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Effects of different levels of dietary Mn and Zn on the distribution of these elements in the blood, tibia, liver, excreta and eggs

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Introduction

Nowadays, eggshell quality represents one of the major concerns of avian industry, with a huge influence on egg economics (profit or loss), and also the percent of hatching eggs. An eggshell breaking resistance and flawless eggs offer protection against egg penetration by pathogens such as pathogenic bacteria Salmonella sp.

It has been estimated that eggs with damaged shells account for 6–10% of all produced eggs, what leads to great economic losses (Washburn, 1982; Roland, 1988). Therefore a great deal of effort has been applied to improving eggshell quality in the fields of genetics, environmental condition, and nutrition, especially mineral nutrition (Nys, 2001). Manganese (Mn) and zinc (Zn), as cofactors of metaloenzymes responsible for carbonate and muco-polysaccharides synthesis, play an important role in eggshell formation (Swiatkiewicz, Koreleski (2008). Mabe et al. (2003)suggested that trace elements as Zn, Mn and Cu could affect mechanical properties of eggshell by effect on calcite crystal formation and modifying crystal-lographic structure of eggshell. Manganese and Zn are essential trace elements, usually supplemented in laying hens diets. However, if the literature already clarified (established) that Mn and Zn ratio have a beneficial effect on the laying hen eggshell quality, there is still lots of discussions concerning which is the level these two trace elements should be supplemented in basal diet to influence positively eggshell's mechanical properties. Inal et al. (2001) found, that 25 mg Mn/kg in the diet is sufficient for maximum egg production but not for optimal shell quality. In the study of Fassani et al. (2000), Mn addition (40–200 mg/kg) to the diet for Leghorn hens in the second cycle of production, improved shell thickness when the diet was supplemented with 200 mg Mn/kg. In the study of Stevenson (1985) high dietary levels of Zn (100 or 200 mg/kg) had no beneficial influence on egg quality measured as eggshell thickness, whereas Zamani et al. (2005) reported, that supplementation of basal diet contained 50 mg Zn/kg with additional amounts of Zn had positive effect on eggshell thickness.

The purpose of this study was to estimate, when Mn and Zn is supplemented in laying hen diets for improving eggshell's mechanical properties, the effect of different levels of both dietary trace elements on their distribution in the blood, tibia, liver, excreted and eggs.

Material and Methods

- ❑ An experiment was conducted on 120 Lohmann Brown Classic layers (22 weeks) for 6 weeks. The layers were assigned to 4 groups (30 layers / 10 cages / group/3 layers/cage) and housed in two tier batteries. The light regim was 16 hours/day, between 04:30 a.m and 8:30 p.m. At the end of the experiment, 6 laying hens/ group were slaughtered.
- ❑Diet formulation considered both the nutritional requirements for laying hens (NRC, 1994) and, also, Lohmann Brown hybrid producer compliance requirements. The groups (C, E1, E2 and E3), received the same basal diet with 2724 kcal/kg metabolisable energy; 17.96% crude protein; 3.79% Ca and 0.68% P.
- ❑The diets differed by the dietary Mn and Zn levels provided by mineral premixes. The commercial premix for diet C included 7190 (mk/kg) Mn and 6000 (mg/kg) Zn. The premixes for the experimental groups included the following levels of trace minerals (mk/kg): 8500 Mn and 14500 Zn (E1); 10000 Mn and 8000 Zn (E2) 20000 Mn and 16000 Zn (E3).
- ❑Throughout the experiment the feed intake of the groups and the egg production were recorded on a daily basis .
- ❑ Intake and excreta samples were taken weekly out of each group.
- ❑ Every two weeks were collected randomly 18 eggs/group. After the physical parameters of quality were determined for collected eggs, there were formed 6 samples/group of egg yolk, egg white and egg shell.
- ❑In the end of the experiment blood sampleswere also collected; 6 hens from each group were thereafter slaughtered and bone and liver samples were collected.
- ❑Out of samples collected during the experiment: feed, excreta, egg yolk, egg white, egg shell, serum, tibia, liver, Mn and Zn concentration were determined. The Mn and Zn concentrations in all the samples were determined by FAAS after microwave digestion.
- ❑All data were processed statistically by StatView and ANOVA. The data strings were characterized (descriptive statistics).

