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EFFECT OF SUPPLEMENTING ORGANIC TRACE MINERALS (ZINC, MANGANESE, IRON, COPPER AND SELENIUM) ON EMBRYONIC DEVELOPMENT AND CHICK QUALITY OF GIMMIZAH CHICKENS

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ABSTRACT: The current study was carried out to investigate the effect of dietary some organic trace minerals supplementation for improving the amount and uptake of yolk minerals, development of the chick embryo, hatchability % and chick quality of Gimmizh chickens. A total of 160 hens and 40 cocks aged 24 wks were distributed randomly among eight experimental groups (20 hens and 5 cocks/group).Birds were fed different experimental eight diets. Two control diets were formulated to meet nutrient requirements of chickens as recommended by NRC (1994). The first diet was considered as negative control and supplemented with 100% inorganic trace minerals (Inorg-TM) and the second one was considered as positive control and supplemented with 100% organic trace minerals (Org-TM).The third group was supplemented with 50% of organic trace minerals. The rest five diets were supplemented with 50% of the organic form of zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), or selenium (Se), respectively. The premix was formulated to contain the requirements of trace elements in inorganic form (sulphate), organic form (peptide chelate) or in combination. Eggs were daily collected from each group for 7 days at 32, 34 and 36 wks of hen's age. A total of 1680 hatched eggs representing the eight experimental dietary supplementations groups were incubated.

Results indicated that:

1- Supplementation the diets with either 100% or 50% Org-TM realized the highest records of all studied yolk organic trace elements concentration at day of setting,

Key Words: Organic trace minerals, chicks, embryo, yolk, hatchability.

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embryonic days (13 and E18), and at day of hatch compared with those for control Inorg-TM .

2- Supplementation the diet with both concentrations of Org-TM either 50% or 100% recorded the highest relative minerals consumption from the yolk during incubation compared to those for control Inorg-TM.
3- Supplementation the diet with 100% Org-TM and 50% organic trace minerals either complexed or separated as a single element significantly increased the body weight of baby chicks and relative heart weight compared to those for control Inorg-TM. Whereas, relative yolk sac for the baby chicks was significantly increased for control Inorg-TM compared with those for all experimental groups.
4- Significant increase of hatchability of fertile eggs % was observed for eggs of both groups 50% and 100% Org-TM compared with all experimental groups and control Inorg-TM.
5- Lengths of the chicks produced from hens fed 100% and 50% Org-TM,50% Org-Zn, 50% Org-Mn, and 50% Org-Cu were significantly longer than those for other groups.

It is concluded from the results of this experimented work that supplementation the chicken's diet with complexed 50% Org-TM is quite enough for realizing the expected goal of hatching success and good quality of chicks.

INTRODUCTION

The importance of trace minerals to the growth and development of embryos is supported by many publications stating that minerals deficiency can reduce hatchability, increase mortality, and causes skeletal, immune, and cardiovascular system disorders (Angel,2007 and Dibner et al., 2007). Zinc (Zn) plays a role in the development of the immune system of the chicken embryo (Kidd, 2003) and plays regulatory roles in bone development, such as its association with the changes in gene transcription that accompany endochondral ossification (Dibner et al., 2007). Manganese (Mn) is essential for formation of the bone cartilage model (Gilbert, 1997). Iron (Fe) has an essential role in cellular oxidative energy metabolism due to the component of the oxygen transport proteins myoglobin and hemoglobin and of specific redox enzymes (Chang et al., 1996). Copper (Cu) is involved in the synthesis of hemoglobin, erythrocuprein, and other plasma proteins, some of which participate in Fe transport (Leeson, 2009). Copper also plays a role in many enzyme systems, such as cytochrome oxidase, which is key for oxidative phosphorylation (Leeson, 2009). Also, it has an important role in bone strength (Dibner et al., 2007). Selenium (Se) is important for the antioxidant role, helping to prevent damages caused by free radicals (Papazyan et al., 2006).

It is well documented that the hens' diet mineral concentration and availability are correlated with minerals in the egg for embryo utilization (Dibner et al., 2007). In contrast to inorganic trace minerals, hens fed with organic trace mineral have shown to increase the amount of minerals in the egg components (Dobrzanski et al., 2008 and Hanafy et al., 2009). Organic trace minerals in broiler diets appear to have greater bioavailability compared with inorganic trace minerals (Abdallah et al., 2009). Recently, it was enounced that organic complexed minerals may be added at a much lower levels in the chicken diets than the current recommendations for inorganic minerals, without any negative effect on productive performance

(Swiatkiewicz et al., 2014). The purpose of current study was to examine the role of supplementing the trace organic minerals in the chicken diet either separated or complexed on the amount and uptake of yolk minerals, organs weights of embryos and baby chicks, besides hatchability% and chick quality.

MATERIALS AND METHODS

This study was carried out at El-Sabahia Poultry Research Station (Alexandria), Animal Production Research Institute (APRI), Agricultural Research Center, Egypt. A total of one hundred and sixty laying chickens and forty cocks of Gimmizah strain at 24 week of age were housed individually in single cages and distributed randomly to eight treatment groups (20 females and 5 males per each).

