Trace organic minerals as a replacement of inorganic sources for layers: effects on productivity and mineral excretion.

A. BORUTA[1], E. SWIERCZEWSKA [1], K. GLEBOCKA[2*] and L. NOLLET[3],

[1] The Faculty of Animal Sciences, Warsaw Agricultural University, 8 Ciszewskiego Str., 02-786 Warsaw, Poland; [2]Alltech Poland, 82 Byslawska Str., 04-968 Warsaw, Poland; [3]Alltech Netherlands, , Ridderkerk, The Netherlands

***Corresponding author: kglebocka@alltech.com**

The aim of the recent study was to evaluate the effectiveness of a complete replacement of the inorganic form of minerals (Cu, Zn, Mg and Fe) supplemented to layers feed with an organic form (Bioplex®, Alltech Inc.) at lower inclusion level. The trial was performed on Hy-Line® laying hens placed in individual cages. Birds were on trial from week 30 to 70. Birds were assigned to four dietary treatments; each treatment consisting of 48 hens in 6 repetitions of 8 animals. Groups were given feeds supplemented with inorganic or organic form of minerals in the following concentration: Control (15ppm Cu, 60ppm Zn, Mn and Fe (all inorganic sources)): 8, 17 and 33 % of inorganic concentration as organics. Performance, bone strength and mineral excretion were measured and statistically analyzed by ANOVA. Performance (lay and FCR) was similar in all the groups. Control layers consumed significantly (P<0.05) more feed than the group receiving 17% organics. A significant improvement was noted in bone strength (P<0.01) and a reduction of faecal concentration of minerals (P<0.05) in the organic groups compared to the control. The organic form maintained performance at a dosage 12 times lower compared to the commercial inorganic level.

Key words: laying hens; organic minerals supplementation; mineral excretion; productivity

Introduction

In developed countries, livestock production and animal productivity have been always pushed to the limit. Laying hens are one example, where flock management has been designed to optimize production of the highest quality product. However, the current trend requires efficiency in all aspects of the production system. Efficient poultry production requires that all the essential nutrients in the diet must be provided in adequate amounts and in forms that are most biologically useful for the animal.

Animal tissues contain mineral elements in variable amounts which are needed to survive and for efficient poultry production. Most of the advances in understanding the nutritional requirements of minerals in poultry production were made focusing on avoiding deficiencies in the different phases of production. The requirements for broilers and laying hens for calcium (Ca) and phosphorus (P) are reasonably well known (NRC, 1994), but information on trace mineral requirements and related effects on aspects such as immune function, resistance to disease, growth and carcass composition are still limited (NRC, 1994). In addition, in the last two decades the negative effects certain minerals being excreted into the environment have became important. In this aspect, the impact of P on the environment is still the most studied but contamination with copper (Cu), zinc (Zn) and other minerals is also important.

Decreasing the mineral content in poultry manure through nutritional changes is one approach to reduce environmental contamination. Accurate estimates of mineral requirements for each type of production, selecting mineral sources according to bioavailability (organic or inorganic) and the use of phytases can help to implement strategies to reduce mineral contamination and cost of production.

The objective of this study was to evaluate the effectiveness of replacing an inorganic source of trace minerals supplement (Cu, Zn, Mg and Fe) with an organic source in laying hens diets.

Materials and methods

The experiment was conducted at the Agricultural Experimental Site "RZD Wilanow-Obory" facilities, under the scientific supervision of the Faculty of Animal Sciences of the Warsaw Agricultural University (Warsaw, Poland), in compliance with the Polish legislation on experimental animals.

One hundred and ninety-two (30 wk of age) Hy-Line® layers (Hy-Line International, West Des Moines, IA. USA) were randomly allotted to one of four dietary treatments, each treatment consisting of 48 hens in 6 repetitions (A – F) of 8 animals. The dietary treatments included: a control group (100 % inorganic mineral supplementation: 15ppm Cu, 60ppm Zn, Mn and Fe) and three treatments in which the inorganic source of minerals was replaced by an organic one (Bioplex®, Alltech Inc): 8, 17 and 33 % of mineral concentration being supplemented as organic form respectively.

