

# Effect of removal of vitamin-trace mineral premix and calcium and phosphorus supplements from grower and finisher diets on broiler performance

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**Abstract.** Two experiments were conducted to evaluate the effects on broiler performance when withdrawing vitamin-trace mineral premix (VTP) and supplemental calcium and phosphorus (SCP) from diets at 35 to 42 d of age Experiment 1 (Exp 1) and at 28 to 42 d of age (Exp. 2). Four corn-soybean meal dietary treatments were used: 1) Control, complete diet; 2) removal of VTP; 3) removal of SCP; 4) removal of VTP and SCP. Day-old chicks were randomly assigned to 16, 3 x 4 m pens. A randomized complete block statistical design was used. Body weight, feed consumption, feed efficiency, and mortality were determined. Carcass weight and yield were recorded at processing. Compared to control, no significant differences ( $P < 0.05$ ) were observed among dietary treatments for body weight, feed consumption, feed efficiency, carcass weight, and carcass yield when changes were made during 35 to 42 d of age (Exp. 1) or 28 to 42 d of age (Exp. 2). In conclusion, VTP or SCP withdrawal from broiler diets alone or in combination during the last 7 or 14 d prior to slaughter demonstrated no adverse effects on live performance or carcass composition.

**Key words:** Broiler, calcium, phosphorus, trace minerals, vitamins.

**Resumen.** Dos experimentos fueron conducidos para evaluar el efecto de retirar las premezclas vitamínicas y minerales, y suplementación de calcio y fósforo en las dietas de pollos de engorde desde los 35 a 42 días de edad (Exp. 1) y desde los 28 a 42 días de edad (Exp. 2). Cuatro dietas a base de maíz y harina de soya fueron usadas: 1) dieta testigo; 2) retiro de las premezclas vitamínicas y minerales (VTP); 3) retiro de la suplementación de calcio y fósforo (SCP); y 4) retiro de las premezclas vitamínicas y minerales más la suplementación de calcio y fósforo. Pollitos de un día de edad fueron asignados al azar a 16 corrales experimentales de 3 x 4 m. Un diseño de bloques completos al azar fue usado. El peso corporal, consumo de alimento, eficiencia alimenticia, y mortalidad fueron determinados semanalmente. El peso en canal y rendimiento fueron evaluados al momento del sacrificio. Comparando con el testigo, no se observaron diferencias significativas ( $P < 0.05$ ) entre los tratamientos para el peso corporal, consumo de alimento, eficiencia alimenticia, peso en canal y el rendimiento de canal cuando los retiros se hicieron durante los 35 a 42 días de edad (Exp. 1) ó 28 a 42 días de edad (Exp. 2). En conclusión, el retiro de VTP o SCP de las dietas de los pollos de engorde individualmente o en conjunto durante los últimos 7 a 14 días antes del sacrificio ha demostrado no tener ningún efecto adverso en la productividad y características de la canal.

**Palabras claves:** Calcio, fósforo, minerales traza, pollo, vitaminas.

## INTRODUCTION

It is difficult to establish optimum nutritional levels for any single type of broiler, due to the variability in requirements between lines and different production systems used. Many nutritional requirements, especially the vitamins and minerals, have been evaluated with and based on studies conducted using young birds from 3 to 4 wk of age. Gwyther *et al.*, (1992) found that when nutrient levels greater than those recommended by National Research Council, (1994) were used, birds had heavier body weights, greater body weight gains and improved feed conversion. This finding lead us to believe that one can

make modifications in diet formulation when types of birds or management situations change.

The use of supplements in the diet is necessary because grains and different types of meals do not totally fulfill vitamin and trace mineral requirements. Most broilers grown commercially are fed diets composed mainly of corn and soybean meal. Although vitamin and trace mineral supplements make up only a small part of the total feed cost, withdrawal of them from the diet during the final phase prior to processing could reduce production costs significantly.