Birds were fed different experimental eight diets. Two control diets were formulated to meet nutrient requirements of chickens as recommended by NRC (1994). The first diet was considered as negative control and supplemented with 100% inorganic trace minerals (Inorg-TM) and the second one was considered as positive control and supplemented with 100% organic trace minerals (Org-TM). The third group was supplemented with 50% of organic trace minerals. The rest five diets were supplemented with 50% of the organic form of zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), or selenium (Se), respectively. The premix was formulated to contain the requirements of trace elements in inorganic form (sulphate), organic form (peptide chelate) or in combination. Table (1) demonstrates the experimental design and Table (2) represents the compositions of the basal diets. Feed and fresh water were offered ad-libitum through treatments. Artificial lighting was used to provide birds 17 hrs lighting daily.

At 30 wk of age, hens were inseminated twice a week with diluted semen (1:1) from cocks received the same treated diets. Eggs were daily collected from each group for 7 days at 32, 34 and 36 wks of hen's age. A total of 1680 hatching eggs representing the eight experimental dietary groups were incubated three times as replicates in Egyptian- made incubator at 37.8°C and 55%RH during incubation and transferred to hatcher operated at 37.2 °C and 65 % RH. Macroscopic fertility was determined as percentage of fertile eggs from total egg set. Hatching egg were numbered, and weighed (49.63±0.53g) before set in the incubator. Macroscopic fertility was determined as percentage of fertile eggs from total eggs set. Hatchability of fertile eggs% was calculated as relative to the number of fertile eggs.

Yolk Minerals Concentration:

Five eggs were taken randomly on day of setting (DOS), days of incubation (E13 and E18), and 5 chicks on day of hatch (DOH) were representing each group for yolk minerals analyses .The yolk content of each egg was separated from the yolk sac membrane and samples (100-150mg) from each yolk content were taken for detection of Zn, Mn, Fe, and Cu according to the method of Yair and Uni (2011) and Se according to the method of Browen and Watkinson (1977).

Minerals Relative Consumption:

The relative consumption of each mineral during incubation was calculated by dividing the amount of consumed mineral by its initial amount on DOS using the formula

$$C = \frac{A\ consumed * 100}{A\ DOS} \quad \{1\}$$

where C is the percentage of relative consumption during incubation.

$$A consumed = A\ DOS - A\ DOH \quad \{2\}$$

where ADOS is the amount of each mineral in the yolk on DOS and ADOH is the amount of each mineral in the yolk on DOH (Yair and Uni 2011) .

Yolk Sac and Organ Weight:

Random samples of five embryos at days 13 and 18, and five baby chicks were taken from each group for detection of yolk sac, liver, and heart weights (g). Yolk sac and organs weights were expressed as percentages of embryo and chick weights, respectively.

Chick Length and Quality:

All hatched chicks were examined macroscopically in order to identify different qualitative characteristics as described by Tona et al. (2003). Chick length was measured from the tip of the beak to the end of the middle toe with the chick's dorsal surface extended over a ruler (Wolanski et al., 2007).

Statistical Analysis:

Data were statistically analyzed according to SAS program (SAS, 2004) using GLM Procedure. One-way analysis of variance was carried out using the following model: $Y_{ij}=\mu+T_i+E_{ij}$

Where Y_{ij}=individual observation, μ=overall mean, T_i=the effect of treatments, E_{ij}=the experimental random error. Differences among treatments means were separated by Duncan's multiple rang test (Duncan, 1955).

RESULTS AND DISCUSSION

Yolk Minerals Concentrations from Day of Setting up to Day of Hatch:

Table (3) presents the examined mineral Zn concentration in egg yolk on DOS, E13, E18, and DOH. The Zn concentration was decreased gradually from DOS to DOH through the days of incubation among all the experimental groups.

Highest significant ($P\leq0.05$) records of yolk Zn concentration were observed in 100 and 50 % Org-TM compared with the other experimented groups at DOS. However, on DOH groups of 100% and 50%Org- TM and 50%Org- Zn represented significantly ($P\leq0.05$) higher records of yolk Zn concentration compared with those for others. Also, data of this table showed no significant differences in yolk Zn concentrations among hens fed diets containing 100%Org- TM, 50%Org- TM and 50% Org-Zn on E13,E18,and DOH.

Data of Table (4) shows that supplementation the diet with 100% and 50%Org-TM and 50%Org-Mn significantly ($P\leq0.05$) increased yolk Mn concentration compared with all other experimented groups through all treated days (DOS, E13, E18, and DOH). The same trend of gradual decrease for Zn mineral from DOS to DOH through the days of incubation was detected for mineral as shown in Table (4).

Moreover, marked reduction of yolk Fe concentration between the DOS and DOH due to supplementation of organic minerals is demonstrated in Table (5). Furthermore, the same trend of significant increase for yolk Mn concentration due to supplementation the diet with 100 % Org-TM and 50% Org-TM was observed for yolk Fe concentration compared to all experimented groups through all experimented days, besides group of 50%Org-Fe supplementation recorded the same significant increase (Table5).

