COPPER AND IRON SUPPLEMENTATION IN THE DIETS OF LAYING HENS IN THE TROPICAL ENVIRONMENT – EFFECTS ON PRODUCTION TRAITS

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(Received 13 November 1987; accepted for publication 29 April 1988)

ABSTRACT

One hundred and thirty five fifty-two week-old hybrid layers (Hubbard Strain), were allocated to 9 dietary treatments of 15 birds each. The birds were fed, on one of 9 diets, consisting of three levels of supplemental copper: 0, 200 and 400 ppm and three levels of supplemental iron: 0, 100 and 200 ppm for 12 weeks. Per cent day egg production, egg grade, feed intake, efficiency of feed conversion, mortality and body weight change were measured.

No significant effects of copper or iron or their interaction, were observed for any of the traits measured in the study. However, diets supplemented with 100ppm Fe/400ppm Cu, showed slight improvements in egg production and efficiency of feed conversion over the control. The diet supplemented with 100ppm Fe/200ppm Cu also showed the most marked body weight gain.

The results of this study seem to indicate that the effects of copper supplements, equivalent to those found to stimulate growth in pigs and chicks, are of little or no significance in old layers in a tropical environment. The results also showed that concurrent supplementation of copper containing diet with iron is not necessary for old layers.

Key Words: Layers, copper, iron, production.

INTRODUCTION

Copper and Iron have been recognised as essential trace elements for poultry for many years, and, the important functions, which they perform in metabolism, have been determined.

Copper has been used as a growth stimulant in pig feeding (Barber *et al.*, 1955) but knowledge of its effects on poultry performance is limited (Agricultural Research Council, 1975). The limited inquiries to date on the domestic fow have mainly con-

centrated on the effect of copper in the chick. While some workers claimed small improvements in chicks growth resulting from supplement of up to 250mg Cu/kg diet, others have reported no effect or even a growth depression (Smith, 1960). The effects of adding copper and iron to broiler diets have also been investigated (Markus *et al.*, 1969).

Few reports (Thomas *et al.*, 1974; Jackson, 1977; Jackson *et al.*, 1979; Jackson and Stevenson, 1981) depicted the effects of feeding copper as sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) in the

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Nigerian Journal of Animal Production 15(1988); 91-97

diet of laying hens. A consistent finding in most of these experiments has been the marked reduction in food intake and egg production, which accompanies the consumption of diets high in supplementary dietary copper. The reports, however, of the effect of copper at lower levels, have been conflicting. While increased food intake and egg production have been reported (Jackson, 1977; Jackson *et al.*, 1979), Stevenson and Jackson (1980a) did not observe such a difference in their parameters.

The limited information available on the effect of supplemental dietary iron on the performance of farm animals (Bray *et al.*, 1959) seems to indicate that benefits can be derived from its inclusion in livestock rations.

This paper therefore reports investigations on the effects of supplementary copper and iron and their interaction on some production traits in commercial layers, in a tropical environment.

MATERIALS AND METHODS

One hundred and thirty five, fifty-two week-old hybrid layers (Hubbard strain), obtained from the Poultry unit of the Teaching and Research Farm, University of Ibadan, were used in the experiment. The birds had previously been fed on standard starter, grower and layer diets compounded at the University of Ibadan.

The birds were wing-banded, individually weighed and randomly distributed into 9 treatments of 15 birds each, in a way that the initial live weights of the birds in any treatment, were as nearly the same as those of the birds in all the other treatments. The treatments comprised 9 experimental diets, consisting of the basal diet without added iron, and, copper plus graded levels of iron and/or copper, expressed in parts per million (ppm) of the diet in a 3 x 3 factorial design, consisting of 3 levels of copper; 0, 200 and 400 ppm and 3 levels of iron; 0, 100 and 200 ppm, giving a total of 9 diets with varying copper (Cu) and Iron (Fe) as shown below:

Diets	1	2	3	4	5	6	7	8	9
Suppl.									
Cu (ppm)	0	200	400	0	200	400	0	200	400
Suppl.									
Fe (ppm)	0	100	200	200	0	100	100	200	0

The basal or control diet (Table 1) consisted of maize, wheat offal, groundnut meal (GNM) fish meal, oyster shell, salt and vitamin/mineral premix (Zoodry V.M.301). The sources of supplemental copper and iron were crystalline copper sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) and ferrous sulphate ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$) respectively. The crystals were finely ground and mixed with the diets. Samples of the basal diet were analysed for copper and iron contents and the results of the chemical analyses together with the composition of the control diet, in relation to

other ingredients, are given in Table 1.

