Effects of the mineral premix based on phosphate fritte with chelated bioelements on broiler performance

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ABSTRACT

The purpose of the study was to quantify broiler performance following the use of PM – BC 126 (mineral premix with chelated bioelements) produced by SC Cerasil SA, Oradea, in the compound feeds formulation. The biological test was conducted on 1040 COBB broilers, during 0-42 days of age. The broilers were assigned to 4 groups, a control (C) group and three experimental groups (E1, E2 and E3) with 260 broilers per groups (4 groups × replicates × 130 broilers). The broilers were phase-fed according to their age: start (0-14 days), grower-developer (15-28 days) and finisher (29-42 days) compound feeds formulations. For each stage of growth, based on the chemical analyses of the raw feed ingredients, compound feeds formulations (control formulations) were developed based on corn, soybean meal, full fat soy, fish meal, 0.5% vitamin premix and 0.5% classical IBNA premix (trace elements from inorganic salts). In the experimental groups, the classical mineral premix was replaced by PM – BC 126 as follows: 0.1% (E1), 0.5% (E2) and 1% (E3). The results show that PM – BC 126 can replace the classical mineral premix throughout the growth period (0-42 days); broiler performance was better (+3.21% up to 3.35% weight gain and 1.54%-2.05% lower feed conversion ratio). The cost of feed by kg of weight gain also decreased by 1.07% compared to the control group. The replacement of the classical mineral premix with 1% PM – BC 126 was not economically justified.

Keywords: mineral premix with chelated bioelements, broilers, body weight, feed conversion ratio, economic efficiency

INTRODUCTION

Sufficiently large amounts of minerals are required for a normal animal feeding; the minerals are needed for bone formation and they also play a functional role in sugar and lipid metabolism, in maintaining the osmotic pressure, in regulating the acid-base balance, in maintaining cell permeability and for the neuro-muscular activity (Stoica, 2001).

The metallic chelates are chemical structures consisting of a metal atom and ligands that act as donor of electrons, while the metal atom is acceptor. The chelated substances were first developed by Werner (1901) and their name comes from the Greek *chelos* which means pliers. According to Kratzer and Vohra, cited by Miloş and Drînceanu (1980), is of particular importance because the formation of soluble chelates ensures the presence of minerals bonded by chelates to the liquid from the areas of intestinal absorption, thus favouring their absorption. The use of chelated trace elements started after 1930. The minerals need to meet several conditions so as to be absorbed: they have to be chelated with amino acids; the molecular mass of the chelates must not exceed 1000; their pH should be the specific one; certain specific alkalis, acids and enzymes are required for absorption)Reddy, 1992). PM – BC 126 (*mineral premix with chelated bioelements*), produced by SC Cerasil SA Oradea, consists of phosphatic *fritte* (glass melted at 1280 -1300°C and cooled suddenly, which dives fine, irregular glass grains). The *fritte* thus obtained is an inorganic chelates based on rings of condensed polyphosphates (with 4-6 bonds), the bioelements acting as ligands of the metallic ions. These rings produce complex structures with behaviour similar to that of the organo-metallic chelates.

The biological test was conducted in the experimental farm of the National Research-Development Institute for Animal Biology and Nutrition, to quantify the productive performance of using PM – BC 126 in broiler diets.

MATERIAL AND METHODS

The biological test was conducted on 1040 COBB broilers, during 0-42 days of age. The broilers were assigned to 4 groups, a control (C) group and three experimental groups (E1, E2 and E3) with 260 broilers per groups (4 groups $\times$ replicates $\times$ 130 broilers).

Table 1 Composition of PM- BC 126

Bioelements	**g/ kg premix**
P	158.600
Na	118.680
Ca	96.920
Mg	58.50
Fe	11.000
Cu	2.110
Zn	12.610
Mn	9.960
Co	0.096
Se	0.120
K	0.138
I	0.456
TOTAL	469.190

The broilers were phase-fed according to their age: *start* (0-14 days), *grower-developer* (15-28 days) and *finisher* (29-42 days) compound feeds formulations. For each stage of growth, based on the chemical analyses of the raw feed ingredients, compound feeds formulations (control formulations) were developed based on corn, soybean meal, full fat soy, fish meal, 0.5% vitamin premix and 0.5% classical IBNA premix (trace elements from inorganic salts). In the experimental groups, the classical mineral premix was replaced by PM – BC 126 as follows: 0.1% (E1), 0.5% (E2) and 1% (E3).