Generally, Data of yolk Cu concentrations in Table (6) represented significant increase for groups of 100% and 50% Org-TM , and 50%Org- Cu compared to all other experimental groups through DOS and days of incubation period, whereas, this mentioned notion of significant was not realized at day of hatch.

Sharp decrease of yolk Se concentration from the DOS to DOH was detected for each group of mineral supplementation (Table 7).The significant increase of yolk Se concentrations at DOS, E13and E18 is attributed to supplementation the diet with 100% and 50% Org-TM, and 50% Org-Se compared with those for control Inorg-TM and other groups .Generally, concentrations of yolk Se at DOH represented the same mentioned trend of increase.

Data presented in all mentioned tables reveal that there was marked decrease of all studied yolk minerals concentrations from DOS until DOH. Moreover, as general speaking, supplementation diets with either 100% or 50% Org-TM realized the highest records of studied yolk trace elements concentrations at DOS, E13, E18 and DOH. Besides, supplementation the diet with 50% for each separate mineral realized the same trend of increase.

Table (8) represents the calculation of relative consumption of studied minerals in egg yolk from day of egg setting in the incubator up to day of hatch due to supplementation the diets with different concentrations of these minerals. Supplementation the diet with both concentrations of Org-TM either 50% or 100% realized the highest numerical records of relative minerals consumption from the yolk during incubation compared to those for other minerals groups and control Inorg-TM. The only exception of this statement was observed for relative Mn consumption in the group of 50% Org-Mn.

Limited research- works had been published on the availability of the organic trace minerals in hatched eggs after supplementation the diet with these elements. The major mineral source for the embryo during incubation is the yolk, which contains most of the Zn, Mn, Fe and Cu (Richards and Packard, 1996 and Richards, 1997) and Se (Papazyan et al., 2006) in hatched eggs. The benefits of supplement organic minerals to breeder flocks are probably attributed to the increased mineral amounts in the embryonated eggs (Cantor, 1997). It appears that during the last days of incubation, the high metabolic demand for minerals (Zn, Mn, Fe and Cu) cannot be fulfilled by the mineral reserves of most chicken's embryos. For that reason, increasing the amount of minerals in the yolk by feeding hens with organic minerals as well as the consumption of minerals by the embryo, might increase the mineral reserves in the yolk and thereby improve embryonic development (Yair and Uni, 2011 and Uni et al., 2012). Moreover, it would appear that the embryo absorbs greater amounts of Se during the last days of incubation than during other periods. Improving the transfer of Se from the hen's diet by using a Se-yeast instead of inorganic Se is a useful strategy to improve the nutritional status of the embryo as well as that of the newly hatched chick (Surai, 2006). Data of reserved trace minerals in the yolk sac as mentioned in the Tables (3, 4, 5, 6 and7) could considered as store and source for supplying the baby chicks with these minerals and expected to affect the baby chicks during the short period after hatch. Supporting to this observation, Gonzales et al. (2003) reported that at posthatch, the residual yolk is the major energy and nutrient source for the transition period from embryonic phase to hatchling (Henderson et al., 2008). Moreover, because most hatchlings are fed only at 36 to 48 h posthatch while being subjected to intensive metabolic demands, the low mineral concentrations in the residual yolk posthatch may impair the development of critical organs and systems during that period (De Oliveira et al., 2008).

Embryo Weight, Relative Yolk, and Internal Organs Weights on E13, E18 and on Day of Hatch:

Table (9) represents the influence of dietary organic trace minerals on embryonic weight, relative weights of yolk, and internal organs for embryos aged 13 days (E13). Supplementation the diet with organic minerals either complexed or separated had no significant appreciable influence on each of embryonic weight, relative weights of yolk sac, heart and liver for embryos aged 13 days. However, percentages of yolk sac weights in eggs produced from hens fed organic minerals diets were less than those from hens fed control Inorg-TM diet.

Results from Table (10) indicated that embryonic weights on E18 were significantly ($p \leq 0.05$) higher in all groups of minerals supplementation compared to control Inorg-TM, except that of 50% Org-Fe group. Least percentages of egg yolk sac were observed for eggs produced from 100% and 50% Org-TM and 50%Org-Se groups compared with all experimental ones including control Inorg-TM. Also, there were no significant differences between all experimental groups with respect to relative weights of heart and liver.

Results of Table (11) indicated that supplementation the diet with 100% Org-TM and 50%Org-TM either complexed or separated as a single element significantly increased the body weight of baby chicks and relative heart weight compared to those for control Inorg-TM. Whereas, relative yolk sac for the baby chicks was significantly ($P \leq 0.05$) increased for control Inorg-TM compared with those for all experimental groups. Moreover, relative liver weight did not represent any significant differences between the other rest groups.

As can be seen from data of Tables (10 and 11) that the decrease of yolk sac weight as an expressed of embryonic and baby chick weights for all groups of treatment compared with control Inorg-TM could be due to the absorption of great amount of trace elements from the yolk sac. These increases of absorbed trace element in the previous mentioned groups could be the reason for increase of metabolic pathway and consequently increase of relative heart weight of baby chicks. This explanation of relative heart weight is supported by EL-Sahn et al. (2013) who reported that the increase of the metabolic process affected and increased relative heart weight of embryo. Virden et al. (2002 and 2004) suggested that the increase of Zn and Mn amino acid supplementation in breeder diets increased ventricular weight of progeny and enhanced cardiac output. Also, Yair and Uni (2011) mentioned that Fe, Zn, Cu, and Mn minerals are important for the development of cardiovascular, immune, and skeletal systems.