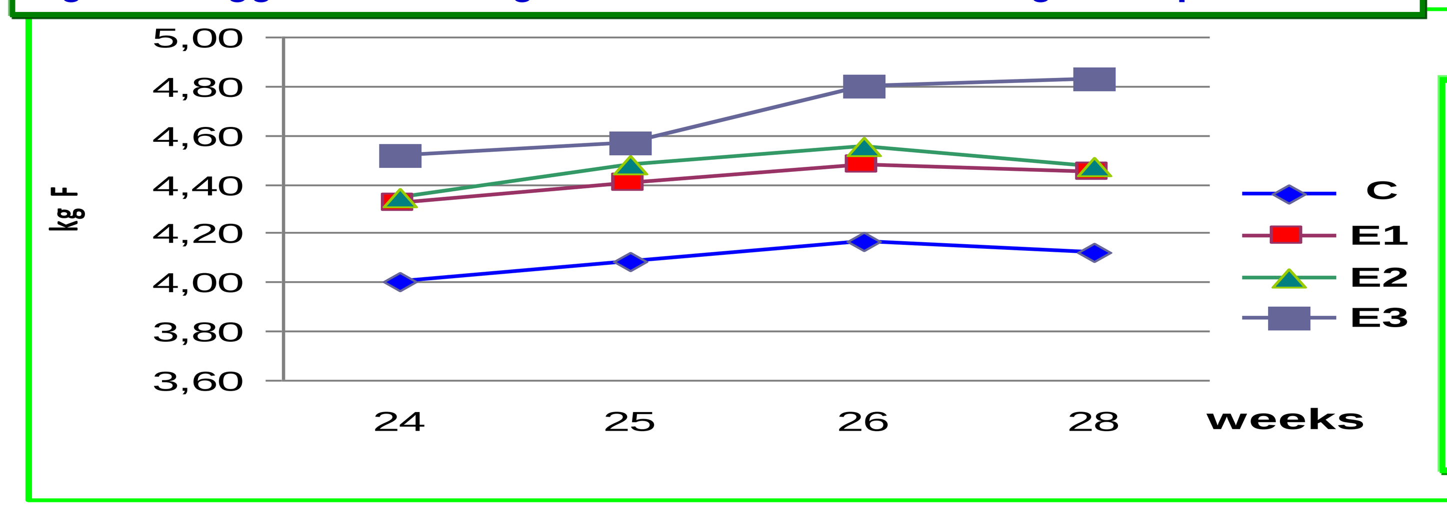
Conclusions

- C group recorded the best productive parameters (consumption, egg production)
- E3 group, which had the highest dietary concentration level of Zn and Mn (Zn 251.8 ppm, 300.8 ppm Mn), obtained the highest eggshell quality parameters regarding eggshell breaking resistance. Taking into consideration that the dietary Ca intake was similar for all groups, it can be concluded that increasing the dietary level of trace elements Mn and Zn had a beneficial effect on eggshell breaking resistance.
- The dietary concentration of Mn was correlated with its concentration in yolk (0879) and whites (0.718). Also, dietary Zn concentration was in good correlation with its concentration in yolk (0.849) and whites (0.877).
- In this experiment, when premixes were used, the best results in terms of egg enrichment in Zn and Mn were obtained in E3 group.

Results and discussion

Productive performances recorded during the experiment revealed that the specific consumption (kg feed / kg egg) in group M (1.971 ± 0.312) was significantly (P ≤ 0.05) lower than those recorded in the experimental groups (E1: 2.14 ± 0.304 , E2: 2.085 ± 0.390; E3: 2.30 ± 0345).

Figure 1- Eggshell breaking resistance evolution during the experiment



The distinction between groups in terms of eggshell breaking resistance (Figure 1) occurred right at the beginning of the experiment. Throughout the experiment, shell eggs E3 (dietary Zn: 251.8 ppm and Mn:300.8 ppm) was significantly(P ≤ 0.05) higher than the values recorded by the other groups.

