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THE EFFECT OF DIETARY SUPPLEMENTATION WITH COPPER SULPHATE OR COPPER CHLORIDE ON LOCAL MAMOURAH STRAIN LAYING HENS:

1- EFFECT OF DIETARY COPPER LEVEL AND SOURCE ON PERFORMANCE, EGG PRODUCTION, EGG QUALITY AND GIZZARD STRUCTURE OF LAYING HENS.

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ABSTRACT

An experiment was conducted using 120 hens of Mamourah local strain of 36 weeks of age. The basal diet was formulated to meet the nutrient requirements of this local strain. Diets with 4 dietary copper concentrations 0, 500, 750 and 1000 mg/kg diet from 2 different sources, copper sulphate ($CuSO_4$. 5 H_2O) and copper chloride ($CuCl_2$. 2 H_2O) were formulated and randomly distributed in such a way that each diet was fed to 15 cages of birds. The feeding trial continued for 56 days. Results showed that body weight of hens increased by feeding copper supplemented diet in the first 4 weeks of the experimental period. Copper chloride as a source of copper recorded significant ($P<0.05$) increase in egg number (about 10.3%) as compared to the copper sulphate during 8 weeks of feeding. Addition of 1000 mg/kg diet reduced the egg number as compared to the other levels in the same period. Feeding levels of copper as two sources for 4 or 8 weeks was without influence on egg weight. Feed consumption tended to be increased by copper supplements in the first 4 weeks of feeding but decreased at 8 weeks of feeding. Addition of 1000mg/kg diet from the two sources of copper recorded numerical decrease in Haugh Units (HU) during two periods.

Copper yolk recorded high values as compared to the other components (white and shell) of egg during the two periods of feeding. Excreta Cu was increased by dietary supplements. Egg quality was not affected by dietary supplements during the two experimental periods except that for shell thickness was significantly ($P<0.05$) increased. Histological examination of the gizzard indicated that the two highest levels of copper chloride (750 and 1000 mg/kg diet) exhibited considerable thickness and damage to the gizzard lining. The variation in tested prameters values could be attributed to differences in strain or seasonal conditions.

Keywords : Copper, layinghens, . Histological, Egg quality

INTRODUCTION

The essentiality of copper for poultry and livestock is well documented (Davis and Mertz, 1987). In recent years additional copper sources have become available and the potential for commercial use as feed additives has expanded. The precise Cu requirements of the hen is unknown, as indicated by a question mark in Table 2-3 of the nutrient requirements of poultry (NRC, 1994). However, for several years, it has been industrialy practice to add 250 mg/kg copper (as $CuSO_4$. 5 H_2O) to laying hen diets as an aid in controlling mold growth and crop mycosis (Mayo *et al.*, 1956; Smith, 1969 and Jenkins et al., 1970). The authors reported that up to about 250 mg Cu/kg diet tends to promote the growth of chicks, while above this level a growth depression occurs and at very high levels considerable mortality may occur.

Regarding laying performance Thomas et al., (1974) and Thomas and Goatcher (1976) reported that 720 ppm copper in the diet reduced consumption, weight gain and egg production in laying hens, but the levels of 480 ppm copper or lower had no effect on performance characteristics. On the other hand, there is no information regarding the effect of Cu on gizzard lining erosions in the laying hens and the limited number of experiments up till now on the domestic fowl have mainly been concerned with the effect of Cu on the gizzard of growing chicks.

The purpose of the present described herein is to study the effect of excessive levels of Cu in the Mamourah local strain laying hen diets on live weight, feed consumption, rate of lay, and excreta Cu. The effect of copper source and level on the interior surface of the gizzard was also studied.

MATERIALS AND METHODS

This study was conducted at the Poultry Nutrition Research Department and Gimmizah Poultry Farm of Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Dokki, Egypt, during the period from November 1999 to February 2000.

The experimental work was conducted using 120 hens of Mamourah local strain of 36 weeks of age. Individual wire cage layers were subjected to a photoperiod of 16 hour and 8 hour dark. Food and water were provided *ad libitum* throughout experimental period. The basal diet (Table 1) was formulated to meet the nutrient requirements of this local strain.

All birds were fed the basal diet for 28 days before the experiment start. The feeding trial continued for 56 days (2 x 28 days/period). Egg production was recorded daily, feed was added as needed and residual feed was measured after 4 and 8 weeks of feeding. Egg weight (EW), egg number (EN), feed consumption (FC) and Haugh Units (HU) were determined at the start and end of the treatment. Three excreta samples per treatment were collected during the 3 last days of the experiment for copper analysis.