Hatchability % and Chick Quality:

Significant increase of hatchability of fertile eggs percentages was observed for eggs of both 50% and 100% Org-TM groups compared with all experimental groups and control Inorg-TM. Moreover, supplementation the diet separately with all experimented trace minerals significantly improved hatchability % compared with control Inorg-TM (Table12).

Supplementation the chicken's diet with organic trace elements had no significant effect on the baby chick's quality score with 100%, average quality score of all chicks, and quality of chicks with lower score than 100. However, lengths of the chicks produced from hens fed 100% and 50%Org-TM, 50%Org-Zn, 50%Org-Mn, and 50%Org-Cu were significantly longer than those for other rest groups.

Improving the bioavailability of the organic trace minerals in yolk could be main factor which affect embryonic growth and in turn the hatching success. This conclusion regarding the improvement of hatchability is supported by different publications due to organic trace minerals supplementation (Hassan et al., 2003 and Hanafy et al., 2009).

Results shown in this table reveal that supplementation the diet of parents with organic trace minerals had no significant detrimental effect on chick quality score. The marked increase of studied chick lengths in this experiment for groups of organic trace minerals supplementation especially for 50% and 100% Org-TM could be due to the effect of organic trace minerals supplementation on the skeletal system which in turn affects the chick length. This interpretation is in harmony with those reported by Favero et al. (2013) who observed that maternal dietary of Org-TM (Cu, Mn, Zn) increased bone development.

It is concluded from the results of this experimental work that supplementation the chicken diet with complexed 50% Org-TM is quite enough for realizing the expected goals of raising the embryonic consumption and the enriching residues of trace minerals in the yolk. This increase of trace minerals could be reflected on metabolic demands of embryos and in turn hatching success. Moreover, the increase of supplementation of complexed Org-TM to 100% is not required to realize more benefits for hatching success and hatchlings quality.

Table (1): The experimental treatments

No	Abbreviation	Treatment	Description	Chemical Structure
1	100% Inorg-TM	100% inorganic trace minerals (negative control)	Inorganic trace minerals	Inorganic trace mineral in form of sulphate
2	100% Org-TM	100% organic trace minerals (positive control)	100% organic Zn, Mn, Fe, Cu, Se	Proteinate- Zn, Mn, Fe, Cu and Se
3	50%Org-TM	Organic trace minerals	50% organic Zn, Mn, Fe, Cu, Se	Proteinate- Zn, Mn, Fe, Cu, Se
4	50%Org-Zn	Organic Zn	50% organic Zn, the other minerals in inorganic forms.	Proteinate- Zn
5	50%Org-Mn	Organic Mn	50% organic Mn, the other minerals in inorganic forms.	Proteinate- Mn
6	50%Org-Fe	Organic Fe	50% organic Fe, the other minerals in inorganic forms.	Proteinate- Fe
7	50%Org-Cu	Organic Cu	50% organic Cu, the other minerals in inorganic forms.	Proteinate-Cu
8	50%Org-Se	Organic Se	50% organic Se, the other minerals in inorganic forms.	Proteinate- Se

Table (2): Composition and calculated analysis of chicken's diet.

Ingredients	(%)
Yellow corn	63.55
Soybean meal (44%)	25.10
Di-Ca-P	1.45
Limestone	8.10
Vit. &Min.Mix[1]	0.30
DL-Met 98%	0.10
Na Cl	0.40
Mineral supplementations	1.00
Total	100
Calculated Analyses:	
Crude Protein, %	16.50
ME, Kcal/kg	2700
Ca, %	3.50
Available P, %	0.40
Met + Cys, %	0.66
Lys, %	0.89

[1]Supplied per kg of the diet: Vit A, 12000 IU; Vit D, 2000 IU; Vit. E, 40mg; Vit K_3 , 4mg; Vit B_1 , 3mg; Vit B_2, 6mg; Vit B_6 , 4mg; Vit B_{12}, 0.3mg; niacin, 30mg; pantothenic acid, 12mg; folic acid, 1.5mg; biotin, 0.08mg; choline, 300mg; Mn, 100mg; Cu, 10mg; Fe, 40mg; Zn, 70mg; Se, 0.3 mg,; I,1.5mg; Co, 0.25mg.