Investigations have been conducted to look at the removal of vitamin-trace mineral premix (VTP) and supplemental calcium (Ca) or phosphorus (P) in the last phases

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of broiler production, and certain results indicate this as a possibility. Thomas and Twining (1971); Skinner *et al.*, (1992b); Christmas *et al.*, (1995) reported that removal of supplemental vitamins and trace minerals from broiler diets for various time periods had no significant effects on body weight, feed consumption, feed efficiency, or mortality. However, Deyhem and Teeter (1993) reported that the removal of both supplemental vitamin and trace minerals from the diet 28 to 49 d of age reduced weight gain and feed efficiency. Removal of trace minerals alone showed no detrimental effect, but the removal of vitamins alone reduced weight gain, feed efficiency, and breast yield. After removing supplemental Ca and P from the diets at 42 to 49 d of age, Skinner *et al.*, (1992a) found no

adverse effects on body weight, feed conversion, leg problems or carcass quality. Twining *et al.*, (1965) indicated that a Ca level between 0.7 and 0.8% was required for optimum growth, and that total P levels greater than 0.5% did not significantly improve growth of chickens 42 to 56 d of age. O'Rourke *et al.*, (1955) indicated that diets containing 0.6% Ca and 0.5% total P, or 0.9% Ca and 0.6% total P are adequate for broiler growth 28 to 56 d of age. Chen and Moran (1994) removed P supplementation (dicalcium phosphate) at 42 to 49 d of age. They found that body weight, feed conversion, and mortality were not significantly different between treatments, although a higher incidence of broken bones and bruises were observed at processing. Because studies are limited, the

**Table 1.** Composition of experimental diets in experiment 1 (35 to 42 d) and experiment 2 (28 to 42 d).

Ingredients and analysis	Experiment 1 (35 to 42 d)				(%)	Experiment 2 (28 to 42 d)			
	T1	T2	T3	T4		T1	T2	T3	T4
<b>Ingredients</b>									
Ground corn	62.91	62.91	61.20	61.20		60.26	60.26	58.52	58.52
Soybean meal (46%CP)	29.27	29.27	30.65	30.65		32.99	32.99	34.38	34.38
Dicalcium phosphate	0.80	0.80	0.00	0.00		0.98	0.98	0.00	0.00
Ground limestone	1.85	1.85	0.00	0.00		1.89	1.89	0.00	0.00
Salt (NaCl)	0.30	0.30	0.38	0.38		0.32	0.32	0.38	0.38
Vitamin + mineral premix <sup>1</sup>	0.30	0.00	0.30	0.00		0.30	0.00	0.30	0.00
Oxitet <sup>®</sup> T-41	0.12	0.12	0.12	0.12		0.12	0.12	0.12	0.12
Avatec <sup>®3</sup>	0.12	0.12	0.12	0.12		0.12	0.12	0.12	0.12
Vegetable oil	4.28	4.28	4.57	4.57		3.00	3.00	3.30	3.30
DL-methionine	0.11	0.11	0.10	0.10		0.11	0.11	0.10	0.10
L-lysine	0.03	0.03	0.00	0.00		0.00	0.00	0.00	0.00
Sand	0.00	0.30	2.65	2.95		0.00	0.30	2.87	3.17
<b>Calculated analysis</b>									
Crude protein	18.50	18.50	19.00	19.00		20.00	20.00	20.50	20.50
Calcium	0.90	0.90	.069	.069		0.95	0.95	.076	.076
Available phosphorus	0.35	0.35	0.18	0.18		0.40	0.40	0.19	0.19
Methionine	0.43	0.43	0.43	0.43		0.45	0.45	0.45	0.45
Lysine	1.10	1.10	1.11	1.11		1.18	1.18	1.22	1.22
ME (kcal/kg)	3,200	3,300	3,200	3,200		3,100	3,100	3,100	3,100

<sup>1</sup> The vitamin and mineral premix provide the following per kilogram of diet: vitamin A, 3,478,261 IU (*all-trans-retinal*); cholecalciferol 869,56 IU; vitamin E, 2,174 IU (*dl- $\alpha$ -tocopheryl*); vitamin K<sub>3</sub>, 652 mg; riboflavin, 1,956 mg; niacin, 10,869 mg; D-calcium pantothenic acid, 2,609 mg; choline, 86,957 mg; vitamin B<sub>12</sub>, 5 mg; folic acid, 109 mg; manganese, 30,435 mg; zinc, 21,739 mg; iron, 13,043 mg; copper, 3,043 mg; iodine, 652 mg; cobalt, 65 mg; selenium, 43 mg; mold inhibitor, 3,043 mg; antioxidant, 4,348 mg.