For copper analysis, eggs were placed in boiling water for 5 minutes. After cooling to room temperature, the yolk was separated from albumin and frozen at –20 °C. Samples for Cu analysis were determined by using UNICAM 969 AA Spectrometer, Jackson, (1967).

At the end of experiment three hens from each treatment were sacrificed. Gizzards were removed to expose the lining, washed with water, weighed and scored. Samples of gizzards were taken for histopatho logical examination.

Tissue samples were fixed in 10% neutral buffered formalin. Fixed tissues were trimmed, embedded in paraffin, sectioned at 4µm and stained with hematoxylin and eosin (Carleton et al., 1980). The scoring was done on the lining appearance and microscopic examination of the gizzards (A = Normal, B = Erosion and C = Sever erosin). The weight of gizzard was calculated per unit body weight.

Table (1): Composition of layer ration (basal diet).

Ingredients	%
Yellow corn	67.19
Soybean meal 44%	22.95
Limestone	7.68
DI-calcium phosphate	1.45
Salt, table	0.35
Vitamins & Minerals mixed	0.30
DL-Methionine	0.08
Total	**100.00**
Calculated analysis:	
Crude protein %	16.0
Metabolizable Energy (Kcal/kg)	2761
Crude fiber %	3.14
Crude fat %	2.73
Calcium %	3.30
Available phosphors %	0.40
Lysine %	0.83
Methionine %	0.35
Methionine + cystine %	0.62
Copper mg/kg diet (determined)	7.05

Vitamin-mineral premix: From AGRI-VIT company, supplied per kilogram of diet: 10000 IU vit. A, 2000 IU vit. D_3, 10 mg vit E., 1.0 mg vit. K_3, 1mg vit. B_1, 5 mg vit. B_2, 1.5mg vit B_6, 0.01 mg vit. B_{12}, 0.05 mg Biotin, 250 mg choline chloride, 10 mg Pontothnic, 30 mg Niacin, 1.0 mg Folici acid, 60 mg Mn, 50 mg Zn, 30 mg Fe, 4 mg Cu, 0.3 mgl, 0.1 mg SE and 0.1 mg Co.
Diets with 4 dietary copper concentrations 0, 500, 750 and 1000 mg/kg from 2 different sources, copper sulphate ($CuSO_4$. 5 H_2O) and copper chloride (Cu $Cl_2.2H_2O$) were randomly fed to 15 cages of birds.

Table (2):The equivalent copper dietary supplemental from two different sources.

Source mg/kg diet		Level content ppm Cu
Copper sulphate 25% Cu ($CuSO_4$. 5 H_2O)	Copper chloride 37% Cu ($CuCl_2$. 2 H_2O)	
0.0	0.0	0.0
500	337.83	125
750	506.75	187.5
1000	675.67	250

Statistical analysis of the data, using the GLM producer of SAS (1986) was used on 2 (source of copper) x 4 (concentration in diet) factorial design. The data analyses were according to the following model.

$$Y_{ijk} = \mu + t_i + p_j + (tp)_{ij} + e_{ijk}$$

Where:

- μ is the general mean.
- t_i is the effect source of copper, $_i$ = 1 and 2 where 1 = copper sulphate ($CuSO_4$. 5 H_2O), 2 = copper chloride ($CuCl_2$. 2 H_2O).
- p_j is the effect due to levels of copper, $_j$ = 1, 2, 3 and 4 where 1 = 0, 2 = 500 3 = 750 and 4 = 1000 mg/kg diet.
- $(tp)_{ij}$ is possible interaction between main effects.

e_{ijk} is the random error.

Table (3): The effect of incorporating copper in excess of the requirement on performance of laying hen at 28 days X ± SE.

