Study concerning the effects of using organic trace mineral supplements (Mn and Zn) on egg quality

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SUMMARY

This study aimed to evaluate the influence of Mn and Zn supplements (from organic sources) added to laying hens diets on egg quality. The experiment was conducted for 42 days on 192 Lohmann Brown laying hens (45 weeks old). The birds, housed in cages (2 birds/cage), were divided into 3 groups (C, E1, E2). The three diets had the same basal formulation characterized by 17.96% crude protein and 2724.31 kcal/kg metabolisable energy. The diets for the 3 groups differed by the mineral source, by the level of Mn and Zn from mineral premix, respectively. Diet C had 73 mg Mn (as Mn_2O_3)/kg feed and 64 mg Zn (as ZnO)/kg feed. Diet E1 used the same level of Mn (as manganese chelate of glycine hydrate with 20% Mn) and Zn (as zinc chelate of glycine hydrate with 25% Zn) as diet C. Diet E2 used two times higher levels of Mn and Zn compared to Lohmann Brown Guide Manual (200 mg Mn and 160 mg Zn/kg feed from organic sources). During this experimental study, every two weeks egg samples were collected randomly (18 eggs/group), and 6 samples of yolk, white and eggshell were formed (3 eggs/sample). The results showed that eggshell breaking strength and eggshell thickness were not significantly ($P \leq 0.05$) different between groups. The yolk samples of egg collected from E2 group, contained Zn concentrations significantly ($P \leq 0.05$) higher than in groups C, E1 respectively.

Keywords: hens, Mn, Zn, organic minerals**,** egg, quality

INTRODUCTION

Nowadays, there is a current increasing interest in studying organic or chelated trace minerals that can be easily absorbed and metabolized. The poultry sector, encouraged by the results, has continuously searched for

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further answers in regard to organic trace minerals sources and their utilization in laying hen diets. Most mineral sources used in laying hens diets are derived from inorganic compounds such as oxides, sulphates, carbonates and phosphates. However, organic mineral sources have emerged on the market with the prospect of being more easily absorbed and retained by birds, thereby reducing the excretion of trace minerals that potentially pollute the environment (Zamani et al., 2005). Among other authors, the organic minerals were characterized by AAFCo (2001) as metal ions, chemically link with an organic molecule, forming unique structures and providing stability with high mineral bioavailability. The higher bioavailability of organic minerals is probably related to different mechanism of absorption (by peptide or amino acid uptake mechanisms in the intestine) and to better protection from binding to dietary constituents such phytates and forming of indigestible complexes (Wedekind et al., 1992; Power and Horgan, 2000; Swiatkiewicz et al., 2001). However, the practical results of organic trace mineral supplementation in poultry diets remain controversial, due to the differences between sources and supplementation levels used (Vieira, 2008). Zinc (Zn) and manganese (Mn) are known to have specific roles in avian metabolism, all of which are relevant to the laying hen. Zinc is an integral component of the enzyme carbonic anhydrase (Keilin and Mann, 1939). Subsequently, numerous other zinc enzymes have been discovered (> 200 enzymes) and recently a second group of proteins, probably more numerous than the zinc enzymes have been shown to function in transcription factors (Berg, 1990). Manganese plays an important role as activator of enzyme system in the metabolism of carbohydrates, fats, proteins and nucleic acid, collagen formation, bone growth, eggshell formation and the function of the immune system, involved in enzymes related with oxidative phosphorylation in mitochondria (Avitech, 2002).

The purpose of the present study was to evaluate the effect of using organic trace minerals on egg quality compare to the inorganic trace minerals sources of Mn and Zn.

MATERIAL AND METHODS

The experiment was conducted in an experimental room of IBNA Balotesti, on 192 Lohmann Brown hens, aged 46 weeks, divided into 3 groups with 2 repetitions per group. During the experiment (from 46 to 52 weeks old) the light regimen was 16 hours/day, between 04:30 a.m. and 8:30 p.m. Food and water were provided ad libitum. Diets formulation considered both the nutritional requirements for laying hens (NRC,1994) and Lohmann Brown hybrid producer compliance requirements. The basic structure of experimental diets was the same for all three groups (Table 1).

