Animal Feed Science and Technology 232 (2017) 182–189

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Dietary administration of glycine complexed trace minerals can improve performance and slaughter yield in broilers and reduces mineral excretion

M. De Marco[a,*], M.V. Zoon[b], C. Margetyal[a], C. Picart[a], C. Ionescu[b]

[a] NEOVIA Group, Talhouët, Saint Nolff, B.P. 80234, 56006, Vannes Cedex, France
[b] PANCOSMA S.A., Voie des Traz 6, 1218, Le Grand Saconnex, Geneva, Switzerland

ARTICLE INFO

Keywords:
Broiler chicken
Trace minerals
Metal chelates of glycine hydrate
Metal chelates of amino acids hydrate
Excretion
Breast yield

ABSTRACT

The aim of this study was to compare the effects of iron (Fe), copper (Cu), zinc (Zn) and manganese (Mn) supplementation from different sources on performance, slaughter characteristics and mineral excretion of broilers. Metal chelates of glycine, hydrate (GC) were compared to inorganic sources (sulfates and oxides, SO) and metal chelates of amino acids, hydrate (AC). 4800 one day-old broilers (Ross PM3) were randomly assigned to 6 treatments, each consisting of 8 pens (1:1 sex ratio). A diet without trace mineral supplementation served as negative control (NC). The positive control (PC) was NC with a full dose of trace minerals (FD) as SO: Cu, Fe, Zn and Mn at 10, 30, 80 and 100 ppm respectively. GC½ = NC + ½FD as GC, GCFD = NC + FD as GC, AC½ = NC + ½FD as AC, ACFD = NC + FD as AC. Feed intake (FI), body weight (BW), average daily gain (ADG) and feed conversion ratio (FCR) were determined per pen. At day 31, excreta samples were collected in 3 pens per treatment. At day 35, 50 birds were slaughtered and yields were recorded. Differences were tested by one-way ANOVA, followed by Tukey's post hoc test ($P < 0.05$). After 35 days, chickens fed NC showed a lower FI, ADG and BW than PC ($P < 0.001$, $P = 0.001$, $P = 0.001$). GC½ and GCFD showed the same performance and using GC½ enables to achieve PC performance. AC½ and ACFD were also equivalent. However, AC½ was just enough to achieve PC performance, showing a statistically lower performance than GCFD. FCR was not affected. Breast weight and yield were affected by treatments ($P = 0.026$, $P = 0.021$). GCFD showed the highest breast weight and yield and GC½ was enough to reach and even exceed the breast characteristics of PC. AC½ showed the lowest carcass characteristics, its breast weight and breast yield being significantly lower than results obtained with GCFD. GC½ and AC½ lead to a significant intermediate mineral excretion between NC and PC ($P < 0.001$). Mineral excretion with AC was always higher than with GC.

1. Introduction

Trace minerals such as iron (Fe), copper (Cu), zinc (Zn) and manganese (Mn) play important roles in various body functions by

Abbreviations: AC, metal chelates of amino acids hydrate; ADFI, average daily feed intake; ADG, average daily gain; BW, body weight; Cu, copper; FCR, feed conversion ratio; FD, full dose; Fe, iron; FI, feed intake; GC, metal chelates of glycine hydrate; Mn, manganese; NC, negative control; PC, positive control; SD, standard deviation; SEM, standard error of the means; SO, sulfates and oxides; Zn, zinc

* Corresponding author.
E-mail addresses: mdemarco@neovia-group.com (M. De Marco), mieke.zoon@pancosma.ch (M.V. Zoon), cmargetyal@neovia-group.com (C. Margetyal), cpicart@neovia-group.com (C. Picart), catherine.ionescu@pancosma.ch (C. Ionescu).

http://dx.doi.org/10.1016/j.anifeedsci.2017.08.016
Received 14 June 2017; Received in revised form 20 August 2017; Accepted 21 August 2017
0377-8401/

providing structure to bones, being part of many enzymes activities, hormones secretion pathways and playing important functions in the immune defense system (Underwood and Suttle, 1999; Bao and Choct, 2009; Richards et al., 2010). Fe is an essential element in all living organism, important for oxygen transport, mitochondrial respiratory chain and cell proliferation (Milanović et al., 2008) and is involved in energy metabolism, neurotransmitter synthesis, and phagocyte antimicrobial activity, as well as in the synthesis of DNA, collagen, and bile acids (Shi et al., 2015). Cu is an essential microelement for animals, present in many enzymes systems in the body, serving as a cofactor for example for superoxide dismutase, cytochrome oxidase or ceruloplasmin (Świątkiewicz et al., 2014). Zn is necessary for the functional and structural integrity of more than 300 Zn-dependent enzymes and a large number of functional proteins (Jahanian et al., 2008). It is involved in gene expression, in the modulation of appetite control, fat absorption and anti-oxidant defense (Salim et al., 2008). In all species a Zn deficiency is linked to lack of appetite, retardation of growth, skeletal and reproductive disorders (Sadoval et al., 1999; Underwood and Suttle, 1999). Moreover, Zn is essential in the immune system modulation of avian species, being a cofactor of many enzymes and hormones (e.g. superoxide dismutase, deoxythymidine kinase, thymulin) involved in it (Kidd et al., 1996). The functions of Mn can be linked to the metalloenzymes, which are activated by this element. It is involved in cartilage development, blood clotting, as well as in lipid and carbohydrate metabolism. Its deprivation can cause skeletal abnormalities, ataxia and reproductive disorders (Underwood and Suttle, 1999).

