Effects of Manganese and Iron Organic Sources in Layer Diets on Nutritional Quality of Eggs

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Abstract

Organic trace minerals present a higher bioavailability and stability, therefore lower rates of inclusion in feed will be needed to meet the poultry nutritional requirements which will lead to a lower environmental output. The purpose of this study was to determine the effect of total replacement of the inorganic Mn and Fe salts by organic forms of these elements on nutritional quality of eggs and on apparent absorption coefficients. The study was conducted on 192 laying hens, 2 birds/cage, divided into 3 groups (C, E₁, E₂). All groups received a similar diet (17.96% crude protein (CP) and 2724.31 kcal/kg metabolizable energy (ME)). Diet E₁ used the same level of Mn and Fe as diet C, but in chelated form (71.9 mg Mn/kg and 60 mg Fe/kg). Compared to C, diet E₂ had the same level of Fe (inorganic source) but the Mn concentration was 200 mg/kg (organic source). Every two weeks, egg samples were collected randomly (18 eggs/group). All droppings were daily collected in order to form average weekly samples/cage, from which Mn, Fe was determined by FAAS. The analytical results showed a significant ($P \leq 0.05$) increasing of Mn concentration in egg yolk for E₂ (1.84 ± 0.28 mg/kg) compare to C (1.46 ± 0.16 mg/kg) and E₁ (1.59 ± 0.30 mg/kg). The apparent absorption coefficients of Fe and Mn were higher for E₂ compare to the other two groups (E₁, C). A possible explanation of these results could be the existent interactions between the trace elements found in animal organism, a high concentration of Mn being able to influence positively the absorption of Fe in organism. The chelate source of trace minerals can be a way of obtaining Mn enrichment eggs but only using amounts of Mn above conventional rate.

Keywords: *chelated minerals, egg quality, Fe, laying hens, Mn*

Introduction. Chelates benefits consist of greater physical stability, which reduces the separation of trace elements and vitamins in feed oxidation and increases their adoption (Stanacev *et al.*, 2013). Some authors noticed no differences between inorganic and organic sources of Mn or Zn (Swiatkiewicz and Koreleski, 2008), others suggested that use of organic sources of Mn substantially affects laying performance and eggshell quality (Sun *et al.*, 2012). However, there is an impairment of iron absorption when high levels of manganese are fed (Baker & Halpin, 1991).

Aims and objectives. The purpose of this study was to determine the effect of total replacement of the inorganic Mn and Fe salts by organic forms

of these elements (C and E₁). For E₂, the effects of organic Mn supplementation and an inorganic form of Fe were studied on the nutritional quality of eggs and on apparent absorption coefficients.

Materials and methods. A study was carried out on 192 Lohmann Brown laying strain, divided into 3 groups of 32 cages/group (2 hens/cage), in an experimental house provided with digestibility cages. All groups received a similar diet (17.96% CP and 2724.31 kcal/kg ME). Diet E₁ used the same level of Mn and Fe as diet C, but in chelated form (71.9 mg Mn/kg and 60 mg Fe/kg). Compared to C, diet E₂ had the same level of Fe (inorganic source) but the Mn concentration was 200 mg/kg (organic source). During the study, all droppings were daily collected in order to form average weekly

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

Balance parameters		C	E ₁	E ₂
Manganese	Ingested (g/ hen/day)	23.26 ± 2.18	21.01 ± 2.74	34.36 ± 5.02
	Excreted (g/ hen/day)	19.26 ± 3.21	17.60 ± 3.02	26.47 ± 2.94
	Absorption (%)	17.19 ± 1.05 ^c	16.25 ± 1.54 ^c	22.91 ± 3.07 ^{a,b}
Iron	Ingested (g/ hen/day)	53.28 ± 5.27	53.10 ± 6.41	55.05 ± 6.01
	Excreted (g/ hen/day)	33.65 ± 6.07	31.69 ± 5.21	32.03 ± 7.13
	Absorption (%)	36.82 ± 4.82	40.28 ± 5.42	41.82 ± 6.02

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

samples/cage. The following characteristics were evaluated: feed intake, feed conversion, production, eggs weight, egg shell thickness and egg shell breaking strength. At the beginning of the experiment and in the final experimental week 18 eggs/group were collected, 6 samples/group of shell and yolk were analyzed for: dry matter, ash, Mn and Fe according to Regulation (EC) no. 152/2009.

Results and discussion. Table 1 presents data concerning the amount of manganese ingested/excreted and the absorption coefficients, for E₂ group compared to C and E₁, calculated according to total collection technique described by Ajmal Khan (2003).

The absorption coefficient for Mn was significantly higher for E₂ compared to C and E₁. Using the same level of Fe concentration for all three groups, but the varied sources: E₁ (organic source) and C, E₂ (inorganic source), the apparent coefficients of iron registered the highest value for

E₂ group, but the results are without any statistically significance. At the end of experiment, the analytical results showed an improvement of nutritional quality of eggs in terms of significant ($P \leq 0.05$) increasing of Mn concentration in egg yolk for E₂ (1.84 ± 0.28 mg/kg) compare to C (1.46 ± 0.16 mg/kg). No statistically differences were registered for Fe concentrations in yolk samples.

Conclusion. The apparent absorption coefficient of Mn was higher for E₂ compare to the C. The chelate source of trace minerals can be a way of obtaining Mn enrichment eggs but only using amounts of Mn above conventional rate.

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Fig. 1. Iron (a) and manganese (b) concentrations in egg yolk during the experimental period