Table 1. The basic structure of diets

Ingredient	Structure (%)
Corn	32.67
Rice	15
Wheat	15
Rapeseed meal	15
Soybean meal	10
Sunflower oil	1
Monocalcium phosphate	1.06
Calcium carbonate	8.7
Salt	0.3
DL- Methionine	0.16
L Lysine	0.06
Choline	0.05
Premix*	1*
Total	100
Determined crude chemical composition	
Metabolizable energy (ME) kcal/kg	2724.31
Dry matter %	96.47
Crude protein %	17.96
Crude fat %	5.86
Crude fibre %	5.95
Ash %	14.48
Calcium %	3.79
Total phosphorus %	0.68
Available phosphorus %	0.34

***Vitamin-mineral supplied per 1 kg of diet:** (1350000 UI/kg vit.A; 300000 UI/kg vit.D3; 2700 UI/kg vit.E; 200 mg/kg Vit.K; 200 mg/kg Vit.B1; 480 mg/kg Vit.B2; 1485 mg/kg pantothenic acid; 2700 mg/kg nicotinic acid; 300 mg/kg Vitamin B6; 4 mg/kg vitamin B7; 100 mg/kg vitamin B9; 1.8 mg/kg vitamin B12; 2500 mg/kg vitamin C; 7190 mg/kg manganese; 6000 mg/kg iron; 600 mg/kg copper; 6000 mg/kg zinc; 50 mg/kg cobalt; 114 mg/kg iodine; 18 mg/kg selenium; 6000 mg/kg; Premix structure was different between groups by Mn and Zn concentration and source

The vitamin mineral premix of the C group was a conventional one (ZOOFORT produced by IBNA Balotesti) and this was the variable factor in respect of trace minerals source and supplementation level between groups. Diet C had 73 mg Mn (as Mn_2O_3)/kg feed and 64 mg Zn (as ZnO)/kg feed. Diet E_1 used the same level of Mn (as manganese chelate of glycine hydrate with 20% Mn) and Zn (as zinc chelate of glycine hydrate with 25% Zn) as diet C. Diet E2 used two times higher levels of Mn and Zn compared to Lohmann Brown Guide Manual (200 mg Mn and 160 mg Zn/kg feed from organic sources). Productivity parameters monitored in the experiment were: hens weight, average daily feed intake, laying percentage, feed conversion ratio (kg feed/kg egg), average egg weight. Feed ingredients and compound feed samples were sampled and analyzed for: dry matter, protein, fat, cellulose, ash, Ca, P, Mn and Zn according to Regulation (EC) no. 152/2009. At the beginning of the experiment (week 46) and in the final experimental week (week 52) 18 eggs/group were collected and analyzed for physical parameters of eggshell quality: eggshell weight (Kern maximum precision balance (0.01g), thickness (Egg Shell Thickness Gauge, Sanovo engineering A/S, Denmark), breaking strength (Egg Force Reader, Sanovo engineering A/S, Denmark). Of the 18 eggs harvested/group, 6 samples of shell (3 eggs/sample) were formed and analyzed for: ash (gravimetric, SR EN ISO 2171: 2010), Ca (Titrimetric, ISO 64901: 2006), Mn (atomic absorption spectrophotometry, SR EN ISO 6869: 2002) and Zn (atomic absorption spectrophotometry, SR EN ISO 6869: 2002).

Statistical analysis: The analytical data were compared performing analysis of variance (ANOVA), using STATVIEW for WINDOWS (SAS, version 6.0). The differences between mean values within the groups were considered significant at $P<0.05$

RESULTS AND DISCUSSION

Our results were similar to those obtained by Branton et al. (1995), where although the average daily feed intake was not different between the three groups, the laying percentage registered at group E_1 was significantly ($P\leq0.05$) higher compare to C and E2 groups, but at the same group the eggs weight was significantly lower than to the other two groups (Table 2).