Birds were housed in individual cages compiled into a cage battery. A randomized complete block design was used with blocks based on physical location of the cages within the barn. Birds were randomly distributed to each of four dietary treatments within each block with six replicate battery cages of eight layers per cage. The experiment lasted 40 weeks and a two-phases feeding scheme (weeks 1- 22 and 23- 40 of the trial) was applied. Feed intake and refusal were recorded on a weekly basis. Egg production, numbers of dirty, broken and shell-less eggs was registered daily. For each treatment repetition the averaged egg weight per week was computed and registered.

At 40th, 55th and 70th week of hens' age, fecal samples were collected for DM and mineral analyses. The mineral content of the fecal samples was determined by flame atomic absorption spectrophotometry (FAAS) on a Shimadzu AA-660 spectrophotometer. At the end of the experiment 3 birds from each repetition (18 birds per treatment) were randomly selected and euthanized in order to determine bone strength. The right femur bone was removed and samples were stored at -20°C until analysis. Three-point bone breaking test was performed on a Zwick 1445 Machine (ZWICK GmbH). Laboratory analysis and bone performance test were carried out at Warsaw Agricultural University.

Bird performance, mineral excretion and bone strength data were analyzed as a complete block design by ANOVA (Statistica, 1995). Followed by post hoc pair wise comparisons (Tukey-Kramer test; Snedecor and Cochran, 1989).

Results and discussion

Birds remained healthy throughout the experiment. Table 1 shows the effects of experimental treatments on laying hens performance. Production performance was similar in all the groups. Although no significant, a numerical improvement was noticed on laying percentage, egg mass (g) and feed conversion in Bioplex® supplemented chickens.

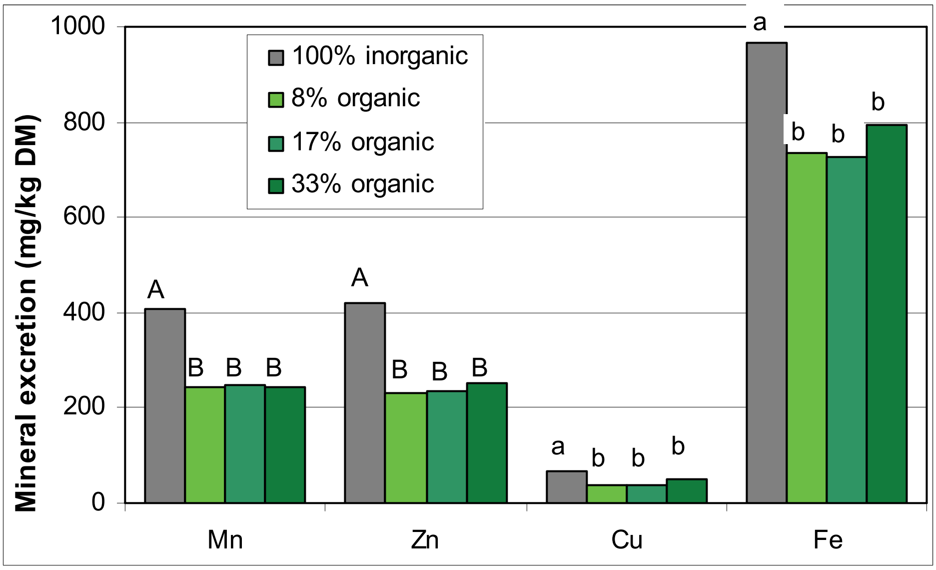
Table 1 Performance of laying hens receiving inorganic or organic mineral supplementation

	100% inorganic	8% organic	17% organic	33% organic
Egg weight, g	66.08	65.43	65.84	65.16
Lay, %	87.81	89.87	91.07	89.23
Egg mass, g (egg weight x lay)	57.98	58.75	59.91	58.08
Feed intake, g	125.46^{a}	123.97	122.89^{b}	123.59
FCR	2.17	2.11	2.05	2.13

^{a,b} different superscript indicate significant differences at P<0,05

Control fed layers consumed significantly ($P < 0.05$) more feed than hens fed treatment number 3 (17 % of organic mineral inclusion). Statistical analyses did not show any other significant difference between the dietary treatments.

