter (s) in the same row are significantly different at P≤ 0.05.
*MSE: standard error mean; LBW: live body weight; BWG: body weight gain; FC: feed consumption ; FCR : feed conversion ratio

ducks, egg production, hatching traits, organic zinc.

Table (5): Effect of enriching ducks diet with organic zinc (oZn) during summer season on blood hematological measurements and serum constituents of laying ducks at 35 weeks of age .

Parameters*	Organic zinc, mg/kg				MSE*	P-value
	0	40	80	120		
Hematological parameters						
Hemoglobin, g/l	11.19 ^{b}	12.85 ^{a}	13.32 ^{a}	12.35 ^{a}	0.263	0.001
RBC, x 10^6 /mm	2.67	2.98	3.11	2.87	0.088	0.377
WBC, x10^3 /mm	30.11	30.66	30.74	30.18	0.221	0.692
Lymphocytes (L), %	63.15 ^{b}	72.91 ^{a}	71.02 ^{a}	71.40 ^{a}	0.931	0.001
Heterophlis (H), %	26.70 ^{a}	18.66 ^{b}	19.20 ^{b}	18.82 ^{b}	0.876	0.001
H/L	0.423 ^{a}	0.257 ^{b}	0.270 ^{b}	0.264 ^{b}	0.017	0.001
Serum constituents						
Total protein, g/dl	5.41	5.82	5.40	5.48	0.20	0.876
Albumin , g/dl	1.48	1.692	1.53	1.56	0.053	0.574
Total cholest., mg/dl	169.10 ^{a}	140.70 ^{b}	110.55 ^{b}	118.40 ^{b}	7.216	0.006
Triglycerides, mg/dl	580.05	445.00	338.25	442.35	47.54	0.376
HDLc, mg/dl	49.95 ^{b}	71.65 ^{a}	70.25 ^{a}	82.70 ^{a}	3.46	0.001
LDLc, mg/dl	90.15 ^{a}	62.50 ^{b}	69.70 ^{b}	70.05 ^{b}	2.95	0.001
AST , IU	57.60 ^{a}	48.15 ^{b}	49.70 ^{b}	46.40 ^{b}	2.86	0.051
ALT , IU	36.90 ^{a}	33.65 ^{b}	32.30 ^{b}	31.50 ^{b}	0.971	0.051

Means bearing different superscripts letter (s) in the same row are significantly different at $P \leq 0.05$.

* MSE: standard error mean; RBC : red blood cells ; WBC : white blood cells ; HDL : high density lipoprotein ; LDL: low density lipoprotein ; AST : Aspartate transaminase ;ALT : Alanine transaminase

Table (6): Effect of enriching ducks diet with organic zinc (oZn) during summer season on blood serum antioxidants constituent of laying ducks at 35 weeks of age.

Parameters*	Organic zinc, mg/kg				MSE*	P-value
	0	40	80	120		
GSH, U/dl	10.31	14.44	13.64	13.25	0.608	0.072
SOD, U/dl	2.69	3.00	2.87	2.93	0.08	0.621
CAT, U/dl	32.51	36.14	40.13	40.50	1.420	0.147
TAOC , µmol/ml	0.145 ^{b}	0.175 ^{a}	0.181 ^{a}	0.192 ^{a}	0.005	0.005
MDA, µmol/ml	1.410	1.335	1.285	1.180	0.032	0.068

Means bearing different superscripts letter (s) in the same row are significantly different at $P \leq 0.05$.

*MSE: standard error mean; GSH: reduced glutathione; SOD: superoxide dismutase; CAT: catalase; TAOC: total antioxidants capacity; MDA: malondialdehyde

Table (7): Effect of enriching ducks diet with organic zinc (oZn) during summer season on economic evaluation of laying ducks through 26-37 weeks of age.

Parameters	Organic zinc, mg/kg				MSE*	P-value
	0	40	80	120		
Feed consumed cost, LE	89.25 [a]	88.44 [ab]	87.99 [bc]	87.12 [c]	0.25	0.005
OZn adding cost, LE	0.00 [d]	0.35 [c]	0.71 [b]	1.05 [a]	0.09	0.000
Total cost, LE	89.25	88.79	88.70	88.17	0.19	0.248
Total eggs selling, LE	97.13 [c]	105.80 [b]	108.35 [b]	114.26 [a]	1.53	0.001
Net revenue , LE	7.88 [c]	17.01 [b]	19.65 [b]	26.09 [a]	1.60	0.001
Economic efficiency	0.088 [c]	0.192 [b]	0.221 [b]	0.296 [a]	0.02	0.001

Means bearing different superscripts letter (s) in the same row are significantly different at P≤ 0.05.

