ABSORPTION COEFFICIENTS ASSESSMENT OF CU AND ZN ORGANIC TRACE ELEMENTS AND THEIR DEPOSITION IN EGG YOLK

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Abstract

The aim of this study was to evaluate the influence of Cu and Zn supplements (organic sources) added to laying hens diets on absorption coefficients and egg yolk concentration. The experiment was conducted for 6 weeks on 192 laying hens, housed in cages (2 birds/cage), divided into 3 groups (C, E1, E2). All batches received a similar basal diet (17.96% CP and 2724,31 kcal/kg ME). Diet E1 used the same level of Cu and Zn as diet C, but in chelated form (6 mg Cu/kg and 60 mg Zn/kg). Compared to C, diet E2 had the same level of Cu (inorganic source) but the Zn concentration was 160 mg /kg from organic source. Every two weeks, egg samples were collected randomly (18 eggs/batch). During the balance weeks, all droppings were daily collected in order to form average weekly samples/cage, from which Cu, Zn was determined by FAAS. The apparent absorption coefficients of Cu did not differ significant, but it was noticed a slight increasing of Cu coefficient for the group which received organic Cu: 20.89% (E1), 18.83% (E2) vs 17.45% (C). Organic source of Zn lead to a better absorption, significant uninsured, for E1 (12.70%) and E2 (15.60%) compared to C (9.07%). Alternatively, the analytical results showed a significant ($P \leq 0.05$) improvement of Zn concentration in egg yolk for E2 (75.86±1.51 mg/kg) compare to C (71.19±2.23 mg/kg) and E1 (73.24±2.24 mg/kg). The chelate source of trace minerals can be a way of obtaining Zn enrichment eggs but only using amounts of Zn above conventional rate.

Key words: hens, Zn, Cu, organic minerals, egg yolk

INTRODUCTION

Marker parameters of animal metabolism (absorption coefficients, excreta concentration, target tissues storage, etc.) show that an appropriate level (according to requirements and rules) of minerals in food, ensures adequate quantities of minerals in tissues. Therefore, the analysis of the mineral content of the feed can sometimes be an indication of the minerals content that the organism needs to satisfy. Poultry feed supplementation with minerals is essential for the following reasons: areas of concentrations of trace elements in the feed are very different, depending on a various number of factors such as: soil-plant relationships, vegetation stages, the variation between different parts of the plant (grains, leaves, etc.), feed production technology.

Many plant foods, especially cereal grains and legumes, have a high content of zinc but the bioavailability is low due to the presence of phytate [9]. As for cooper, its absorption is affected by nteractions with phytate, ascorbic acid, fibre, tannin etc. which appear to complex with copper [2] and other trace elements.

Zn is essential for several body functions and has three general physiological roles: catalytic, structural and regulatory.

Zn-dependent enzymes can be found in all known classes of enzymes [6] and Zn appears to be part of more enzyme systems than all of the other trace minerals combined [7].

Cooper is involved in mitochondrial oxidative phosphorylation, free radical detoxification, neurotransmitter synthesis and

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denaturation, pigment formation, connective tissue synthesis and Iron (Fe) metabolism [12], [3].

Laying hens diets are commoly supplemented with Cu, Fe, Mn, Zn, which are added in animal diets as salts – the conventional sources, although in the recent years the unconventional sources – organic ones or the natural are required [11].

Until now, Panel on Additives and Products on substances used in Animal Feed (FEEDAP) [4] opinions indicate that the organic forms of trace elements generally have somewhat higher bioavailability compared to their inorganic counterparts.

The present study describes the obtained results of an, where the objective was to assess the effets of laying hen diets supplemented with different levels and sources Zn and Cu on absorption coefficients and egg yolk concentration.