The compound feeds formulations were isoprotein, isoenergy and had similar levels of total and digestible lysine, sulphur amino acids and were in agreement with the feeding requirements for the intensive broiler rearing. The following nutrients were supplied for each stage of growth: 2960 kcal. metabolisable energy/kg feed, 22.70% crude protein, 0.92% methionine+ cystine, 1.38% lysine, 1.0% calcium and 0.50% available phosphorus (*start*); 3116 kcal. metabolisable energy/kg feed, 21.70% crude protein, 1.0% methionine+ cystine, 1.30% lysine, 0.90% calcium and 0.45% available phosphorus (*grower-developer*); 3227 kcal. metabolisable energy/kg feed, 19.05% crude protein, 0.90% methionine+ cystine, 1.14% lysine, 0.90% calcium and 0.45% available phosphorus (*finisher*), (Table 2).

Table 3 shows the composition of the classical IBNA mineral premix (trace minerals and inorganic salts).

The broilers had free access to the feed and water.

The broilers were housed under microclimatic conditions similar to those in a poultry farm with floor rearing, on permanent litter (wood shavings) in separate pens for each group and replicate, with 24h light regimen.

The following parameters were monitored:

§ Average feed intake (g);
§ Body weight gain by growth stage (g);
§ Average daily weight gain by age period (g)
§ Feed conversion ratio (kg feed/kg gain);
§ Stock liveability (%);
§ Economic efficiency (%)

Statistic calculations

The data were processed statistically by variance analysis, using the Fisher test and to assess the significant differences between the experimental groups, with the Student test; the differences between groups were considered statistical for $P<0.05$.

Table 2 Compound feed formulation by broiler age (%)

Period / ingredients	Start (0 – 14 days)	Grower-developer (15 – 28 days)	Finisher (29 – 42 days)
Corn	51.22	49.37	52.79
Soybean meal (44% CP)	21.50	17.70	-
Full fat soy (35% CP)	18.00	23.00	40.30
Fish meal (60% CP)	5.00	3.50	-
Corn gluten (60% CP)	-	-	2.00
Oil	-	2.30	-
Monocalcium phosphate	1.40	1.34	1.73
Calcium carbonate	1.15	1.11	1.43
Salt	0.40	0.30	0.30
Vitamin premix with coccidiostatic (start + grower)	0.50	0.50	-
Vitamin premix without coccidiostatic (finisher)	-	-	0.50
Mineral premix*	0.50	0.50	0.50
DL - methionine	0.18	0.27	0.26
L- lysine HCl	0.07	0.03	0.13
Choline HCl 60%	0.08	0.08	0.06
TOTAL	100	100	100
Analysed			
ME Kcal/kg	2960	3116	3227
Crude protein	22.70	21.70	19.05
Methionine, total	0.55	0.65	0.51
Methionine, available	0.44	0.51	0.46
Methionine +Cystine, total	0.92	1.00	0.93
Met. + Cys., available	0.81	0.90	0.82
Lysine, total	1.38	1.30	1.14
Lysine, available	1.20	1.13	1.00
Calcium	1.00	0.90	0.90
Phosphorus, available	0.50	0.45	0.45

*- In the experimental groups, the mineral premix was replaced by "PM- BC 126" in the following amounts: 0.1% (group E1); 0.5% (E2); 1.0% (E3).

Table 3. Structure of the classical IBNA mineral premix (mg/kg CF)

Mineral	Source	mg
Mn	Manganese oxide 62%	100
Fe	Ferrous sulphate 20%	80
Zn	Zinc oxide 80%	80
Cu	Copper sulphate 25%	8
Co	Cobalt chloride 25%	0.25
Se	Sodium selenite 45%	0.15
I	Potassium iodide 76%	1.0

RESULTS AND DISCUSSION

Table 4 shows data on boiler performance. Until the age of 28 days, broiler bodyweight were not influenced significantly (P> 0.05) by the dietary level of mineral premix with chelated bioelements, as replacer of the classical mineral premix. Broiler weight at 42 days was 2006.10 g in group C, 2069.56 g in group E1, 2069.59 g in group E2 and 2071.93 g in group E3, with significant differences between the experimental groups and the control group (P< 0.05).