Table (3): Effect of dietary organic trace minerals supplementation on Zn concentration (mg) in egg yolk at different days of incubation and at hatch

Minerals supplementation	DOS[1]	Days of incubation[2]		DOH[3]
		E 13	E18	
100% Inorg-TM[4]	0.910 ± 0.034b	0.634 ± 0.015c	0.105±0.002b	0.025± 0.001c
100%Org-TM[5]	1.400 ± 0.013a	0.740 ± 0.010a	0.145±0.002a	0.035±0.004a
50%Org-TM	1.385 ± 0.016a	0.725 ± 0.013a	0.135±0.002a	0.033±0.001a
50%Org-Zn	1.050 ± 0.062b	0.705±0.014ab	0.145±0.002a	0.032±0.002a
50%Org-Mn	1.005 ± 0.023b	0.646 ± 0.013c	0.110±0.001b	0.027±0.005bc
50%Org-Fe	0.946 ± 0.081b	0.666±0.012bc	0.115±0.002b	0.029±0.004b
50% Org-Cu	1.032 ± 0.044b	0.634 ± 0.009c	0.110±0.003b	0.027±0.004bc
50% Org-Se	0.958 ±0.033b	0.632 ± 0.019c	0.115±0.002b	0.029±0.003b

[a, b,c] Mean ± SE values within column with different superscripts differ significantly ($P \leq 0.05$).

[1]DOS =Day of setting; [2]E=Embryonic day; [3]DOH=Day of hatch

[4]Inorg- TM: negative control inorganic trace minerals; [5]Org-TM: positive control organic trace minerals; Zn:zinc; Mn:manganese ;Fe:iron; Cu:copper; Se:selenium.

Table (4): Effect of dietary organic trace minerals supplementation on Mn concentration (µg) in egg yolk at different days of incubation and at hatch

Minerals supplementation	DOS[1]	Days of incubation[2]		DOH[3]
		E 13	E18	
100% Inorg-TM[4]	21.04±0.22b	14.90±0.29c	7.45 ± 0.14b	5.70 ± 0.02c
100%Org-TM[5]	28.45±0.17a	18.78±0.32ab	9.35 ± 0.14a	7.30 ± 0.05a
50%Org-TM	28.30±0.14a	19.49±0.27a	9.26 ± 0.17a	7.20 ± 0.03a
50%Org-Zn	21.55±0.22b	14.63±0.77c	7.55 ± 0.25b	5.70 ± 0.03c
50%Org-Mn	27.60±0.26a	17.51±0.28b	9.25 ± 0.14a	6.90 ± 0.05b
50%Org-Fe	20.81±0.12b	15.10±0.66c	7.35 ± 0.14b	5.65 ± 0.031c
50% Org-Cu	20.74±0.25b	15.18±0.36c	7.45 ± 0.25b	5.50 ± 0.06c
50% Org-Se	20.17±0.11b	15.15±0.64c	7.65 ± 0.14b	5.65 ± 0.06c

[a, b,c] Mean ± SE values within column with different superscripts differ significantly ($P \leq 0.05$).
[1]DOS =Day of setting; [2] E=Embryonic day;[3]DOH=Day of hatch
[4]Inorg- TM: negative control inorganic trace minerals; [5]Org-TM: positive control organic trace minerals; Zn:zinc; Mn:manganese ;Fe:iron; Cu:copper; Se:selenium.

Table (5): Effect of dietary organic trace minerals supplementation on Fe concentration (mg) in egg yolk at different days of incubation and at hatch

Minerals supplementation	DOS[1]	Days of incubation[2]		DOH[3]
		E 13	E18	
100% Inorg- TM[4]	1.83± 0.03 d	0.51 ± 0.04b	0.26 ± 0.00d	0.27 ± 0.00b
100%Org-TM[5]	3.56 ±1.10 a	0.78 ± 0.02a	0.39 ± 0.00a	0.37 ± 0.00a
50%Org-TM	2.90 ± 0.10b	0.78 ± 0.01a	0.39 ± 0.00a	0.37 ± 0.00a
50%Org-Zn	1.80 ± 0.06d	0.55 ± 0.03b	0.26 ± 0.00 d	0.26 ± 0.00b
50%Org-Mn	1.92 ± 0.04 d	0.52 ± 0.04 b	0.28 ± 0.00 c	0.27 ± 0.00 b
50%Org-Fe	2.35 ± 0.10 c	0.78 ± 0.02a	0.39 ± 0.00a	0.38 ± 0.00 a
50% Org-Cu	1.83 ± 0.07 d	0.51 ± 0.04b	0.31 ± 0.00b	0.28 ± 0.00b
50% Org-Se	1.92 ± 0.025d	0.51 ± 0.03b	0.30 ± 0.00b	0.28 ± 0.00b

[a, b, c, d] Mean±SE values within column with different superscripts differ significantly ($P \leq 0.05$)
[1]DOS =Day of setting; [2]E=Embryonic day; [3]DOH=Day of hatch ;[4]Inorg- TM: negative control inorganic trace minerals; [5] Org-TM: positive control organic trace minerals; Zn: zinc; Mn: Manganese; Fe: iron; Cu: copper; Se: selenium.