At the start of the study, all the birds were fed the control diet for one-week adjustment period. Thereafter, each of the nine experimental diets was fed to triplicate groups of five chickens for twelve weeks.

The data collected included individual body weights taken at the beginning and end of the trial, feed consumption of each treatment group determined weekly, egg production, recorded daily and egg size recorded twice weekly. The full experimental results were recorded for the 12 week-period.

Table 1
Composition of control diet (Treatment 1)

Ingredients		Percentage in diet
Yellow maize		50.20
Groundnut cake		15.00
Palm Kernel meal		6.00
Fish meal		1.50
Blood meal		3.00
Wheat offal		13.90
Oyster shell		6.00
Bone meal		4.00
Salt		0.30
*Vitamin-mineral premix		0.10
Total		100.00
Calculated Crude Protein	(%)	17.6
Calculated Calcium	(%)	3.5
Calculated Phosphorus	(%)	0.6
Calculated ME (KCal/kg)		2548
Determined Copper: basal diet (ppm):		38.0
Determined Iron: basal diet (ppm):		761

* Vitamin-mineral premix (Zoodry V.M. 301) supplied the following per kg of diet:

* Vitamin A, 16,675 I.U.; Vit D₃ 3350 I.U;

* Vitamin E, 16.68 I.U.; Vitamin K, 3.35mg; Vitamin B₂, 7.50 mg;

* Vitamin B₆, 5.0 mg; Nicotinic acid, 41.53mg; Calcium — pantothenate, 138.35 mg; Vitamin B₁₂, 0.02mg; Vitamin C, 33.35 mg; Choline Chloride, 33.35 mg; Manganese, 166.68 mg; Iron 83.35 mg; Zinc 66.68 mg; Copper 41.68 mg; Iodine, 2.24 mg; Cobalt 0.34 mg; Selenium 0.08 mg.

All the data were subjected to analysis of variance (Steel and Torrie, 1960) and dif-

ferences among means were compared, using Duncan Multiple Range Test.

RESULTS

A total number of 6 birds died during the 12-week experimental period. One each from treatments 4 and 9; two from treatment 6 and two from treatment 8. All the dead birds were observed to exhibit uterine prolapse and prolapse of the intestine. Tables 2 and 3 show the means and standard errors for the traits measured. Although some differences were observed in each of the parameters, the effects of added dietary copper, or iron or of an interaction between the two were not statistically significant.

Birds on copper-supplemented diets, showed slightly greater body weight gain, than the control birds but a slight depression in body weight occurred with increasing level of dietary iron supplementation. For the interaction between the two elements, the 200ppm Cu-100ppm Fe and 200ppm Cu-200ppm Fe, showed the most marked body weight gain and the most marked body weight loss respectively.

Averaged over dietary iron levels, feed consumption was lower for the copper-supplemented diet than for the control, the value being higher for 400ppm Cu-supplemented diet. The same trend was observed on the laying performance, where the 400ppm level of inclusion of dietary copper resulted in about the same egg production but higher feed conversion efficiency than the control. The birds fed 200ppm Cu-supplemented diet had the lowest feed consumption, the lowest hen-day production and the lowest efficiency of feed conversion into eggs.

The laying performance of the birds in terms of hen-day egg production and efficiency of feed conversion, was best at a dietary iron supplementation level of 100 ppm, when averaged for all the copper levels.

Treatment effects on eggs grades in this study, were not significant.