The cumulated gain, over the experimental period was 3.22% higher in group E1, 3.21% higher in E2 and 3.35% higher in E3 as compared to the control group.

Feed conversion ratio was 1.95 kg CF/kg gain in group C, 1.92 kg CF/kg gain in group E1 and E2 and 1.91 kg CF/kg gain in group E3, being 1.54% and 2.05%, respectively, lower than in group C.

Stock liveability was not influenced by the type of mineral premix or by the inclusion rate in any of the experimental period.

The economic efficiency was higher in the experimental groups E1 and E2 as follows: CF cost/kg achieved weight gain was 1.07% lower in E1 and 0.30% lower in E2 compared to C. In group E3, CF cost/kg achieved weight gain was 0.56% higher than in C, which shows that this variant is not profitable economically. No other major effects of the administered diets were noticed.

Table 4 Effects of the rate of classical mineral premix replacement by the premix with chelated bioelements on broiler performance

	Control (classic mineral premix)	**Experimental (premix with chelated bioelements)**		
	C (0.5%)	**E1 (0.1%)**	**E2 (0.5%)**	**E3 (1.0%)**
Initial weight[1)] (g)	44.52	44.87	45.04	44.56
Weight at 14 days[1)] (g)	385.00	394.04	394.71	396.24
Weight at 28 days[1)] (g)	1171.90	1163.27	1177.23	1160.46
Final weight at 42 days (g)	2006.10[b]	2069.56[a]	2069.59[a]	2071.93[a]
Total period (0-42 days)				
Cumulated gain (g)	1961.58	2024.69	2024.55	2027.37
Average daily gain (g/day)	46.70	48.21	48.20	48.27
Differences, compared to C (%)	100	103.22	103.21	103.35
Cumulated feed intake (kg)	3.818	3.897	3.894	3.892
Average daily feed intake (g/day)	90.90	92.79	92.71	92.67
Feed conversion ratio (kg feed/ kg gain)	1.95	1.92	1.92	1.91
Stock liveability (%)	97.31	97.69	96.92	98.46
CF cost (% compared to C)	100	100.04	100.90	101.96
CF cost /kg gain (% compared to C)	100	98.93	99.70	100.56

[1)] Not significant differences (P>0.05)

[a, b] – means in a row with different superscripts differ significantly (P<0.05)

Contrea et al. (1968) cited by Miloş and Drînceanu (1980), showed that the metallic ions with the phosphoric acid precipitate as insoluble phosphate in broiler gut, but chelation prevents their inactivation. Contrea and Miloş (1970), cited by Miloş and Drînceanu (1980), used in poultry diets inorganic polymers such as condensed phosphates, polyphosphates and metaphosphates as chelating agents of the metallic ions with role of trace elements. The live weight gains were higher in all experimental variants in which chelated macroelements were used than in the groups treated with the same mineral levels, but unchelated.

Using the disodium salt of EDTA as chelating agent, in broiler diets, Kratzer (1969), cited by Miloş and Drînceanu (1980), found that it had a favourable effect on trace elements utilisation. According to Kratzer (1959) and Stracher (1963), cited by Miloş and Drînceanu (1980), EDTA improves the utilization of the additional dietary zinc given to hen and turkey chicks, resulting in 10.1-13.9% higher live weight gains. Scott and Zeigler (1963), cited by the same authors, give evidence on the existence of natural chelates that favour zinc utilisation, which are to be found in fish liver, casein and in a soluble alfalfa extract. The broilers used less time to forage and had higher water intakes.

Recent research by Julean et al. (2007) and by Drinceanu et al. (2003, 2004) show that some chelated mineral supplements given to broilers had no adverse effects on broiler performance.

CONCLUSIONS

The experimental results show that the mineral premixes with chelated bioelements included at levels of 0.1% or 0.5%, may replace the classical mineral premix (with trace elements from inorganic salts) in the compound feeds formulations for broilers throughout their entire growth period (0-42 days). Broiler performance was higher (+3.21 to 3.35 weight gain and 1.54-2.05% lower feed conversion ratio). The cost of feeds/kg weight gain also decreased by up to 1.07% (0.1% chelated mineral premix) compared to the control group. The replacement of the classical mineral premix with 1% chelated mineral premix was not economically justified.

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