Table (6): Effect of dietary organic trace minerals supplementation on Cu concentration (µg) in egg yolk at different days of incubation and at hatch

Minerals supplementation	DOS[1]	Days of incubation[2]		DOH[3]
		E 13	E18	
100% Inorg- TM[4]	24.76 ± 0.95b	11.83 ± 0.13c	6.10 ± 0.32c	2.90 ± 0.15
100%Org-TM[5]	32.80 ± 0.31a	14.90 ± 0.23a	8.50 ± 0.05a	3.60 ± 0.01
50%Org-TM	28.80 ± 0.52a	14.5 0± 0.12ab	8.15 ± 0.14a	3.22 ± 0.30
50%Org-Zn	25.90 ± 0.98b	12.15 ± 0.14c	6.45 ± 0.14bc	2.95 ± 0.14
50%Org-Mn	25.11 ± 0.32b	12.00 ± 0.10c	6.65 ± 0.14bc	2.95 ± 0.02
50%Org-Fe	25.75 ± 0.61b	12.25 ± 0.20c	6.65 ± 0.20bc	3.15 ± 0.10
50% Org-Cu	29.00 ± 0.89a	14.03 ± 0.10b	8.35 ± 0.31a	3.33 ± 0.19
50% Org-Se	26.00 ± 0.11b	12.25 ± 0.14c	7.75 ± 0.14b	3.00 ± 0.11

[a, b,c] Mean ± SE values within column with different superscripts differ significantly ($P \leq 0.05$)

[1]DOS =Day of setting; [2]E=Embryonic day; [3]DOH=Day of hatch

[4]Inorg- TM: negative control inorganic trace minerals; [5]Org-TM: positive control organic trace minerals; Zn:zinc; Mn:manganese ;Fe:iron; Cu:copper; Se:selenium.

Table (7): Effect of dietary organic trace minerals supplementation on Se concentration (ppm) in egg yolk at different days of incubation and at hatch

Minerals supplementation	DOS[1]	Days of incubation[2]		DOH[3]
		E 13	E18	
100% Inorg- TM[4]	0.264 ± 0.001c	0.225 ± 0.006bc	0.111 ± 0.002bc	0.044± 0.001bc
100% Org-TM[5]	0.530 ± 0.001a	0.331 ± 0.008a	0.153 ± 0.003a	0.054 ± 0.002a
50% Org-TM	0.512 ± 0.001a	0.314 ± 0.002a	0.145 ± 0.003a	0.061 ± 0.003a
50% Org-Zn	0.274 ± 0.001c	0.189 ± 0.008c	0.090 ± 0.003c	0.039 ± 0.001bc
50% Org-Mn	0.276 ± 0.001c	0.224 ± 0.001bc	0.113 ± 0.003bc	0.046 ± 0.001ab
50% Org-Fe	0.275 ± 0.002c	0.244 ± 0.002b	0.124 ± 0.003b	0.046 ± 0.001ab
50% Org-Cu	0.275± 0.001c	0.186 ± 0.002c	0.090 ± 0.003c	0.038 ± 0.001bc
50% Org-Se	0.400± 0.006b	0.310 ± 0.001a	0.143 ± 0.006a	0.051 ± 0.001a

[a, b, c] Mean±SE values within column with different superscripts differ significantly ($P \leq 0.05$)

[1]DOS =Day of setting ; [2] E=Embryonic day; [3]DOH=Day of hatch

[4]Inorg- TM: negative control inorganic trace minerals; [5]Org-TM: positive control organic trace minerals; Zn: zinc; Mn: manganese ;Fe: iron; Cu: copper; Se: selenium.

Table (8): Effect of dietary organic trace minerals supplementation on relative minerals consumption1 in egg yolk from day of setting up to day of hatch

Minerals supplementation	Minerals consumption[1] %				
	Z n	**Mn**	**Fe**	**Cu**	**Se**
100%Inorg- TM[2]	97.3	72.9	85.2	88.3	83.3
100% Org-TM[3]	97.5	74.3	89.6	89.0	89.8
50% Org-TM	97.6	74.6	87.2	88.8	88.1
50% Org-Zn	97.0	73.5	85.6	88.6	85.8
50% Org-Mn	97.3	75.0	85.9	88.3	83.3
50% Org-Fe	96.9	72.8	83.8	87.8	83.3
50% Org-Cu	97.4	73.5	84.7	88.5	86.2
50% Org-Se	96.8	72.0	85.4	88.4	87.3

[1]Relative minerals consumption =the amount of consumed mineral/its initial amount on day of setting
[2]Inorg- TM: negative control inorganic trace minerals; [3]Org-TM: positive control organic trace minerals; Zn: zinc; Mn: manganese ;Fe: iron; Cu: copper; Se:selenium.

Table (9): Effect of dietary organic trace minerals supplementation on embryonic weight, and relative yolk sac, heart and liver weights for embryos aged 13 days

Minerals supplementation	Embryo weight (gm)	Yolk[1] (%)	Heart (%)	Liver (%)
100% Inorg- TM[2]	10.08± 0.10	76.34±0.72	0.76 ± 0.03	1.87 ±0.12
100% Org-TM[3]	10.92± 0.12	74.69±0.84	0.84 ± 0.05	2.00 ± 0.15
50% Org-TM	11.60± 0.62	71.21±1.74	0.79 ± 0.03	1.98 ± 0.20
50% Org-Zn	11.81± 0.18	72.03±0.96	0.78 ± 0.02	1.65 ± 0.24
50% Org-Mn	10.07± 0.58	75.17±2.40	0.78 ± 0.06	2.38 ± 0.12
50% Org-Fe	10.61± 0.21	73.84±1.54	0.75 ± 0.02	2.10 ± 0.21
50% Org-Cu	11.08± 0.61	72.21±0.99	0.81 ± 0.02	2.34 ± 0.10
50% Org-Se	10.50± 0.33	72.61±1.72	0.75 ± 0.02	2.02 ± 0.20