Figure 1 shows the results of the analysis performed in faecal samples. Regardless of trace element, Bioplex® supplemented birds showed a significant reduction of mineral faecal excretion compared to control fed birds. Copper and iron analyses showed significant difference ($P < 0.05$) while in case of manganese and zinc the difference was highly significant ($P < 0.01$). This was achieved in majority probably due to lower level of minerals added to feed. At the same time, clearly this decreased level of supplementation was enough to maintain the production level commercially acceptable.



^{A,B} different superscript indicate significant differences at P<0,01
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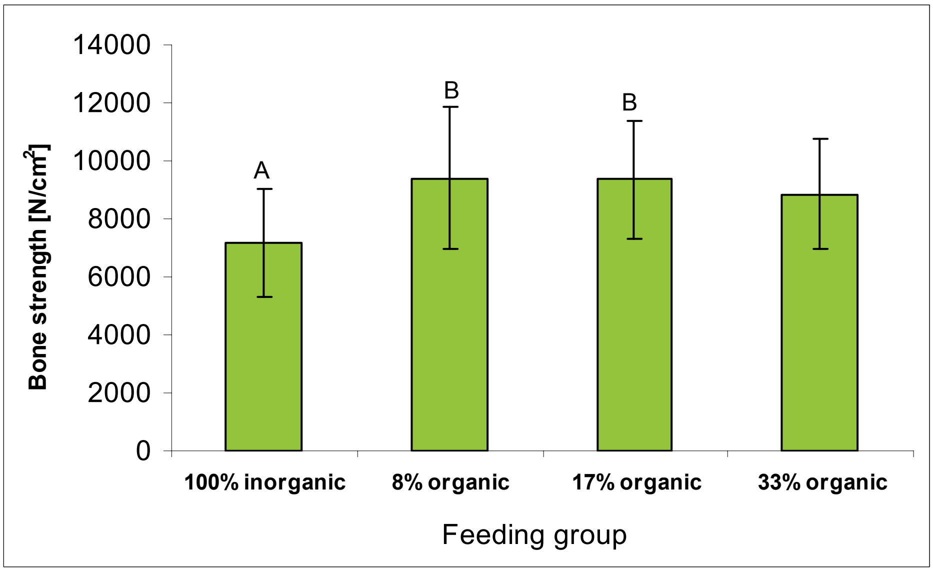
Figure 1. Mineral excretion in feces depending on the amount and mineral form in the feed



^{A,B} different superscript indicate significant differences at P<0,01

Figure 2. Femur bone strength of hens fed either inorganic or organic (Bioplex®) source of trace minerals

Figure 2 illustrates the results of the effects of experimental treatments on laying hen's bone strength. Birds fed with either dietary treatment with 8 or 17 % of Bioplex® showed increased bone strength ($P \leq 0.01$) than control fed hens (100% inorganic). This result suggests better retention of minerals in bones, which is especially important in animals under intensive production by long periods of time. Weak mineral status might be a reason of poor hens' productivity or even culling.

In conclusion, the organic form of minerals supplemented in hens' feed maintained performance at a dosage 12 times lower compared to the commercial inorganic level. Bone strength was improved by organic minerals supplementation showing better animal status. Mineral excretion was reduced compared to the inorganic control, being favorable for the environment. Full replacement of inorganic minerals with an organic form is possible, effective and safe (for animal and environment). Based on the above results the use of Bioplex® can be recommended in egg production farms because they are effective regarding animal performance, better utilized by animals and safer for the environment.

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