DISCUSSION

It is difficult to attribute the few deaths recorded in this study, manifested by uterine and intestinal prolapse to dietary supplementation of copper or iron, since Jackson (1977) observed no mortality on one-year old shaver layers fed up to 1920 ppm Cu, a level for in excess of the maximum used in this study.

The lack of apparent effect of added dietary copper on body weight change, feed consumption and laying performance observed in this study is in agreement with published reports (Jackson, 1977; Jackson *et al.*, 1980a, b; and Jackson and Stevenson 1981) where similar observations at lower levels of inclusion than used in this study were recorded. In addition, significant improvements and depressions in the values of the data were also recorded by some of the authors at moderately high and very high levels of inclusion respectively. Although the differences were not significant, the result of this investigation seems to indicate that dietary copper supplementation above 200 ppm would be necessary to improve efficiency of feed conversion in mature laying hens, and that, it may be possible to further improve feed conversion efficiency beyond 2.26kg feed/dozen eggs with copper addition above 400 ppm level, as there was some indication that the 400 ppm level of copper supplementation, could have been near the point, at which improvement in efficiency of egg production would occur.

The lack of statistical significance of treatment effects on egg grade, observed in this study, contrasts with the report of Jackson *et al.* (1979), who observed a significantly higher egg weight at 200mg Cu/kg diet than at 400mg Cu/kg diet. However, total egg weight rather than the proportion of eggs of specified size, was used as a test criterion in their study.

From the results of this study, it appears

Table 2
Mean daily feed intake, efficiency of feed conversion, % hen day egg production, and body weights of laying hens given control and copper and/or iron supplemented diets

	Iron Levels (ppm)		Copper Levels		Average Iron Effect	SEm.
	0	200	400			
Body weight kg						
Initial body weight	0 (1)1.79 (7)1.79 (4)1.80 Average Cu effects 1.79	(5)1.79 (2)1.70 (8)1.85 1.78	(9)1.84 (6)1.80 (3)1.80 1.82	1.81 1.76 1.82		0.59
Final body weight	0 100 200 Average Cu effects	1.91 1.82 1.90 1.86	1.89 1.88 1.81 1.86	1.91 1.83 1.96 1.90		0.55
Body weight change (kg)	0 100 Average Cu effects	0.121 0.029 0.080	0.103 0.184 0.084	0.064 0.031 0.084	0.096 0.081	0.09
Daily feed intake (kg)	0 100 Average Cu effect	131.9 126.3 127.3	123.4 115.7 121.4	121.8 126.4 124.0	125.7 122.8	4.03
Hen day egg production (%)	0 100 Average Cu effect	71.8 72.4 69.5	67.8 62.9 65.6	66.7 72.7 69.2	68.8 69.3	4.86
Efficiency of feed conversion (kg feed/dozen eggs)	0 100 200 Average Cu effect	2.28 2.26 2.44 2.33	2.42 2.30 2.43 2.39	2.26 2.18 2.35 2.26	2.33 2.25 2.41	0.162

SEm = Standard error of estimate

Table 3
Egg grade of laying hens given control and copper and/or iron supplemented diets

	Iron Levels (ppm)		Copper Levels		Average Iron Effect	SEm.
	0	200	400			
Egg grade (%)						
Extra Large	84.6	79.0	79.0	80.9		
Large	11.1	21.0	21.0	17.7		
Extra Large	80.6	56.3	75.5	71.8		
Large	19.2	42.5	21.5	27.7		
Extra Large	83.3	82.8	76.7	81.0		
Large	16.7	17.0	23.3	19.0		
Average Cu effects						
Extra Large	82.8	72.7	78.1	Extra Large	8.71	
Large	15.7	26.8	21.9	Large	8.27	

SEM = Standard error of estimate

that the effects of copper supplements equivalent to those found to stimulate growth in pigs and chicks, are of little or no significance for old layers. Results also showed that concurrent supplementation of copper containing diet (containing up to 400 ppm Cu) with iron with a view to averting possible adverse effects, such as anaemia and copper toxicosis, is not necessary for old layers.

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