[1]Yolk sac%= [yolk sac weight/(embryo weight with yolk sac)]*100 and Organ,%=(organ weight/embryo weight)*100
[2]Inorg- TM: negative control inorganic trace minerals; [3]Org-TM: positive control organic trace minerals; Zn: zinc; Mn: manganese ;Fe: iron; Cu: copper; Se: selenium.

Table (10): Effect of dietary organic trace minerals supplementation on embryonic weight, and relative yolk sac, heart and liver weights for embryos aged 18 days

Minerals supplementation	Embryonic weight (gm)	Yolk[1] (%)	Heart (%)	Liver (%)
100% Inorg- TM[2]	18.40 ± 0.21d	44.71 ± 0.58a	0.64 ± 0.03	2.26 ± 0.24
100%Org-TM[3]	21.95 ± 0.44ab	41.11± 1.3cd	0.75 ± 0.03	2.53 ± 0.34
50%Org-TM	22.88 ± 0.39a	37.89± 1.20d	0.77 ± 0.05	2.55 ± 0.15
50%Org-Zn	21.10± 0.27abc	43.54 ± 1.5ab	0.80 ± 0.04	2.21 ± 0.18
50%Org-Mn	20.24± 0.48bc	41.35 ± 1.08abc	0.76 ± 0.04	2.18 ± 0.15
50%Org-Fe	20.04 ± 0.98cd	43.37 ± 0.92ab	0.85 ± 0.06	2.29 ± 0.11
50% Org-Cu	22.45± 0.85a	44.65 ± 1.39a	0.87 ± 0.09	2.36 ± 0.40
50% Org-Se	22.66± 0.67ab	37.63± 0.51d	0.74 ± 0.07	2.17 ± 0.10

[a,b,c, d] Mean ± SE values within column with different superscripts differ significantly ($P \leq 0.05$)

[1]Yolk sac%= [yolk sac weight/ (embryo weight with yolk sac)]*100 and Organ,%=(organ weight/embryo weight)*100

[2]Inorg- TM: negative control inorganic trace minerals; [3]Org-TM: positive control organic trace minerals; Zn:zinc; Mn:manganese ;Fe:iron; Cu:copper; Se :selenium.

Table (11): Effect of dietary organic trace minerals supplementation on body weight, and relative yolk sac, heart and liver weights for baby chicks

Minerals supplementation	Baby chicks (gm)	Yolk[1] (%)	Heart (%)	Liver (%)
100%Inorg- TM[2]	30.09 ± 0.28c	10.54 ± 0.16a	0.71± 0.01b	3.26 ± 0.11
100% Org-TM[3]	34.89 ± 0.59ab	8.97 ± 0.16b	0.78 ± 0.02a	3.47 ± 0.16
50% Org-TM	36.88 ± 1.30a	8.73 ± 0.16b	0.77 ± 0.01a	3.51 ± 0.15
50% Org-Zn	34.29 ± 1.43ab	9.21 ± 0.15b	0.76 ± 0.01a	3.47 ± 0.19
50% Org-Mn	34.47 ± 1.42ab	9.43 ± 0.23b	0.76 ± 0.01a	3.39 ± 0.20
50% Org-Fe	33.26 ± 0.78b	9.25 ± 0.27b	0.77 ± 0.01a	3.73 ± 0.14
50% Org-Cu	34.75 ± 0.78ab	9.10 ± 0.35b	0.76 ± 0.01a	3.54 ± 0.13
50% Org-Se	33.78 ± 0.85ab	9.15 ± 0.37b	0.76 ± 0.01a	3.83 ± 0.12

[a,b,c] Mean ± SE values within column with different superscripts differ significantly ($P \leq 0.05$)

[1]Yolk sac%= [yolk sac weight/(chick weight with yolk sac)]*100 and Organ,%=(organ weight/chick weight)*100

[2]Inorg- TM: negative control inorganic trace minerals; [3]Org-TM: positive control organic trace minerals; Zn: zinc; Mn: manganese; Fe: iron; Cu: copper; Se: selenium.