Items	BW	EN	EW	FC	HU
Before treatment at 28 days as range (basal diet)	1838.5± 49.0 to 1948.3±52.2	16.7±1.9 to 20.7±0.85	55.5±0.40 to 59.31.4	2451.5±10.71 to 2807.5±85.9	69.6±4.6 to 85.0±2.5
After treatment at 28 days:					
Among levels mg/kg diet:					
0	1879.6±40.6	21.8±0.63	54.4±0.79	3451.8±53.8[b]	86.7±2.3
500	1888.9±39.9	20.8±1.00	54.9±0.55	3490.4±44.5[b]	84.5±1.9
750	1929.6±38.4	21.1±1.00	53.5±0.93	3581.2±41.6[ab]	84.2±1.7
1000	1925.2±46.5	21.4±0.55	56.8±0.71	3607.8±37.3[a]	83.2±1.7
Betweensource:					
Copper sulphate	1904.0±29.9	20.9±0.66	54.8±0.59	3530.6±33.1	85.3±1.3
Copper chloride	1907.6±28.4	21.6±0.53	54.9±0.51	3535.0±31.6	84.0±1.4
Interactions:					
Sulphate mg/kg:					
0	1923.85±63.8	21.1±1.0	53.8±1.50	3376.1±60.1[b]	91.0±2.2
500	1888.00±59.8	20.9±1.7	56.0±0.73	3497.9±59.0[ab]	83.8±2.3
750	1898.71±51.5	21.1±1.3	52.9±1.30	3602.4±51.6[a]	85.2±2.3
1000	1909.20±73.5	20.7±0.77	57.0±0.85	3649.1±54.1[a]	81.2±1.8
Chloride mg/kg:					
0	1835.4±49.6	22.7±0.73	54.9±0.67	3527.6±68.5[ab]	82.4±3.1
500	1890.0±54.6	20.6±1.1	53.8±0.75	3482.3±69.2[ab]	85.2±3.3
750	1968.3±58.1	21.1±1.6	54.2±1.40	3554.7±69.6[ab]	83.2±2.6
1000	1938.0±61.0	22.0±0.77	56.5±1.10	3574.8±51.5[ab]	85.2±2.7

a, and b Mean that are not followed by the same superscripts are significantly different (P<0.05).

0, 500, 750 and 1000 mg/kg amount of added copper sources in the diet, BW = body weight, EN= Number of egg per 28 days, EW = Egg weight, FC = Food consumption and HU = Haugh unit.

RESULTS AND DISCUSSION

Interaction between copper source and quantity were tested and found to be not significant in performance. Body weight of hens increased by feeding copper supplemented diet in the first 4 weeks experimental period (Table 3). It is of interest to notice that level and sources of supplemental copper had no significant effect on body weight in the subsequent 8 weeks experimental period. The reason may be due to that hens reached the optimum body weight during the first 4 weeks experimental period. Improvement in body weight could be attributed to copper which may act as growth promoting factor (Pesti and Bakalli, 1996; El-Awady, 1996 and El-Awady *et al.*, 1996). The explanation is supported by El-Medney *et al.*, (2001). Egg number tended to increase by copper supplements after 4 weeks of feeding. Copper chloride as source recorded significant (P<0.05) increase in EN (about 10.3%) as compared to the copper sulphate as a source during 8 weeks of feeding (Table 4). Addition of 1000 mg/kg diet reduced the EN compared to the other levels at 8 weeks of feeding, (Ankari *et al.*, 1998). Feeding levels of copper as sulphate or chloride for 4 or 8 weeks was without influence on egg weight. The present result is on line with the data reported by Pesti and Bakalli, (1998). Feed consumption tended to be increased by copper supplements in the first 4 weeks of feeding but decreased for 8 weeks of feeding, (Pesti and Bakalli, 1998).

Table(4):The effect of incorporating copper in excess of the requirement on performance of laying hen at 56 days X ± SE.

Items	BW	EN	EW	FC	HU
At 56 days					
Among levels mg/kg diet:					
0	1776.2±41.5	21.1±0.75	53.4±0.77	3284.7±25.9	83.5±2.0
500	1779.0±40.9	20.0±1.10	55.1±0.58	3294.2±24.9	81.7±1.7
750	1818.2±30.9	20.7±0.95	53.7±0.82	3292.3±23.9	85.4±1.1
1000	1768.9±46.5	19.6±1.00	55.1±0.76	3312.6±26.9	79.9±1.3
Between source:					
Copper sulphate	1804.9±27.8	19.4±0.70[b]	54.7±0.51	3296.2±15.35	82.2±1.3
Copper chloride	1765.9±28.8	21.4±0.62[a]	54.0±0.53	3296.1±20.00	83.1±1.0
Interactions:					
Sulphate mg/kg:					
0	1825.4±60.4	20.5±1.2	54.00±1.30	3276.4±39.1	85.6±3.6
500	1777.3±56.4	19.0±1.7	55.30±0.83	3300.7±30.7	79.4±2.0
750	1825.3±45.1	19.9±1.1	54.20±1.10	3290.9±23.9	84.4±1.9
1000	1791.7±67.9	18.1±1.5	55.41±0.94	3318.7±31.5	79.4±2.1
Chloride mg/kg:					
0	1726.9±55.9	21.8±0.82	52.8±0.91	3293.1±35.7	81.4±1.9
500	1781.4±61.7	21.1±1.20	55.0±0.83	3283.1±40.9	84.0±2.5
750	1809.2±43.1	21.7±1.60	53.2±1.30	3294.1±44.4	86.4±1.0
1000	1750.7±65.5	20.8±1.30	54.8±1.20	3307.7±42.4	80.4±1.7

a, and b Mean that are not followed by the same superscripts are significantly different ($P<0.05$).

