EFFECTS OF CHELATED ORGANIC TRACE MINERAL BLENDS BASED DIET ON EGG-QUALITY CHARACTERISTICS OF EARLY-LAY BIRDS

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ABSTRACT

Trace minerals commonly used in poultry are supplied by inorganic salts have low bioavailability because they can form complexes with other nutrients in the gut. A 80-weeks experiment was conducted to evaluate the effects of diet supplemented with chelated organic trace mineral blends on the egg quality characteristics of late-lay birds. The experiment involved a total of 500 one- day old pullet chicks were randomly allotted to five dietary treatments consisting of positive control, recommended level of inorganic trace minerals in the premix 16, 64, 64 mg/kg of Cu, Zn and Mn (T1), negative control, basal diet with 0.0, 0.0,0.0 mg/kg of Cu, Zn and Mn i.e. premix free of Cu, Zn and Mn (T2), diets with 16, 64, 64 mg/kg of chelated Cu, Zn and Mn, 100% higher than the manufacturer's recommendation (T3), diets with 8, 32, 32 mg/kg of chelated Cu, Zn and Mn, at the manufacturer's recommendation (T4) and diets with 4, 16, 16 mg/kg of chelated Cu, Zn and Mn at 100% lower than the manufacturer's recommendation (T5), respectively. Each treatment was replicated ten times with 10 birds per replicate. Egg quality characteristics were evaluated as response criteria in the experiment. Data were subjected to one-way Analysis of Variance in a Completely Randomized Design. At the late-lay phase, egg weight, egg length, egg width and Haugh unit were significantly ($P<0.05$) improved with birds fed T3. A significant ($P<0.05$) increase in percentage albumen, albumen height, percentage yolk and yolk height were observed for birds fed T3 at the late-lay phase. The study concluded that supplementation of chelated trace mineral blends at 100% higher than manufacturer's recommended level in the diets of egg-type chickens resulted in an improved laying performance in respect to the egg quality characteristics of the early-lay birds.

Keywords: Layers, Chelated Trace mineral Blends, Copper, Zinc, Manganese, Egg Quality, Early-lay

INTRODUCTION

Trace minerals, such as Zn, Mn and Cu, are involved in a wide variety of physiological processes, making them essential for optimal bird growth and health (8). They act as catalysts in many enzyme and hormone systems (7) and, as a result, influence growth, bone development, feathering, enzyme structure and function, and appetite (6). These elements are involved in myriad of metabolic and physiological processes which are critical to the general well-being of man and animals. However, subclinical inadequacies, severe deficiency or imbalance of these vital micronutrients results in metabolic disorders which are often expressed as poor growth rate, low feed efficiency, loss of appetite, reproductive disorders, impaired immune response and deficiency diseases in many avian species (1). Organic Trace Minerals (OTM) have been hypothesized to have a higher bioavailability than inorganic salts (2) though their effects on the long term use for pullets has not been documented, its use in premix formulation has been suggested as a potential solution to mitigating mineral pollution. This implies that OTM may be added at a much lower concentration in the diet than ITM, without causing any negative effect on production performance and potentially reducing mineral excretion (4).

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Poultry Unit, Directorate of University Farms (DUFARMS), and Animal Nutrition Laboratory, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. All birds used in these experiments were provided proper care and management and the study protocols were in accordance with the Animal Care Use and Review guidelines of the Federal University of Agriculture, Abeokuta .

Test Ingredients

The chelated organic Zn/Cu/Mn used were obtained from Novus Intl., USA and trace mineral (Cu, Zn and Mn) free premix was formulated at Rotinol, Gbonogun, Odo Eran, Abeokuta, Ogun State.