Table (12): Effect of dietary organic trace minerals supplementation on hatchability % and baby chicks' quality

Minerals supplementation	**Hatchability of fertile eggs%**	**Chick quality**			
		Baby chicks with score 100(%)	**Average score of all chicks**	**Average score of Chicks with score <100**	**Chick length (cm)**
100% Inorg- TM[1]	87.20± 0.40c	61.00	90.40±5.40	84.00±6.90	16.16±0.44b
100% Org-TM[2]	92.58± 0.44a	66.60	96.00±3.11	90.01±6.00	17.66±0.16a
50% Org-TM	92.53± 0.90a	66.20	92.82±4.84	82.15±5.85	17.50±0.29a
50% Org-Zn	89.90± 0.23b	67.00	96.04±3.14	90.04±6.60	17.50±0.50a
50% Org-Mn	90.50± 0.44b	64.00	95.90±3.13	89.75±5.71	17.83±0.33a
50% Org-Fe	91.10± 0.31b	62.20	92.69±4.81	81.80±5.83	16.17±0.44b
50% Org-Cu	89.70± 0.50b	65.00	90.24±4.60	83.80±4.43	17.50±0.28a
50% Org-Se	90.30± 0.34b	65.11	93.69±3.24	89.56±3.35	16.16±0.44b

[a, b, c] Mean±SE values within column with different superscripts differ significantly ($P \leq 0.05$)

[1]Inorg- TM: negative control inorganic trace minerals; [2]Org-TM: positive control organic trace minerals; Zn: zinc; Mn: manganese; Fe: iron; Cu: copper; Se: selenium.

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الملخص العربى

تأثير أضافة المعادن العضوية النادرة (الزنك والمنجنيز والحديد والنحاس والسيلنيوم) على التطور الجنينى وجودة الكتاكيت لدجاج الجميزه

هنـــــاء محمد خليل ،عبـــــده جاد عبدالله، أمانـــــى عـــادل الصحن، امينه شعبان السعدنى، نهاد عبد الجليل، امل عبد السلام

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تم عمل هذه الدراسة للتحقق من تأ ثير بعض الاضافات العضوية المعدنية النادرة فى العلف على تحسن كمية المعادن فى الصفا ر والماخوذ منها ، التطور الجنينى،نسبة الفقس وجودة الكتاكيت لدجاج الجميزة . ١٦٠ دجاجة و٤٠ ديك من عمر ٢٤ تم توزيعهم عشوائيا الى ٨ مجاميع (٢٠ دجاجة و٥ ديك/مجموعة) .تم تغذية الطيور على ٨ مجاميع. تم عمل مجموعتين مقارنة وذلك للحصول على كافة الاحتياجات الغذائية كما هو موصى به فى N R C (١٩٩٤) .الاولى مجموعة مقارنة سالبة تم امدادها بالعناصر المعدنية النادرة فى صورة غير عضوية والثانية مجموعة مقارنة موجبة تم امدادها بالعناصر المعدنية فى صورةعضوية .المجموعة الثالثة تم امدادها ٥٠% معادن عضوية نادرة. باقى الخمس مجاميع تم امدادها ٥٠% فى الصورة العضوية لكل من زنك،منجنيز،حديد ،نحاس،سيلينيوم ،على التوالى. تم عمل بيرميكس يحتوى على الاحتياجات من المعادن النادرة اما فى صورة غير عضوية (سلفات) او صورة عضوية (ببتيدات) او كلاهما تم تجميع بيض يوميا من كل مجموعة لمدة ٧ ايام عند٣٢ و٣٤ و٣٦ اسبوع من عمر الدجاجات.تم تحضين ١٦٨٠ بيضة تفريخ ممثلة للثمانى معاملات.

تم تلخيص النتائج كالتالى:

١- امداد العلف بنسبة ٥٠% و١٠٠%معادن عضوية فى صورة مركبة سجل اعلى تركيزات للمعادن النادرة المقدرة فى الصفار وذلك عند ايام صفرو١٣و١٨من التفريخ وعند الفقس مقارنة بالمعادن الغير عضوية النادرة.

٢- امداد العلف ٥٠% و١٠٠% بالمعادن العضوية النادرة فى صورة مركبة ادى لزيادة الاستهلاك النسبى لهذه المعادن من الصفار اثناء التفريخ مقارنة بمجموعة المعادن الغير عضوية النادرة.

٣- امداد العلف ٥٠% و١٠٠% معادن عضوية نادرة فى صورة مركبة او ٥٠% فى صورة مفردة لكل عنصر ادى الى زيادة وزن الكتاكيت الحديثة الفقس ووزن القلب النسبى لها مقارنة بمجموعة المعادن الغير عضوية النادرة ،بينما لوحظ زيادة معنوية فى وزن الصفار النسبى للمجموعة المقارنة (معادن غير عضوية) مقارنة بباقى المجاميع الاخرى.

٤- زادت نسبة الفقس للبيض المخصب زيادة معنوية لمجموعتى ٥٠% و١٠٠% معادن عضوية نادرة مقارنة بالمجاميع الاخرى.

٥- زادت معنويا اطوال الكتاكيت الحديثة من اناث تم تغذيتها على ٥٠% و١٠٠% معادن عضوية نادرة و ٥٠% منجنيز عضوى و٥٠ %نحاس عضوى ٥٠% زنك عضوى مقارنة بالمجاميع الاخرى.

الخلاصة:

من نتائج هذا البحث يمكن استنتاج ان تزويد العلف بنسبة ٥٠% من العناصر النادرة فى صورة عضوية مركبة من مجموعة من العناصر (الزنك والمنجنيز والحديد والنحاس والسيلنيوم) قد حقق البحث الهدف المطلوب من تحسين عملية الفقس وانتاج كتاكيت ذات جودة افضل.