In commercial broiler diets, trace minerals are commonly supplemented in the form of inorganic salts, such as sulfates, oxides, and carbonates but their bioavailability is low (high rates of loss due to dietary antagonisms). For all the reasons described above, they are usually provided with large safety margins to support high performance and avoid deficiencies, which is easy because of their low costs. It results in trace minerals dietary inclusions that are much higher than those recommended by the National Research Council. This causes excess mineral accumulation in soil has been shown to reduce crop yield caused by soil phytotoxicity and potentially contaminates surface and underground water supplies (Mohanna and Nys, 1999; Nollet et al., 2007; Zhao et al., 2010).

In recent decades, based on the hypothesis of their potentially higher bioavailability than inorganic salts, the use of organic trace mineral sources has been suggested as a solution to reduce mineral feed supplementation and consequently excretion, without decreasing performance. In literature, several studies report the efficacy and stability of organically complexed or chelated trace minerals in comparison with inorganic forms (Bao et al., 2007; Nollet et al., 2007, 2008; Aksu et al., 2011; Yang et al., 2011; Manangi et al., 2012). However, the results show variable effects of using organic trace minerals on growth performance, mineral excretion, immune system, and carcass yields. El-Husseiny et al. (2012) showed that birds fed a diet supplemented with 50% Zn + 50% Mn + 50% Cu, added as organic minerals, improved growth performance, carcass characteristics, tibia quality accompanied by an increase in trace mineral deposition in tibia, liver and excreta compared to the chickens fed inorganic trace minerals. Similar results were obtained by Sirri et al. (2016), who showed that diets containing organic minerals (Zn, Cu and Mn) lead to a higher body weight and a better feed conversion in comparison with diets based on inorganic minerals.

On the contrary, other authors observed no significant differences between birds fed inorganic or organic minerals on growth performance (Nollet et al., 2007; Yang et al., 2011). These differences can be partly attributed to different factors. The first factor is that trials are performed at different trace mineral basal level in the diet which can influence the response to additional trace element supplementation. The second factor is that organic trace mineral sources can have various chemical forms, being either protein or amino acid chelated metals (methionine chelated or glycine chelated being the most studied). Moreover, all these studies are usually carried out by comparing inorganic with a sole organic trace mineral source. Nowadays, on poultry just few studies are available on the equivalence of different organic sources thus making it difficult to understand the differences between the products available on the market (Huang et al., 2009, 2013; Zhang et al., 2016). Moreover in those studies just single organic trace minerals were compared.

For these reasons, the aim of this trial was to evaluate the effect of Cu, Fe, Zn and Mn supplementation on growth and mineral excretion of broilers by comparing inorganic sources (a combination of sulfates and oxides) to two organic sources: metal chelates of glycine, hydrate and metal chelates of amino acids, hydrate.

2. Materials and methods

The experimental protocol and all procedures used during the trial were designed according to the guidelines of the current European and French laws on the care and use of experimental animals (European directive 2010/63 EU).

2.1. Trace mineral sources

In this trial, the following trace mineral sources (Cu, Fe, Zn, Mn) were compared: inorganic trace minerals as sulfates and oxides (Cu, Fe from sulfates and Zn, Mn from oxides; SO), metal chelates of glycine, hydrate trace minerals (GC) and metal chelates of amino acids, hydrate trace minerals (AC).

2.2. Experimental design, birds and diets

A total of 4800 one-day-old Ross PM3 broiler chickens with an average initial body weight of 37.1 g ± 0.1 (SD) were used in this trial. The experiment was conducted over 35 days. At day 0, chicks were weighed and randomly assigned to 6 treatments, each consisting of 8 pens as replicates (100 chicks/pen; sex ratio 1:1). Each pen was 5.5 m^2 and equipped with two feeders, seven nipple drinkers and wood shavings as litter. During the first week of the experiment, the chicks were kept at 32 °C. The temperature was reduced by 2–3 °C every week until the final temperature of 20–22 °C was reached. Lighting schedule was 23 h light: 1 h darkness