Diets and feeding management

The egg-type chicken diet that was used in this study was formulated to meet the nutrient requirements of the birds at all phases (5). The treatments included supplementation of trace minerals at recommended level of inorganic supplementation according to NRC, 1994 (16, 64 and 64 mg/kg of Cu, Zn and Mn, respectively) "Positive Control"; supplementation at zero (0.00mg/kg Cu, Zn and Mn, respectively)"Negative Control"; chelated supplementation at 100% higher than manufacturer's recommended level (16, 64 and

64mg/kg of Cu, Zn and Mn, respectively); chelated supplementation at manufacturer's recommended level (8, 32 and 32 mg/kg of Cu, Zn and Mn, respectively); and chelated supplementation at 100% lower than recommended level (4, 16 and 16 mg/kg of Cu, Zn and Mn, respectively). Premix was formulated based on breed specification (without Cu, Zn and Mn dietary supplementation in the control diet) and supplemental levels was defined based on the manufacturer's (Novus Inc.) recommended level of inclusion in diet.

Data Collection

Egg Quality Assessment

Fifteen eggs (3 per replicate) from each treatment were sampled at week ten of early laying period. Quality assessment was done within 24 hours of lay on external (egg weight, egg length, egg breadth and egg shape index) qualities and internal (albumen height, albumen weight, yolk weight, shell weight, shell thickness sand Haugh unit) qualities.

RESULTS AND DISCUSSION

External and Internal qualities of laying chickens fed diets supplemented with chelated organic trace mineral blends (10weeks in lay, Early-lay birds)

Effect of dietary supplementation of chelated organic trace mineral blends on the external and internal egg quality of laying chickens is presented in Table 1 and 2. Chelated trace mineral supplementation increased ($p<0.05$) egg weight from 71.72 g to 76.26 g. Egg weight (g) increased ($p<0.05$) as the level of chelated trace minerals blends supplementation increased (71.72g – 76.26g). Birds fed with diet supplemented with chelated organic trace minerals at 100% increase in manufacturer's recommendation had a superior ($p<0.05$) egg width (54.52 mm) and eggshell thickness (0.65 mm) as compared to the other treatment groups. Eggshell thickness (mm) was similar in inorganic trace mineral supplemented group and groups fed chelated trace mineral supplementation at manufacturer's recommended level. Control groups and chelated supplementation at 100 % lower than recommended level also showed a similar trend for eggshell thickness.

Haugh unit was affected ($p<0.05$) with chelated trace mineral supplementation with birds fed diet supplemented with chelated organic traced mineral blends at 100% higher than manufacturer's recommendation had the best Haugh unit (99.72**).** For the internal qualities, all parameters measured were significantly ($p<0.05$) influenced by trace mineral supplementation. Trace mineral supplementation resulted to improved ($p<0.05$) albumen weight with supplementation of chelated trace mineral at 100 % higher than the recommended level (16, 64, 64 of Cu, Zn and Mn, respectively) had the best ($p<0.05$) weight (74.62%). There was an improvement ($p<0.05$) in the albumen height (ranging from 7.55 mm to 9.31mm) as chelated mineral supplementation increased. Trace mineral supplementation did not influence ($p>0.05$) the colour of the yolk. Yolk height was influenced ($p<0.05$) by various supplementation levels of trace mineral with the control group recording the lowest ($p<0.05$) yolk height (18.27mm). Trace mineral supplementation led to reduced ($p<0.05$) yolk weight.

Birds on diets supplemented with chelated organic trace mineral blends at 100% higher than manufacturer's recommendation had a better ($p<0.05$) yolk width (51.70 mm). Yolk index significantly increased ($p<0.05$) from 0.51 to 0.54. Better Haugh unit observed as a result of trace mineral supplementation showed that trace minerals supplementation (most especially chelated supplementation in treatment 3) improved the egg quality based on the height of the egg white (albumen) of the egg. The observation was similar to those reported by (7) when he fed layers with diet containing Zn and Se bound to an organic molecule. Higher egg mass obtained as a result of chelated trace minerals supplementation indicated that trace minerals supplementation increased HDEP and egg weight. This could have been as a result of chelation which prevented negative interaction between the trace minerals and other nutrients in the gastrointestinal tract of the birds. This was in line with the report of (9).

