The effect of bioplexed trace minerals in broiler diets on production performance and mineral retention

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Livestock is generally fed highly concentrated diets with an excess of nutrients to enable maximized performance. However, this leads to high mineral concentrations (N, P, Cu, and Zn) in manure, exceeding crop requirements and mineral deposition in soil. The use of organically complexed minerals has been suggested, because of an assumed higher bioavailability than inorganic salts. This would imply that Bioplex minerals (Alltech Inc., USA) can be utilized at a much lower concentration in the diet than inorganic minerals, without a negative impact on production performance. This trial was conducted to compare mineral retention, mineral excretion and performance of broiler chickens fed inorganic or organic minerals. 2,040 Mixed sex Ross 308 day-old broilers were randomly allocated to 12 floor pens (170 birds per pen). A three-phase 50% wheat/soybean based diet was used, containing AME 12.2 MJ/kg and CP 21% in starter; AME 12.4 MJ/kg and CP 21% in grower and AME 12.7 MJ/kg and CP 20% in finisher phase. 70 ppm Mn, 37 ppm Zn, 45 ppm Fe and 12 ppm Cu were added as sulphates to the control diet and compared with a test diet containing organic minerals by addition of Bioplexes (Bioplex Mn, Zn and Fe with 10 ppm and Bioplex Cu with 2.5 ppm). Body weight gain, feed intake and feed conversion ratio (FCR) were measured at 14d, 29d and 39d. At day 26, mineral retention was calculated based on feed and droppings analyses. At day 37, carcass mineral deposition was determined in eight broilers per treatment (two pooled samples of four birds). In the starter period, broilers fed the Bioplex diet tended to have a lower FCR compared to the control diet (P= 0.060). No significant differences were observed in production performance during the other feeding phases. Fecal analysis showed that the broilers fed the Bioplex diet excreted lower levels of Mn (46%), Zn (63%), Fe (73%) and Cu (55%), which was anticipated due to the higher mineral intake levels on the control diet. The calculated mineral retention (as % of feed intake) was higher in the Bioplex diet, except for Cu. Retention (in mg) was similar for Zn and Fe for both treatments. Mn and Cu retention was reduced in the Bioplex diets by 20% and 60%, respectively. Mn content in broiler carcasses was lower for the Bioplex test group (-38%), whereas the contents of the other minerals were similar. It was concluded that Bioplex minerals can be utilized at a much lower dietary inclusion level than the recommendations for inorganic minerals, without a negative impact on performance, while also decreasing the mineral excretions.

Keywords: organic minerals; broilers; retention; excretion

Introduction

Diets for livestock are traditionally supplemented with inorganic mineral salts (like oxides and sulphates) to avoid mineral deficiencies. Deficiencies in trace minerals coincide with a wide variety of clinical and pathological disorders as trace minerals fulfill a central role in many metabolic processes. Deficiencies can be caused by inadequate mineral intake or by the presence of antagonists in the diet.

In the Western world, livestock is generally fed highly concentrated diets, which are formulated to provide an excess of nutrients to enable maximized performance. Today, large-scale commercial livestock production systems, have given rise to many environmental concerns, because mineral (e.g. nitrogen, phosphorus and trace minerals) concentrations in manure can lead to mineral depositions that exceed crop nutrient requirements. This awareness stimulated discussions to decrease the mineral supplementation levels in livestock nutrition. The use of organically complexed or chelated minerals in premixes for livestock diets have been suggested, based on the hypothesis that such mineral complexes have a higher bioavailability than inorganic salt analogues. This would imply that bioplexes can be utilized at a much lower concentration in the diet than inorganic minerals, without a negative impact on production performance. Reducing dietary inclusion levels would result in smaller mineral excretions. Leeson (2003) has indicated that chelated trace minerals (Bioplex Products) are at least 30% more bioavailable than inorganic trace mineral salts when fed to broilers. Alltech produces several Bioplex mineral products and is performing research focused on judging the value of these products in target animals.

In this experiment the effect of bioplexed manganese, zinc, iron and copper on production performance of broilers were determined. Besides that, measurements were performed on the effect of the Bioplex products on overall mineral excretion, retention and deposition levels, when compared to the traditional trace mineral supplementation.

Material and methods

A broiler performance trial was performed in September 2005 with two treatments consisting of six replicates. The experiment was done as a randomized block design. 2,040 mixed sex Ross 308 day-old broilers were randomly allocated to 12 floor pens (170 birds per 10 m^2). A 50% wheat/soybean based diet was used in three phases of feeding (AME 12.2 MJ/kg and CP 21% in starter; AME 12.4 MJ/kg and CP 21% in grower and AME 12.7 MJ/kg and CP 20% in finisher). Inorganic minerals were added as sulphates (70 ppm Mn, 37 ppm Zn, 45 ppm Fe and 12 ppm Cu) to the control diet and compared with a test diet containing organic minerals by addition of Bioplexes (Bioplex Mn, Zn and Fe with 10 ppm and Bioplex Cu with 2.5 ppm).

Body weight gain, feed intake and feed conversion ratio were determined from day 1-14, 15-29 and 30-39. The litter score on days 14 and 21 was visually determined by four experienced persons on a scale of 1 (very wet litter) to 10 (very dry litter). On day 26, mineral retention was calculated from feed and droppings analyses. Droppings samples were taken from birds in all pens (12 samples in total) for analyzing the mineral content. For this purpose, ten birds per pen were selected and placed in separate cages. The light was turned down (approx. 15 minutes) until enough droppings were collected (minimum of 50 gram per cage of ten birds) for mineral analysis. After collecting the droppings, birds were returned to their original pen. The collected droppings were homogenously mixed per pen and analyzed for Mn, Zn, Fe and Cu contents to determine the level of mineral excretion.