0, 500, 750 and 1000 mg/kg amount of added copper sources in the diet, BW = body weight, EN= Number of egg per 28 days, EW = Egg weight, FC = Food consumption and HU = Haugh unit.

No consistent trend was observed in HU for 4 and 8 weeks (Table 3 and 4). Addition of 1000mg/kg diet from both sources recorded numerical decrease in HU during two periods Ankari *et al.*, (1998).

Results in (Table 5 and 6) showed that both copper level and sources increased yolk white and shell of eggs for copper supplemented diets in the first 4 weeks of feeding, although the effect was non significant. Cu yolk recorded high values as compared to other component of egg during two periods of feeding. The present result is on line with the data reported by Ankari *et al.*, (1998) and Pesti and Bakalli, (1998). In all studies, a high proportion of ingested Cu appears in feces. In the present study excreta Cu was enriched by dietary supplements (Table 7).

Concerning the effect of copper on egg quality values, egg weight (EW), yolk weight (YW), shell weight (SHW), albumin weight (ALW), yolk height (YH), yolk colour (YC) and shell thickness (SHTH) are shown in Tables 8 and 9.

No significant difference in all egg quality values were detected either between copper levels or sources except shell thickness which was improved by supplemental copper sulphate during first 4 weeks of experimental period. There was a significant difference ($P<0.05$) between levels during 8 weeks of experimental period on shell thickness, interaction between levels and source showed improvements.

From the foregoing egg quality result was not greatly affected by supplementing the dietary copper sources and levels. The variation in tested parameters values could be attributed to strain differences or seasonal conditions.

Unfortunately, no enough data are available concerning the effect of supplementing the diets with different copper sources on egg quality.

Comparing the effect of copper source and level on histopathological changes, it is noticed that there were no detectable changes in the malstructure of gizzard of hens fed a diet containing either low or high levels of copper sulfate (Plates 2, 3 and 4) compared to control (Plate 1). Likewise, there were no detectable lesions in gizzard of hens fed the lowest level (500 ppm) of copper chloride (Plate 5) compared to control one (Plate 1). While at the level of 750 ppm of copper chloride gizzard erosion it was clearly, that the cells of the internal muscle layer appeared more compressible which led to incidence of a longitudinal accumulation in the cells and their nucleuses shapes (Plate 6). The condition become more sever with higher level of copper chloride (1000 ppm) which caused an explosion and distraction in the cell membrane (Plate 7). However, the same results were observed when the scoring was done on the overall appearance of the gizzard lining of each group. The severity of gizzard lining erosion was clear for hens fed 750 or 1000 ppm copper in a chloride form when compared with control. While adding the copper in form of sulfate had no effect (photographic picture not shown). These results are in agreement with those reported by Fisher *et al.*, (1973) and Cyrus and Leo (1976). The mechanism of action of copper in producing a deleterious effect on the lining of the gizzard is not known. One possibility that copper may induce a deficiency of another trace element or interfering with normal utilization causing distraction of the vitamins and therefore creating a vitamin deficiency, which could result in gizzard erosion. Other possibility that high levels of copper salts increased the activity of the gizzard contents and thereby affected the integrity of the gizzard lining (Cyrus and Leo, 1976).

Regarding the effect of copper source and level on the relative weight of gizzard, it could be observed that, birds that received copper either in form of sulfate or chloride exhibited a numerically decrease in a relative weight of gizzard when compared with basal.