Higher egg weight observed in groups fed diet supplemented with CTMB at 100 % higher than recommended level (T3) indicated that the combination of chelated Cu, Zn and Mn at 16, 64, 64 mg/kg, respectively was sufficient to support increase in egg weight. It could also be that the amino acid released from the ligands of the chelates were adequate thereby causing increase in the albumen weight and hence, the egg weight. This agrees with the report of (6) when the authors fed diet supplemented with organic Mn to laying hens. The higher eggshell weight could have also contributed to this. The better egg length and width observed in treatment 3 could have resulted from the bigger egg size recorded in this group. This was in accordance to the work of (8) who reported a higher egg weight in layers when the combination of organic Mn, Zn and Se was fed to the birds.

Increased eggshell thickness was obtained in birds fed diets supplemented with chelated organic trace mineral blends at 100 % lower than the recommended levels (4, 16, 16 mg/kg of Cu, Zn and Mn, respectively) not sufficient enough to cause increase in the eggshell thickness. Increased dietary trace minerals which led to an improvement in the eggshell thickness could be attributed to the influence of these trace minerals in the formation of eggshell and eggshell membrane thereby resulting in eggs with better quality shells. This is in line with (3) who stated that the dietary supplementation of layer diets with organic trace minerals improved eggshell quality, provided organic Mn and Zn are added adequately in combination.

Table 1: Effect of chelated organic trace mineral blends on the external egg quality of laying chickens (10 weeks in lay)

Parameters	T1	T2	T3	T4	T5	SEM	P-value
Egg weight (g)	52.17	51.62	53.26	52.93	51.56	0.44	0.274
Egg width (cm)	44.22	43.56	44.32	44.08	43.41	0.15	0.035
Egg length (cm)	53.41^{bc}	52.32^{cd}	58.26^{a}	55.26^{b}	52.86^{c}	0.17	0.061
Egg shape index	0.82	0.83	0.80	0.81	0.83	0.00	0.036
Haugh unit	73.52	74.19	75.52	75.61	73.47	1.22	0.030
Percentage eggshell	8.59	8.52	8.42	8.60	8.53	0.04	0.676
Eggshell thickness (mm)	0.48	0.53	0.55	0.52	0.50	0.00	0.080

^{a,b,c} Means with different superscripts in a row are significantly (P<0.05) different
T1 – Recommended levels for inorganic trace minerals supplementation
T2 – Supplementation at zero level for Cu, Zn and Mn, respectively
T3 – Chelated supplementation at 100 % higher than manufacturer's recommendation
T4 – Chelated supplementation at manufacturer's recommendation
T5 – Chelated supplementation .at 100 % lower than manufacturer's recommendation

Table 2: Effect of chelated organic trace minerals on the internal egg quality of laying chickens (10 weeks in lay)

Parameters	T1	T2	T3	T4	T5	SEM	P-value
Albumen weight (g)	32.50	33.60	34.62	34.86	33.36	0.10	0.640
Albumen height (mm)	5.55	5.39	5.61	5.56	5.34	0.19	0.528
Yolk colour	8.75	8.72	8.85	8.82	8.80	0.02	0.755
Yolk height (mm)	13.27	13.84	14.53	14.16	13.64	0.08	0.298
Percentage yolk	25.68	24.65	24.88	24.72	24.81	0.15	0.082
Yolk width (mm)	31.22	30.87	31.75	32.83	30.85	0.07	0.194
Yolk Index	0.43	0.45	0.46	0.43	0.44	0.00	0.607

^{a,b,c,d} Means with different superscripts in a row are significantly (P<0.05) different
T1 – Recommended levels for inorganic trace minerals supplementation
T2 – Supplementation at zero level for Cu, Zn and Mn, respectively
T3 – Chelated supplementation at 100 % higher than manufacturer's recommendation
T4 – Chelated supplementation at manufacturer's recommendation
T5 – Chelated supplementation .at 100 % lower than manufacturer's recommendation

CONCLUSION

Chelated trace minerals supplementation at 100 % higher than recommended level improved both internal and external egg qualities in layers at the early-lay phase. Chelated Cu, Zn and Mn could be used in the diets of egg-type chickens at 16, 64, 64 and 8, 32, 32 mg/kg, respectively to improve egg qualities in laying phases.

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