Table 2. Productive performances

Specification	C	E1	E2
Initial body weight, kg	1.675±0.155	1.668±0.139	1.668±0.169
Final body weight, kg	1.898±0.109	1.890±0.104	1.858±0.117
Average daily feed intake (g/bird/d)	124.97 ± 7.7	125.74 ± 7.9	124.45 ± 9.0
Egg production (%)	$87.75 \pm 5.9^{b,c}$	91.55 ± 6.2^{a}	90.44 ± 5.3^{a}
Average egg weight (g)	64.21 ± 1.9^{b}	$63.06 \pm 1.3^{a,c}$	63.89 ± 2.0^{b}
Feed conversion ratio (kg feed /kg egg)	1.95 ± 0.13	1.99 ± 0.13	1.95 ± 0.15

Note: Where: a = significantly different (P≤0.05) compared to C; b = significantly different (P≤0.05) compared to E1; c = significantly different (P≤0.05) compared to E2

Other experiments conducted when evaluating the inorganic and organic form of zinc and manganese supplementation do not report effects of organic minerals on production, feed intake and feed conversion (Ludeen, 2001; Sechinato et al, 2006), with the exception of Branton et al. (1995), who observed an laying percentage improvement of birds that received chelated minerals.

As shown in Table 3, there were no significant differences registered, ($P \leq 0.05$) between the three experimental groups in regard to eggshell weight, eggshell thickness, eggshell breaking strength, ashes and calcium content of the eggshell.

Table 3 Quality parameters of eggshell (average values)

Group	C	E1	E2
Eggshell weight , g	8.186 ±0.90	7.886±0.58	8.254 ±0.55
Eggshell thickness, mm	0.38± 0.07	0.38 ± 0.07	0.37 ± 0.06
Eggshell breaking strength, kgF	4.70 ± 0.62	4.75 ± 0.69	4.49± 0.65
Ash, g %	51.39 ± 0.59	51.43 ± 0.35	50.86 ± 0.70
Ca, g%	33.35± 0.27	33.70± 0.82	33.81 ± 0.63

As in our study, similar results were registered by Mabe et al. (2003), who also did not observe an improvement in egg shell thickness of laying hens supplied with different organic sources of trace elements.

The best results found were obtained in experimental group E2. In correlation with the Zn supplementation from E2 diet (160 mg/kg feed), a significant ($P \leq 0.05$) Zn concentration enhancement in egg yolk was registered (Figure 1), compare to C and E1 groups (64 mg/kg feed). A similar situation was registered in Mn concentration of the egg yolk at group E2, compare to C and E1 groups.

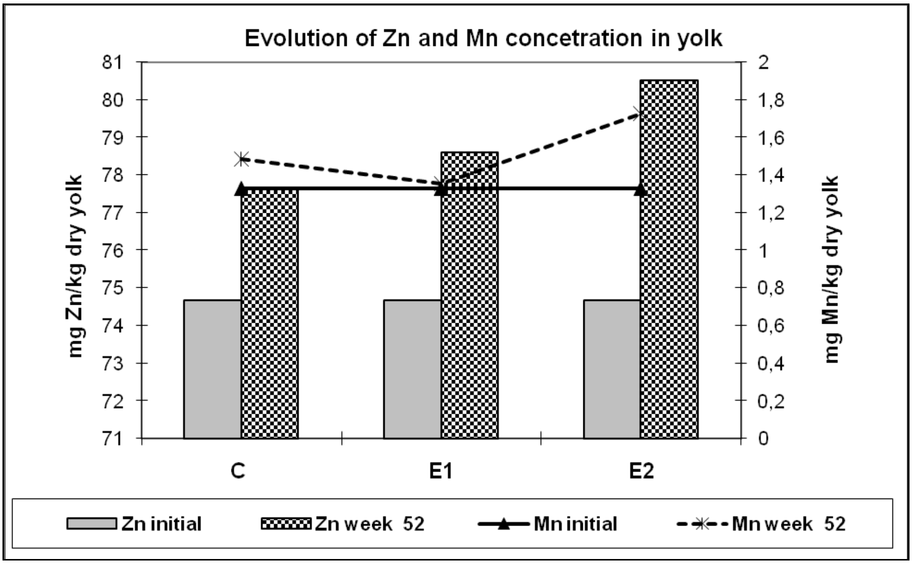

Figure 1 Evolution of Zn and Mn concentration in the yolk

CONCLUSIONS

Concomitant with Zn and Mn supplementation in experimental diets, a significant increase concentration in egg yolk was observed.

Concerning the eggshell quality parameters neither the source, nor the level of the Mn and Zn into diets influenced these studied parameters.

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