On day 37, carcass mineral deposition was determined in eight broilers per treatment. The eight selected broilers per treatment originated from two different replicates (4 birds/pen). This resulted in two mixed samples per treatment that were analyzed for Mn, Zn, Fe and Cu contents, to determine if mineral deposition in bird carcasses was similar for the inorganic and Bioplex mineral supplements.

Results and discussion

In the starter period (day 1-14) feed conversion ratio (FCR) tended to be significantly influenced by treatments ($P= 0.060$). No significant differences in production performance were observed in the other feeding phases or the overall growth period. The litter quality did not differ between treatments on day 14, for all pens were scored equally. No statistical analysis was performed for this parameter. On day 21, the litter quality was scored higher in the pens with the control diets but this did not significantly differ from the Bioplex diet. The results are summarized and presented in Table 1.

Table 1. Technical performance of the broilers per experimental treatment

Treatment Description	1 Control	2 Bioplex diet	LSD (P<0.05)	P-value
Day 1-14:				
Body weight, g	463	466	10	0.419
Feed intake, g	534	529	13	0.355
FCR	1.269	1.246	0.024	0.060
Mortality, %	2.1	1.5	1.6	0.383
Day 15-29:				
BWG, g	1059	1065	34	0.651
Feed intake, g	1763	1771	32	0.551
FCR	1.665	1.663	0.039	0.869
Mortality, %	0.8	1.7	1.4	0.167
Day 30-39:				
BWG, g	899	914	73	0.616
Feed intake, g	1853	1866	61	0.598
FCR	2.070	2.050	0.169	0.763
Mortality, %	1.1	0.8	1.3	0.578
Day 1-39:				
Weight, g	2421	2445	87	0.495
Feed intake, g	4154	4163	44	0.607
FCR	1.747	1.733	0.068	0.616
Mortality, %	3.9	3.9	1.7	0.985
Litter quality day 14[1)]	7.0	7.0	-	
Litter quality day 21	5.6	5.4	0.7	0.693

[1)] Higher values indicate a better litter quality (1= wet litter; 10= dry litter)

On day 26, mineral excretion was calculated from droppings (faeces plus urine) analyses. In Table 2 the results are given per treatment. Assuming DM digestibility of both feeds are similar, droppings analysis showed that the broilers fed the Bioplex diet excreted lower levels of Mn (46%), Zn (63%), Fe (73%) and Cu (55%), which was anticipated due to the higher mineral intake levels of the control diet.

Table 2. Analyzed Mn, Zn, Fe and Cu faecal excretion per treatment on day 26 (mg/kg dry matter)

Treatment	Mn	Zn	Fe	Cu
Inorganic	380	277	707	48.2
Organic	177	175	520	26.7

The mineral retention was calculated from mineral contents in feed and droppings, based on an assumed dry matter digestibility of 72%. It is shown in Table 3 that the mineral retention (as a % of intake) was higher in the Bioplex diet than in the control diets, except for Cu. Retention in g was similar for Zn and Fe indicating that the dietary mineral level can be reduced when Bioplex minerals are used instead of inorganic minerals. For Mn and Cu retention (mg) was reduced in the Bioplex diets by 20% and 60% respectively, which can possibly result in carcass depletion.

Table 3. Calculated mineral retention from mineral contents in feed and droppings, based on an assumed dry matter digestibility of 72%.

	Control feed	droppings	retention		Bioplex feed	droppings	retention	
			%	mg			%	mg
Manganese (mg)	117	380	9	11	58	177	15	8
Zinc (mg)	95	277	18	17	66	175	26	17
Iron (mg)	237	707	16	39	184	520	21	38
Copper (mg)	22	48.2	39	9	11	26.7	32	4

On day 37, carcass mineral deposition was determined in eight broilers per treatment. In Table 4 it is shown that Mn retention in broiler carcasses was lower for the Bioplex test group (-38%) than the control group, whereas the retention of the other minerals was similar. It should be mentioned that measurements done on mineral retention and carcass contents should be treated with care due to the short balance period and the small amount of broilers sampled for carcass analyses.

Table 4. Analyzed mineral content (mg/kg) in broiler carcasses.

Treatment	Sample	Mn	Zn	Fe	Cu
Control (inorganic)	1	11.9	42.3	287	24.8
	2	12.2	39.3	271	23.7
	Mean	12.0	40.8	279	24.2
Bioplex (organic)	1	8.1	43.8	258	22.3
	2	6.6	36.5	270	22.4
	Mean	7.3 (-38%)	40.1 (-2%)	264 (-5%)	22.3 (-8%)

The results of this experiment show that production performance did not significantly differ between treatments, except for the starter phase. In the starter phase, broilers fed the diet with supplemented organic minerals tended to have a lower feed conversion ratio than broilers fed the control diet. Droppings (faeces plus urine) analysis showed that the control diet broilers excreted higher levels of Mn, Zn, Fe and Cu, but the mineral intake levels were also higher on the control diet. Feeding the Bioplex minerals resulted in a lower Mn and Cu retention in mg, but Zn and Fe retention did not differ between treatments. For Mn also a lower Mn concentration in the carcass was observed. Production performance parameters were not negatively affected by the lower dietary mineral supplementation levels.

It can be concluded that Bioplexes can be utilized at a much lower concentration in the diet than the current recommendations as inorganic minerals, without a negative impact on performance, while also decreasing the excess mineral excretion.

References

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