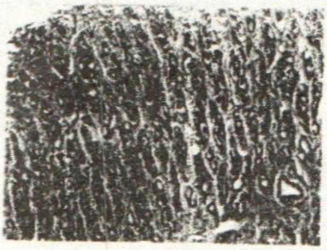

Plate 1: Control (A)*
Grw = 14.4%

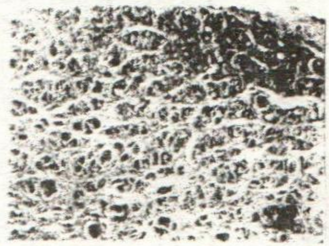

Plate 2: Fed on 500ppm copper sulphate (A)
Grw = 12.4%

Plate 3: Fed on 750ppm copper sulphate (A)
Grw = 10.8%

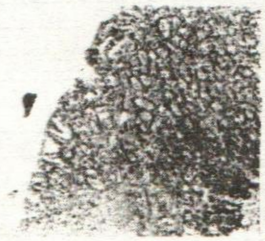

Plate 4 : Fed on 1000ppm copper sulphate (A)
Grw = 13.4%

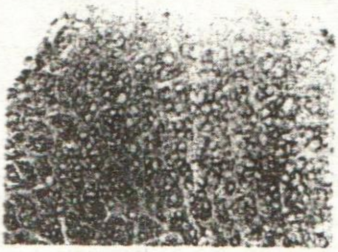

Plate 5: Fed on 500ppm copper chloride (A)
Grw = 12.6%

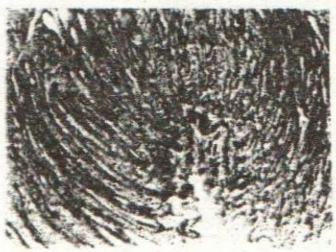

Plate 6 : Fed on 750ppm copper chloride (B)*
Grw =11.5%

Plate 7 : Fed on 1000ppm copper chloride (C)*
Grw = 11.2%

Histological cross sections in the gizzard of hens fed different levels and sources of copper.

Plate 1: Showing normal cells.
Plates 2, 3, 4 and 5: Showing no effect on internal circular muscle layer cells.
Plate 6: Showing a compression and elongation of the cells and nuclei in the internal circular muscle layer.
Plate 7: Showing an explosion and destruction of the cell membrane in the internal circular muscle layer.
* A, B and C are the grades of erosion
A = No erosion B = Erosion C = Severe erosion
* Grw = Gizzard relative weight

Table (5): Effects of added dietary copper (as copper sulphate and copper chloride) on egg copper levels at 4 weeks of age.

Items	Mean ±SE		
	Yolk Cu ppm	WhiteCu ppm	Shell Cu ppm
Before treatment (4 weeks) as range	5.4±1.5 to 8.7 ±0.17	5.1±0.72 to 9.4 ±2.0	4.1±2.0 to 12.6 ±2.5
After treatment (4 weeks)			
Among levels mg/kg diet:			
0	4.1±0.50	1.50±0.41	1.9±0.30
500	3.9±0.73	0.86±0.23	1.2±0.21
750	4.0±0.47	1.20±0.4	1.9±0.48
1000	5.0±0.76	1.30±0.3	2.3±0.39
Between source:			
Copper sulphate	3.8±0.43	1.1±0.24	1.7±0.28
Copper chloride	4.8±0.43	1.3±0.23	2.0±0.25
Interactions:			
Sulphate mg/kg:			
0	2.9±0.20	0.95±0.28	1.8±0.60
500	4.6±1.00	0.95±0.50	1.2±0.30
750	3.1±0.40	1.45±0.76	1.4±0.76
1000	4.4±0.57	1.20±0.60	2.4±0.57
Chloride mg/kg:			
0	5.3±0.44	2.10±0.66	2.1±0.33
500	3.3±1.00	0.78±0.16	1.3±0.33
750	4.9±0.28	1.10±0.44	2.4±0.57
1000	5.6±1.00	1.20±0.33	2.3±0.66

Table (6): Effects of added dietary copper (as copper sulphate and copper chloride) on egg copper levels at 8 weeks of age.

Items	Mean ±SE		
	Yolk Cu ppm	White Cuppm	Shell Cu ppm
After treatment 8 weeks			
Among levels mg/kg diet:			
0	2.2±0.49	0.03±0.01	0.06±0.01
500	1.8±0.45	0.06±0.01	0.06±0.01
750	1.6±0.41	0.05±0.01	0.06±0.01
1000	1.3±0.04	0.05±0.01	0.06±0.01
Between source:			
Copper sulphate	1.9±0.32	0.05±0.01	0.07±0.01
Copper chloride	1.5±0.22	0.05±0.01	0.05±0.01
Interactions:			
Sulphate mg/kg:			
0	3.0±0.76	0.04±0.01	0.06±0.01
500	1.5±0.28	0.04±0.01	0.07±0.01
750	1.8±0.88	0.05±0.01	0.06±0.01
1000	1.4±0.05	0.06±0.01	0.08±0.02
Chloride mg/kg:			
0	1.4±0.10	0.03±0.01	0.07±0.03
500	2.2±0.90	0.07±0.01	0.05±0.01
750	1.3±0.08	0.05±0.01	0.05±0.01
1000	1.3±0.05	0.04±0.01	0.05±0.01

Table (7): Influence of dietary copper (mean ±SE) as copper sulphate and copper chloride levels in excreta of laying hens.