Table 1- Analitical data obtained as result of blood samples determinations

Group	C	E1	E2	E3
Mn in diets (mg/kg)	142,61	178,38	185,01	300,80
Zn in diets (mg/kg)	112,03	197,69	160,61	251,48
HCT (%)	26,25±2,06	27,50±0,58	26,00±1,00d	27,80±1,48c
HB (g/dL)	7,65±0,54d	8,08±0,43	7,98±0,42	8,40±0,47a
Ca (mg/dL)	20,93±2,40	21,47±3,14	20,34±4,78	24,05±2,94
P (mg/dL)	4,22±0,88	5,02±1,30	5,04±1,48	4,97±0,59
Fe (µg/dL)	389,58±68,72	388,83±33,96	402,45±55,01	403,03±40,91
Mn (µg/dL)	106,82±24,45d	89,37±6,02d	109,01±28,22d	130,23±30,60abc
Zn (µg/dL)	418,33±50,34	395,70±86,08	389,62±63,29	426,12±115,90

where: a, b, c,d – significantly different (p≤ 0.05) from C, E1, E2 respectively E3

Table 2 Trace elements concentration in yolk and egg -white samples

	C		E1		E2		E3	
White								
Mn mg/kg	0,53	0,20	0,56	0,19	0,59	0,17	0,59	0,18
Zn mg/kg	2,31	0,21	2,65	0,48	2,59	0,34	2,67	0,37
Yolk								
Mn mg/kg	2,23	0,35[d]	2,66	0,48	2,58	0,47	2,89	0,32[a]
Zn mg/kg	78,51	1,62[d]	79,46	1,92	80,27	1,29	81,19	1,07[a]

Mn and Zn concentration in yolk of group E3 (table 2), was statistically significant different compared to C (P≤ 0,05). This result is in correlation with the difference between the concentrations of Mn and Zn in E3 diet compared with C group. At E3 group, the concentration of Mn in the diet is 210.92% compared to 224.47% C and concentration of Zn 224,47% compared to C group.

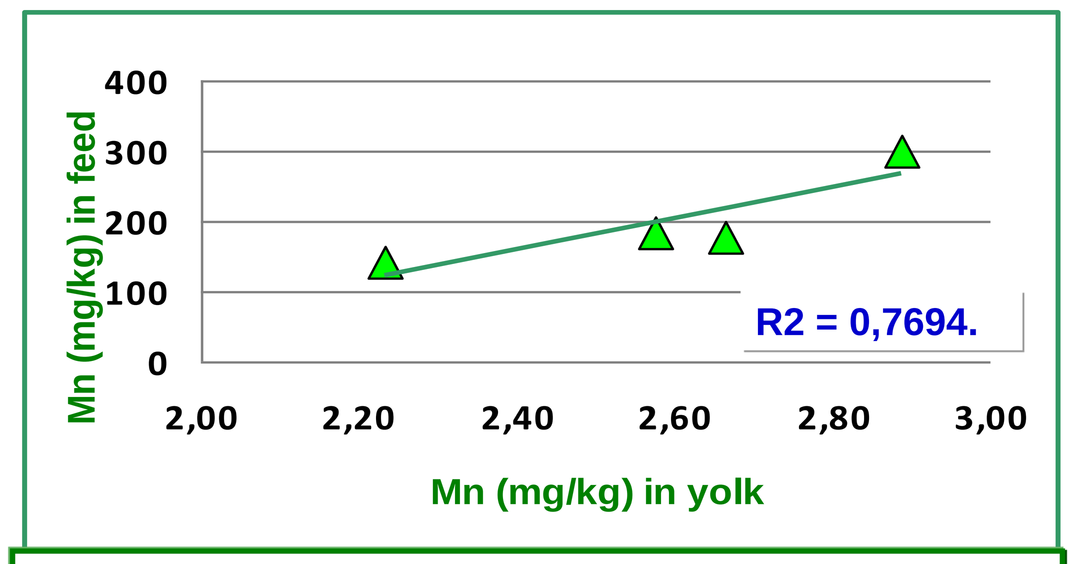


Figure 2- Correlation between Mn content in feed and yolk; Correlation equation:Y = 221,85X – 372,79