*MSE: standard error mean

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الملخص العربى

الاداء الانتاجى والتناسلى للبط الدمياطى المحلى المغذى على العليقة المضاف لها الزنك العضوى خلال فصل الصيف

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هذا البحث يهدف الى دراسة تأثير إضافة الزنك العضوى الى عليقة البط البياض كوسيلة للحد من الأثار السلبية للاجهاد الحرارى خلال فصل الصيف على الأداء الانتاجى والفسيولوجى وصفات التفريخ والتقييم الاقتصادى لليط الدمياطى. تم اختيار عدد ٣٦٠ طائر بط دمياطى (٣٠٠ أنثى ٦٠ ذكر) عمر٢٥ أسبوع وتم تقسيمها عشوائيًا إلى أربعة مجموعات متساوية (فى خمسة مكررات) فى تصميم تام العشوائية. تم تكوين العليقة الأساسية (١٧.٠٢٪ بروتين خام و ٢٨٠١ كيلو كالوري طاقة ممثلة) وتمت تغذية المجموعة الأولى عليها كمجموعة للمقارنة (بدون إضافة) بينما المجموعات الثلاثة الأخرى غذيت على العليقة الأساسية المضاف لها الزنك العضوى بمعدل ٤٠ ، ٨٠ ، ١٢٠ ملجم / كجم عليقة على التوالي خلال الفترة من ٢٥ – ٣٧ أسبوع من العمر خلال فصل الصيف.

أظهرت النتائج زيادة عدد البيض ووزنه وكتلته معنويا وتحسنت كفاءة التحويل الغذائى معنويًا بينما انخفضت كمية العليقة المستهلكة للبط المغذى على العلائق المضاف لها الزنك العضوى مقارنةً بالبط المغذى على العليقة الأساسية بدون اضافة خلال الفترة الكلية للتجربة (٢٥-٣٧ أسبوعً). بينما لم تتأثر صفات جودة البيض بالمعاملات فيما عدا وحدات هوف التى تحسنت معنويا باضافة الزنك العضوى للعليقة كما تحسنت نسبة الفقس للبيض المخصب معنويا بإضافة الزنك العضوى للعليقة بمعدل ٨٠ و ١٢٠ ملجم/كجم عليقة بينما انخفضت نسبة النفوق الجنينى الكلى للبيض الناتج من البط المغذى عليها مقارنةً يالعليقة الضابطة (الكنترول). لوحظ ارتفاعا معنويا لقيم كل من هيموجلوبين الدم ونسبة الخلايا الليمفاوية بإضافة الزنك العضوى للعليقة مقارنة بالمجموعة الضابطة (المقارنة) بينما انخفضت نسبة الخلايا المتعادلة والنسبة بين الخلايا المتعادلة والليمفاوية. كما لوحظ انخفاضا معنويا فى محتوى الدم من الكوليسترول الكلى والمنخفض الكثافة وانزيمات الكبد (AST & ALT) بينما ارتفعت قيمة الكوليسترول عالى الكثافة مقارنةً بالكنترول.كما تحسنت الكفاءة الاقتصادية معنويا للبط المغذى على العلائق المضاف لها الزنك العضوى بمستوياته المختلفة مقارنة بالمجموعة الضابطة وكانت افضل المعاملات تلك التى تغذت على ١٢٠ ملجم زنك عضوى لكل كجم عليقة.

لذا يمكن التوصية بأنه يمكن إضافة الزنك العضوى الى عليقة البط البياض بمعدل ٨٠ او ١٢٠ ملجم /كجم عليقة خلال فصل الصيف كوسيلة للحد من الأثار السلبية للاجهاد الحرارى للبط وتحسين الصفات الانتاجية لانتاج البيض وصفات التفريخ للبيض الناتج وتحسين الصفات الفسيولوجية فضلا عن الكفاءة الاقتصادية للبط