Items	Cu ppm
Among levels ±SE:	
0	41.8 ± 4.7^{c}
500	420.5 ± 34.1^{b}
750	629.5 ± 69.2^{a}
1000	657.3 ± 90.1^{a}
Source ±SE:	
Copper sulphate	395.0±82.3
Copper chloride	479.5±84.2
Interactions:	
Sulphate mg/kg:	
0	42.0 ± 8.0^{c}
500	359.0 ± 41.0^{b}
750	616.3 ± 136.5^{ab}
1000	563.0 ± 165.1^{ab}
Chloride mg/kg:	
0	41.7 ± 6.8^{c}
500	482.0 ± 18.7^{ab}
750	642.6 ± 71.8^{a}
1000	751.7 ± 66.9^{a}

a and b Mean that are not followed by the same superscripts are significantly different (P<0.05).

Table (8): Egg quality of laying hens given control and Cu supplemented diets at 28 days X ± SE.

Items	EW (g)	YW (g)	SHW (g)	ALW (g)	YH (cm)	YC	SHTH (mm)
Before treatment at	50.0± 0.6 to 57.8±1.5	15.7±0.3 to 18.6±0.5	6.7±0.2 to 7.8±0.5	27.9±0.4 to 31.6±1.4	1.8±0.1 to 1.9±0.02	5.2±0.2 to 5.8±0.4	0.39±0.01 to 0.42±0.02
At 4 weeks :							
Among levels mg/kg diet:							
0	53.4±1.1	16.9±0.5	7.3±0.2	29.1±0.6	1.9±0.02	6.0±0.3	0.39±0.01
500	53.2±1.1	16.4±0.5	7.2±0.2	29.6±0.7	1.8±0.05	5.7±0.2	0.38±0.01
750	54.2±1.3	16.6±0.5	7.1±0.1	30.5±0.9	1.9±0.02	5.4±0.2	0.37±0.01
1000	56.3±1.3	17.3±0.4	7.3±0.1	31.7±1.0	1.9±0.02	5.4±0.2	0.37±0.01
Between source:							
Copper sulphate	54.5±0.9	16.7±0.3	7.4±0.1	30.4±0.02	1.9±0.02	5.8±0.2	0.39 ± 0.01^{a}
Copper chloride	54.1±0.8	16.9±0.4	7.1±0.1	30.0±0.05	1.9±0.02	5.4±0.1	0.36 ± 0.01^{b}
Interactions:							
Sulphate mg/kg:							
0	53.2±1.6	16.3±0.5	7.5±0.2	29.3±1.0	1.9±0.02	6.4±0.5	0.42 ± 0.01^{a}
500	53.4±1.8	16.3±0.8	7.4±0.3	29.6±1.3	1.8±0.07	5.6±0.2	0.40 ± 0.01^{ab}
750	52.9±1.7	16.5±0.7	7.2±0.2	29.2±1.0	1.9±0.03	5.6±0.2	0.38 ± 0.01^{ab}
1000	58.5±2.0	17.6±0.4	7.3±0.1	33.4±1.7	1.9±0.02	5.6±0.2	0.37 ± 0.01^{b}
Chloride mg/kg:							
0	53.5±1.6	17.6±0.8	7.1±0.3	28.7±0.8	1.9±0.04	5.6±0.2	0.35 ± 0.01^{b}
500	53.0±1.5	16.5±0.7	7.0±0.4	29.5±0.9	1.9±0.08	5.8±0.2	0.36 ± 0.03^{b}
750	55.5±2.1	16.7±0.9	7.0±0.2	31.7±1.6	1.9±0.03	5.2±0.2	0.36 ± 0.02^{b}
1000	54.2±1.3	16.9±0.6	7.2±0.3	30.1±0.8	1.9±0.04	5.2±0.3	0.38 ± 0.01^{ab}

a, and b Mean within a column with no common superscripts are significantly different (P<0.05).

EW = egg weight, YW= yolk weight, SHW = shell weight, ALW = albumin weight, YH= yolk height, YC = yolk colour and SHTH = shell thickness.

Table (9): Egg quality of laying hens given control and Cu supplemented diets at 56 days X± SE.