<sup>2</sup> Oxitet<sup>®</sup>T-41, broad spectrum antibiotic, 89 g oxytetracycline/kg.

<sup>3</sup> Avatec<sup>®</sup>, prevention of coccidiosis in broiler, 150 g lasalocid sodium/kg.

T1 = Control diet.

T2 = Control diet with removal of vitamin-trace mineral premix (VTP).

T3 = Control diet with the removal of calcium and phosphorus supplements (SCP).

T4 = Control diet with the removal of both VTP and SCP.

objective of this study was to determine the effect of removing the vitamin-trace mineral premix (VTP) and supplemental Ca and P (SCP) alone and combined from broiler diets during 28 to 42 d of age without adversely affecting performance.

## MATERIALS AND METHODS

### Experiment 1

One-day-old straight-run Arbor Acres® broiler chicks were received from a commercial hatchery and placed in an open-sided, naturally ventilated broiler house with a photo regimen of 24 h light.

One hundred chicks per pen were weighed individually and randomly assigned to each of 16 pens (3 x 4 m) at a density of 8.33 birds per square meter. Four treatments were randomly assigned in blocks, to complete a randomized complete block design. Each pen was heated by an electric brooder and provided with bell waterers and tube feeders. Experimental diets and water were provided for free choice. The treatments consisted of 1) control diet; 2) control diet with the removal of vitamin-trace mineral premix (VTP) 35 to 42 d of age; 3) control diet with the removal of Ca and P supplements 35 to 42 d of age (SCP); 4) control diet with the removal of both VTP and SCP 35 to 42 d of age (Table 1). Builders sand replaced the VTP and SCP in the diets. Body weight, cumulative feed consumption, and feed efficiency (feed:gain) were determined for each pen at 42 d of age. Mortality was recorded daily. Carcass weight and percentage yield without giblets (WOG) were determined prechill. The WOG was calculated by dividing carcass weight (without the liver, heart, gizzard, and neck) by live weight.

### Experiment 2

The experimental design and chicks were the same as in Experiment 1. The treatments were also the same except that the removal of VTP and SCP from the diets covered 28 to 42 d of age. Parameters measured and procedures were the same as in Experiment 1.

### Statistical Analysis

Data from each experiment was evaluated by ANOVA using General Linear Models (GLM) procedures (SAS Institute, 1991). Percentage data were subjected to arc sine square root of the percentage transformation and treatment means separated by the test of least significant difference. A probability of  $P < 0.05$  was required for significance.

## RESULTS

Results in Experiment 1, show that the removal of VTP and SCP from broiler diets 35 to 42 d of age showed non-significant differences for body weight, feed consumption, feed efficiency, mortality, carcass weight, and carcass yield (Table 2). Results from Experiment 2, show that the removal of VTP and SCP from broiler diets 28 to 42 d of age also showed differences to be non-significant for body weight, feed consumption, feed efficiency, mortality, carcass weight and carcass yield (Table 3).

## DISCUSSION

Other researchers have found similar results from removal of vitamins or trace minerals for various lengths of time. Waldroup *et al.*, (1968) reported that the presence

**Table 2.** Effect of removing vitamin-trace mineral premix and supplemental calcium and phosphorus from broiler finisher diet, during 35 to 42 d of age on body weight, feed consumption, feed conversion, mortality, carcass weight and yield.

Treatment	Body weight (g)	Feed consumption (g)	Feed conversion	Mortality (%)	Carcass weight (g)	Carcass yield (%)
Control	1838	3524	1.91	3.82	1258	68.4
Vitamin-trace mineral premix removed (VTP)	1797	3354	1.86	3.55	1296	70.1
Supplemental Ca and P removed (SCP)	1774	3328	1.87	7.61	1276	70.1
Both vitamin-trace mineral premix and supplemental Ca and P removed (VTP+SCP)	1693	3351	1.98	3.08	1184	69.9
Standard error of the mean (SEM)	41.45	116.60	0.05	1.63	22.30	1.72

**Table 3.** Effect of removing vitamin-trace mineral premix and supplemental calcium and phosphorous from broiler finisher diet during 28 to 42 d of age on body weight, feed consumption, feed conversion, mortality, carcass weight and yield.