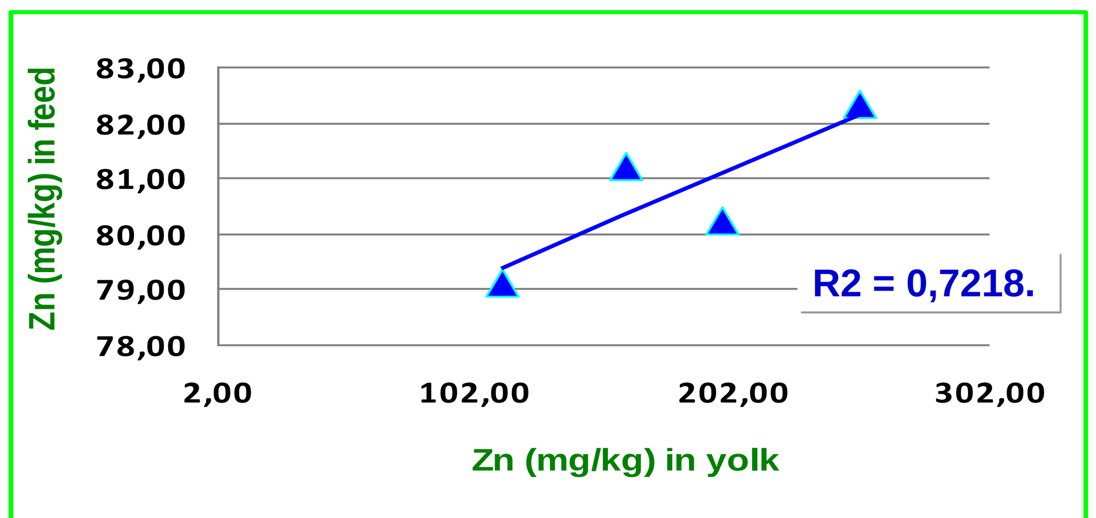


Figure 3- Correlation between Zn content in feed and yolk; Correlation equation: Y = 0,0198X + 77,163

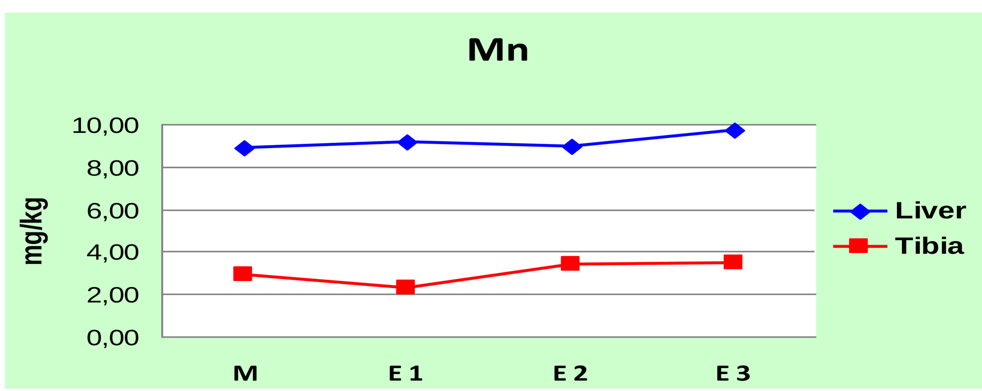


Figure 4- Mn concentration in liver and tibia

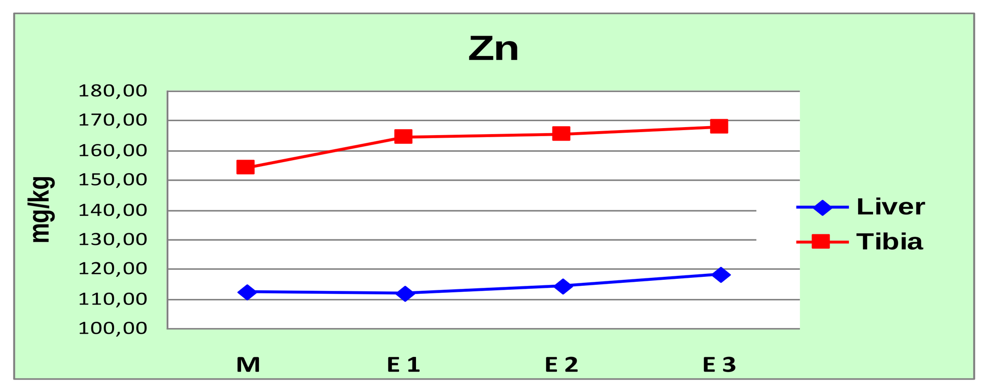


Figure 5- Zn concentration in liver and tibia

There were no significant differences between groups regarding the concentration of Mn and Zn in liver and tibia samples.

Selected bibliography

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