Items	EW (g)	YW (g)	SHW (g)	ALW (g)	YH (cm)	YC	SHTH (mm)
Among levels mg/kg diet:							
0	53.9±1.0	17.0±0.3	6.5±0.2	30.5±0.7	1.9±0.03	5.7±0.4	$0.39±0.01^{b}$
500	53.8±1.3	17.1±0.5	6.8±0.2	29.9±0.9	1.8±0.05	5.5±0.3	$0.42±0.01^{a}$
750	55.3±1.1	17.3±0.6	6.4±0.2	31.5±0.8	1.9±0.03	5.5±0.3	$0.42±0.01^{a}$
1000	55.8±1.0	18.1±0.2	6.8±0.1	30.9±0.9	1.9±0.02	5.4±0.3	$0.42±0.01^{a}$
Between source:							
Copper sulphate	55.1±0.9	17.5±0.3	6.8±0.1	30.8±0.7	1.9±0.03	5.6±0.2	0.41±0.01
Copper chloride	54.3±0.6	17.2±0.4	6.5±0.1	30.6±0.5	1.9±0.02	5.4±0.2	0.42±0.01
Interactions:							
Sulphate mg/kg:							
0	54.2±2.0	16.8±0.5	$6.8±0.2^{a}$	30.6±0.6	1.90±0.05	6.4±0.5	$0.38±0.01^{c}$
500	55.1±2.4	17.7±0.9	$6.9±0.2^{a}$	30.4±1.7	1.80±0.08	5.0±0.3	$0.41±0.01^{bc}$
750	56.2±1.1	17.7±0.9	$6.8±0.2^{a}$	31.6±0.3	2.02±0.04	5.5±0.6	$0.43±0.01^{ab}$
1000	55.2±1.7	17.7±0.6	$6.5±0.1^{a}$	30.8±1.3	1.90±0.03	5.6±0.2	$0.43±0.01^{ab}$
Chloride mg/kg:							
0	53.7±0.6	17.2±0.4	$6.1±0.2^{b}$	30.3±0.2	1.9±0.02	5.0±0.3	$0.40±0.01^{c}$
500	52.5±0.8	16.4±0.5	$6.8±0.3^{a}$	29.3±0.4	1.8±0.06	6.0±0.5	$0.44±0.01^{a}$
750	54.5±1.9	16.9±0.9	$6.1±0.3^{b}$	31.5±1.6	1.9±0.03	5.6±0.4	$0.42±0.01^{ab}$
1000	56.5±1.2	18.4±0.9	$7.0±0.2^{a}$	31.1±1.3	1.9±0.02	5.2±0.6	$0.41±0.01^{ab}$

a, b and c Mean within a column with no common superscripts are significantly different ($P<0.05$).

EW = egg weight, YW= yolk weight, SHW = shell weight, ALW = albumin weight, YH= yolk height, YC = yolk colour and SHTH = shell thickness.

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REFERENCES

Ankari, A. Al., H. Najib and A. Al-Hozab (1998). Yolk and serum cholesterol and production traits, as affected by incorporating a supraoptimal amount of copper in the diet of the Leghorn hen. Br. Poult. Sci., 39: 393-397.

Carleton, R. A., B. Drury and E. A. Wallington, (1980). Histochemical techniques for normal and pathological tissue and identification of parasites. Fifth Edition, Oxford, University Press. New York, Toronto.

Cyrus P. and S. J. Leo (1976). Effect of high dietary copper on gizzard integrity of the chick. Poultry Sci., 55: 113-121.

Davis, K. G. and W. Mertz (1987). Copper in trace elements in human and animal nutrition (5th Ed.). pp. 301-364. Academic Press New York.

El-Awady, Nadia. I. (1996). Utilization of supplemental inorganic sulphate from three sources by Turkey. Poults. J. Agric. Sci., Mansoura Univ., 21: 2497-2507.

El-Awady, Nadia. I., Salwa, B. Abdel-Hady and E. H. El-Ganzory (1996). Utilization of supplemental three sources of inorganic sulphate by broiler chicks. J. Agric. Sci., Mansoura Univ., 21: 3149-3159.

El-Medney, N. M., A. M. Abdel-Maksoud, A. Galal and M. M. Fathi (2001). Reducing plasma and egg yolk cholesterol levels in two laying hen strains by copper sulphate feeding. Egyptian J. Nutrition and Feed 4: 1079-1095.

Fisher. C., A. P. Laursen-Jones, K. J. Hill and W. S. Hardy (1973). The effect of copper sulfate on performance and the structure of the gizzard in broilers. Br. Poult. Sci., 14: 55-58.

Jakson, M. L. (1967). Chemical analysis. Prentice Hall of India private-Limited New Delhi.

Jenkins, N. K., T. R. Morris and D. Valanotis (1970). The effect of diet and copper supplementation on chick growth. Br. Poult. Sci., 11: 241.