Treatment	Body weight (g)	Feed consumption (g)	Feed conversion	Mortality (%)	Carcass weight (g)	Carcass yield (%)
Control	1811	3633	2.00	4.07	1250	69.0
Vitamin-trace mineral premix removed (VTP)	1659	3492	2.11	2.78	1123	67.8
Supplemental Ca and P removed (SCP)	1769	3567	2.01	5.92	1236	69.8
Both vitamin-trace mineral premix and supplemental Ca and P removed. (VTP+SCP)	1742	3478	2.02	4.35	1160	67.6
Standard error of the mean (SEM)	75.40	58.90	0.09	1.30	39.90	2.58

or absence of a commercial mineral mix in a corn-soy-bean meal diet had no significant effect on body weight gains, feed utilization or incidence of toe and hock deformities of broilers 0 to 28 d of age. Thomas and Twining (1971) concluded that supplementation with vitamin and trace minerals does not appear to be necessary provided that broilers are not kept on a finisher feed for more than 10 days. While removing trace mineral or vitamin premixes separately from 35 to 49 d of age Christmas *et al.*, (1995) observed no differences in growth or feed efficiency. When trace minerals and supplemental vitamins were removed simultaneously, weight gain was lower than that of the control group. After removing vitamins, trace minerals, or both from diets of broilers that received complete supplementation with 42 days of age, Skinner *et al.* (1992b) found no significant effect on weight gain or feed efficiency from 42 to 49 days, or on carcass characteristics at processing.

Contrary to these previous findings, Deyhim and Tee-ter (1993) found that combined vitamin and trace mineral withdrawal at 28 to 49 d of age significantly reduced weight gain and feed efficiency. Though the results for body weight in Tables 2 and 3 show non-significance, there was a continued tendency for body weights to be lower in all the treatments where nutrient withdrawal was applied when comparing to the control group. Trace mineral removal alone was without consequence, but birds fed diets lacking vitamins exhibited reduced weight gain, feed efficiency, and breast yield. Kativa *et al.* (1997) removed supplemental vitamins and trace minerals from broiler diets 35 to 42 days post-hatching and observed a decrease in daily weight gain and a slight decrease in the bioavailable riboflavin content of breast and thigh muscle.

Referring to the withdrawal of supplemental Ca and P, Skinner *et al.*, (1992a) found no differences in body weight gain, feed conversions, feed consumption and mortality when supplemental Ca and P were removed from broiler diets at 42 to 49 d of age. Chen and Moran (1994) showed that removing supplemental Ca and P from 42 to 49 d of age negatively affected carcass quality.

Data in Table 2 and 3 show a non-significant decrease in feed consumptions for the withdrawal groups in comparison to control. Results in the literature indicate that anorexia and reduced feed consumption are characteristics of vitamin deficiencies in broilers (Scott *et al.*, 1982; Ruiz and Harms, 1990). This may suggest that the absence of supplemental vitamins and trace minerals and Ca and P in the diet may have provoked this reduction in feed consumption, thus, resulting in lower body weights when comparing the withdrawal treatments to control.

Skinner *et al.*, (1992) emphasized that the removal of supplemental vitamin and trace minerals from broiler diets does not necessarily imply that the diets are absent of these essential nutrients. Diets containing some type of animal protein and lacking supplementation may contain quantities of vitamins sufficient to meet or exceed minimum recommended levels (Roche Technical Data, undated). Gwyther *et al.*, (1992) indicated that vitamin and trace mineral premixes used in commercial broiler industry normally provide the nutrients at two to fourfold the minimum recommended levels; thus some storage within the tissues of the bird is expected, especially fat-soluble vitamins. Skinner *et al.* (1992) suggest that under commercial conditions it may be difficult to produce a vitamin or trace mineral deficiency in birds during the finishing

periods following adequate supplementation early in the growing period.

In conclusion the results of this study suggest that removal of vitamins and trace minerals, and supplemental Ca and P is possible from 28 to 42 d of age without producing significantly negative effects on productivity.

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