MATERIAL AND METHOD

The experiment was conducted in an experimental hall on 192 Lohmann Brown hens, aged 46 weeks, divided into 3 batches of 2 repetitions per batch. During the experiment (46 to 52 weeks) the light regimen was 16 hours/day. Food and water were provided ad libitum. Diet formulation considered the nutritional requirements for laying hens (NRC, 1994). The basic structure of the diets was the same for all three groups and included: corn (32.67), rice (15%), wheat (15%), rapeseed meal (15%), soybean meal (10%), sunflower oil (1%). The diets were characterized by: 2724.31 kcal/kg metabolizable energy, 96.47 % dry matter, 17.96 % crude protein, 3.79 % Ca and 0.34% available phosphorus. The conventional premix structure of the diets was different between groups by different sources of Zn and Cu, and in case of Zn, a different level of inclusion rate, also. Diet E1 used the same level of Cu and Zn as diet C, but in chelated form (6 mg Cu/kg and 60 mg Zn/kg). Compared to C, diet E2 had the same level of Cu (inorganic source) but the Zn concentration was 160 mg /kg from organic source. Diet E2 used two times higher levels of Zn compared to Lohmann Brown Guide Manual (80 mg Zn/kg feed).

Raw materials and compound feed samples were collected and physico-chemical parameters were determined according to the methods of Regulation (EC) no. 152/2009 [9].

Two periods (five days each) of mineral balance were performed in the forth and the sixth week. A daily recording of feed consumption, feed leftovers and excreta were registered. During the balance period, samples of ingesta and excreta were recorded based on chemical determinations. Absorption coefficients assessment of Cu and Zn from feed were calculated based on chemical determination realized from ingesta and excreta samples, corroborated with daily recordings of feed consumption and excreta quantity. Apparent absorption coefficient represents the ratio: (absorbed mineral / ingested mineral quantity)*100, where the absorbed quantity represents the difference between the ingested amount and the excreted amount.

At the beginning of the experiment (week 46) and in the final experimental week (week 52) 18 eggs/batch were collected and analyzed for physical parameters and concentration of Cu and Zn.

Stat View software was utilized to calculate the evolution of mineral consumption and excreta during the experiment, as well as the existent correlations during the balance periods.

RESULTS AND DISCUSSIONS

Mineral balace was calculated as described above and the results are shown in table 1. A difference between groups can be noticed from data presented in the table, concerning the amount of zinc ingested/ excreted, also in case of absorption coefficients, for E2 group compared to C.

Table 1 Apparent coefficients absorption (%) of minerals from ingesta (average values/ group)

	Balance parameters	Control	E1	E2
Zinc	Ingested (g/ hen/day)	28.79 ± 4.18	28.24 ± 5.27	36.19 ± 5.67
	Excreted (g/ hen/day)	26.17 ± 3.47	24.66 ± 4.37	30.54 ± 5.20
	Absorption (%)	9.07 ± 2.8	12.70 ± 1,41	15.60 ±4.52
Copper	Ingested (g/ hen/day)	3.47 ± 0.41	3.52 ± 0.72	3.31 ± 0.62
	Excreted (g/ hen/day)	2.86 ± 0.24	2.78 ± 0.32	2.69 ± 0.57
	Absorption (%)	17.45 ± 2.42	20.89 ± 3.12	18.83 ± 2.11

These results were expected taking into consideration the amount of anorganic/organic zinc, included in premix (60 ppm Zn for C and 160 ppm Zn for E2).

In case of balance parameters, the highest values of Zn were calculated for E2 batch, but due to unexpected variability of the results, the averages could not be statistically assured. The obtained results confirm the expectations, considering that E2 group received a higher Zn supplementation in the diet.

Similar results were obtained by Plaimast [10] who noticed no significant difference in the level of zinc deposition in the yolk when inorganic (zinc sulphate) and organic (zinc amino acid chelate) sources sources were used, both at levels of 60, 300, 600, respectively.

Using the same level of Cu concentration for all three batches, but the varied sources: E1 (organic source) and C, E2 (inorganic source), the apparent coefficients of copper registered the highest value for E1 batch. The obtained values points a higher bioavailability of organic source of Cu compare to inorganic source, the results being without any statistically significance. As presented in table 1, the lower coefficient obtained for E2 batch, compare to E1, can be explained by the Cu-Zn antagonism, a higher supplementation of Zn into diet, giving a slight inhibition of Cu absorption.

Similarly, Henry and Miles [5] observed mineral interactions may be one-way, such as this negative effect of zinc on copper, in which the reverse effect is not observed.

Data concerning Zn concentration in egg yolk, shown an insignificant difference between those batches that received the same Zn concentration, but using different sources: organic vs. inorganic (M and E1).

The group E2, the organic form with the highest inlusion rate of Zn (160 mg/kg) registered an increased yolk concentration, significantly different (P≤0.05) compared to C group.