Mayo R. H., S. M. Hauge, H. E. Parker., F. N. Andrews and C. W. Carrick (1956). Studies on the copper tolerance of young chickens. Poultry Sci., 35: 1156-1157.

National Research Council (NRC) (1994). Nutrient Requirement of Poultry. 9^{th} rev. Ed. National Academy press, Washington D.C.

Pesti, G. M. and R. I. Bakalli (1996). Studies on feeding of cupric sulphate pentahydrate and cupric citrate to broiler chickens, Poultry Sci., 75: 1086-1091.

Pesti, G. M. and R. I. Bakalli (1998). Studies on the effect of feeding cupric sulphate pentahydrate to laying hens on egg cholesterol content. Poultry Sci., 77: 1540-1545.

SAS (1986). SAS user's Guide statistics 1986. Ed SAS inst. Inc, Cary, NC.

Smith, M. S. (1969). Responses of chicks to dietary supplements of copper sulphate. Br. Poult. Sci., 10: 97-108.

Thomas, M. C. and W. D. Goatcher (1976). High level of copper in layer diets. Poultry Sci., 55: 1608 (Abstr.).

Thomas, M. C., M. Y. Norvell, C. C. Calverl and W. D. Goatcher (1974). Some effects of continuous feeding of copper sulphate to laying chickens. Poult. Sci., 53: 1984 (Abstr.).

التأثير الغذائي لإضافة كبريتات النحاس أو كلوريد النحاس على سلالات المعمورة المحلية للدجاج البياض:

١- التأثير الغذائي لمستوى ومصدر النحاس على الأداء الإنتاجي وصفات جودة البيضة والتركيب التشريحي للقونصة للدجاج البياض.

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معهد بحوث الإنتاج الحيواني – مركز البحوث الزراعية- الدقى-جيزة -مصر.

صممت التجربة باستخدام ١٢٠ دجاجة بياضة عمر ٣٦ أسبوع من سلالة محلية (معمورة) وتمت التغذية على عليقة أساسية مناسبة لاحتياجات هذا النوع من السلالات المحلية وتم تقديمها بإضافة ٤ مستويات من النحاس صفر، ٥٠٠ ، ٧٥٠ و ١٠٠٠ ملليجرام/ كيلو جرام عليقة من مصدرين مختلفين من النحاس هما كبريتات النحاس المائية وكلوريد النحاس المائى، واشتملت كل معاملة على ١٥ طائر فـى أقفـاص منفـردة واستمرت مدة التجربة ٥٦ يوما مقسمة على فترتين.

- أظهرت النتائج زيادة فى وزن الجسم نتيجة التغذية بإضافة النحاس للعليقة خلال الفترة الأولى من التجربة.
- حققت إضافة كلوريد النحاس زيادة معنوية (مستوى ٥%) فى عدد البيض المنتج بنسبة ١٠,٣٠% مقارنة بالمصدر الأخر (كبريتات النحاس) خلال ٨ أسابيع من التغذية، وأنه بإضافة مستوى ١٠٠٠ ملليجرام/كيلوجرام عليقة أدى إلى حدوث انخفاض فى عدد البيض المنتج خلال هذه الفترة من التجربة.
- لم يتأثر وزن البيض نتيجة التغذية بإضافة مستويات ومصادر للنحاس خلال فترتي التجربة.
- زاد المستهلك من الغذاء نتيجة لإضافة النحاس خلال الأربع أسابيع الأولى من التجربة وانخفض باستمرارية التغذية حتى نهاية التجربة.
- أدت إضافة ١٠٠٠ ملليجرام/كيلوجرام من كل مصدري النحاس إلى انخفاض قيم HU خلال فترتي التجربة.
- سجلت النتائج زيادة فى محتوى صفار البيض من النحاس عن باقي مكونات البيضة خلال فترتي التجربة.
- زادت كمية النحاس الخارج فى زرق الدجاج نتيجة لزيادة كميات النحاس المضاف.
- لم تتأثر صفات جودة البيضة بالتغذية على هذه الإضافات خلال فترتي التجربة فيما عدا حدوث تحسن معنوي (مستوى ٥%) فى سمك القشرة نتيجة لهذه الإضافات.
- أوضحت الدراسة الهستولوجية للقونصة تأثيرها بالتركيزات العالية من كلوريد النحاس (٧٥٠و ١٠٠٠ ملليجرام/كيلوجرام عليقة) مما أدى إلى حدوث تغيرات فى شكل الخلايا والانوية لطبقة العضلات الداخلية فى القونصة.
- تعزى الاختلافات للمقاييس السابقة إلى نوع السلالة والظروف البيئية.