Relating Zn concentration to the weights of egg components, significantly higher values were obtained for E2 group compared to C, improved egg yolk in Zn being obtained (Figure 1).

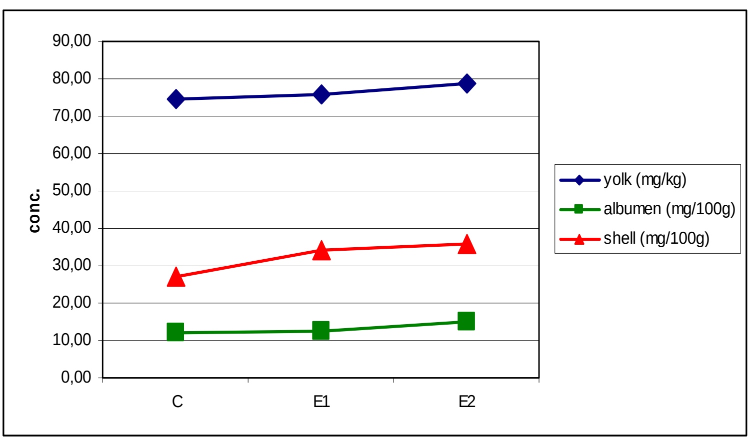

Fig. 1 Zn concentrations in egg components

Table 2 Zn amounts from egg components

	C	E1	E2
mg Zn/yolk	1.25 ± 0.07 [c]	1.29 ± 0.10	1.36 ± 0.06 [a]
mg Zn/albumen	0.04 ± 0.02	0.05 ± 0.02	0.06 ± 0.03
mg Zn/shell	0.02 ± 0.001	0.02 ± 0.01	0.03 ± 0.01

Where: a = significantly different from C; b = significantly different from E1;
c = significantly different from E2

The results shown in table 2, in case of egg yolk, an increasing by 8.8% of Zn content to batch E2 compared to C.

Autors like, Yang [13] shown in their experiments that egg zinc content increased by 55.67 and 70.21 % when laying hens fed diets were fed two different levels of zinc 240 and 840 mg/kg as inorganic form, compared to C who received 60 mg/kg zinc.

Bahakaim [1] observed an increased zinc concentration in egg, when 150 mg/ kg of organic source Zn as zinc methionine supplementation was added in diets' layers.

Figure 2 presents the percentage distribution of Zn amounts in egg components. Calculated percentages are conformable for all three batches.

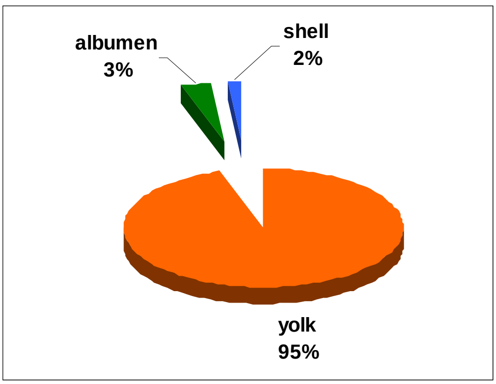

Fig. 2 Zn distribution in egg components

In Plaimast's [10] study, the deposition of zinc in the egg yolk was about 99% of the total zinc in the whole egg.

The results concerning Cu elimination through faeces and the deposition in egg yolk are presented in table 3.

There were no significantly differences of Cu concentrations in egg yolk, between studied batches, taking into consideration that inclusion percentage of Cu in diets was similar, although the source of Cu was different (organic vs. inorganic).

Table 3 Study concerning Cu utilization in organism and its deposition in egg yolk

	Premix mg/kg	Faeces mg/kg	Yolk mg/kg
C	600	678.58 ± 54.47	2.42 ± 0.22
E1	600	689.74 ± 27.35	2.60 ± 0.15
E2	600	725.03 ± 32.01	2.62 ± 0.19

CONCLUSIONS

Under the conditions of this study, it was concluded that the highest dietary supplementation of Zn, from organic source, lead to yolk enrichment, therefore proving a higher bioavailability. Further studies are required in order to study the interactions among trace minerals as Cu and Zn, and their absorption, metabolism and excretion in laying hens, using organic and inorganic forms at different levels of rate inclusion.

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