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ORIGINAL RESEARCH ARTICLE

Effects of serial withdrawal of dietary vitamin mineral premixes on performance, carcass characteristics and organs weight of broiler chickens

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ABSTRACT
Effects of serial withdrawal of dietary vitamin mineral premixes (VMP) on performance, carcass characteristics and organs weight of broiler chickens was investigated in an experiment lasting 42 days. A total of 224, one-day old Arbor acre broilers chicks were randomly allotted to seven dietary treatments of 32 chicks each comprising quadruplicate of eight birds per replicate. Basal starter and finishers diets had VMP withdrawn for 6, 5, 4, 3, 2, 1 and 0 weeks to obtain T1, T2, T3, T4, T5, T6 and T7 dietary treatments respectively. Birds were offered feeds and water ad libitum. The design of the experiment was completely randomized design. Only chicks body weight gain was significantly reduced (P<0.05) at week 1 by VMP withdrawal while other indices of performance were statistically similar (P>0.05). Disparity of performance indices increased (P<0.05) as weeks of VMP withdrawal increased. Dressing percentages were 68.64, 75.41, 73.36, 79.34, 84.24 and 76.84% for birds on T2, T3, T4, T5, T6 and T7 respectively, and were highest for birds on T6. Prima cuts, external offal, organs weight excepting thigh, bile, liver, spleen and abdominal fat deposition were all significantly reduced (P<0.05) by VMP withdrawal. Study revealed that vitamin-mineral premixes could be successfully withdrawn from broilers diets from day 35 of production without any effect on performance and carcass indices of birds.

Keywords: Vitamin-mineral premix, Broiler performance, Carcass primal cuts

INTRODUCTION
Vitamins and minerals are micronutrients that participate in numerous metabolic processes and are therefore indispensable for excellent animal health and productive performance (Alahyari-Shahrasb *et al*., 2011). They are added to poultry diets through supplemental vitamin-mineral premixes (VMP). In poultry production, there is a huge variation in the content and concentration of commercial VMP and this contributed to high cost of production. Most levels recommended by the NRC (1994) were based on old studies, performed under controlled conditions and using the minimum levels to avoid signs of deficiency (Alahyari-Shahrasb *et al*., 2012).

However, with the realization that vitamins and minerals contributions to production goes beyond prevention of diseases, dietary input of premixes are usually in excess of the requirements. Thus, minerals and vitamins were oftentimes added to animals' diet when they may not be needed (Christmas *et al*., 1995). Report (Khajali *et al*., 2006) noted that the vitamin and trace mineral contents of the finishers' diet were sufficiently high to maintain a humoral immune response. Report (Alahyari-Shahrasb *et al*., 2012) also indicated that VMP withdrawal at day 29 of broiler chickens age did not impair feed intake or weight gain, and feed conversion ratio.

However, removal of both vitamins and trace elements especially the vitamin content of premix from the broiler diet at 28 to 49 days reduced weight gain and feed efficiency (Deyhim and Teeter, 1993). A 7-d removal of supplemental vitamins and trace elements from the broiler diet consisting of corn-soybean meal from d 35 to d 42 post hatch have been shown (Patel *et al*., 1997) to decrease weight gain in three broiler strains. Also, supplemental vitamin-mineral premixes removal from starter

and finisher corn-soybean meal diets decreased weight gain in the Arbor Acre broiler strain (Ogunwole *et al*., 2011). Other authors (Skinner *et al*., 1992; Patel *et al*., 1997; Maiorka *et al*., 2002; Khajali *et al*., 2006) reported varied effects of VMP removal from the diets of broilers on feed intake, growth performance, carcass yield and feed conversion ratio. The present investigation was aimed at further documenting the likely effects of serial withdrawal of dietary VMP on performance, carcass characteristics and organs weight of broiler chickens

MATERIALS AND METHODS

The experiment was undertaken at the Poultry Unit of the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria which lies between latitude 7^0, 20^0N and longitude 3^0, 50^0E.

Two sets of diets were formulated at both the starter and the finishers' phases. The first set was without premix while the other was supplemented with 0.25% vitamin-mineral premix in line with the manufacturer recommendation and withdrawn serially in the weeks of production as follows: T1 = Control (diets without premix for six weeks), T2 = diets with premix for one week, without premix for five weeks. T3 = diets with premix for two weeks, without premix for four weeks. T4 = diets with premix for three weeks, without premix for three weeks. T5 = diets with premix for four weeks, without premix for two weeks. T6 = diets with premix for five weeks, without premix for one week and T7 = diets with premix for the entire six weeks. The gross composition of the starter and the finishers diets are shown in Table 1. A total of 224, one-day old broilers chicks were randomly allotted to seven dietary treatments of 32 chicks each comprising quadruplicate of eight birds per replicate.

Table 1: Gross composition of experimental starter and finishers diets

	Starter diet experimental diets		Finishers diet experimental diets	
Ingredients	(%)	(%)	(%)	(%)
Maize	44.70	44.70	45.93	45.93
Soyabean meal	40.00	40.00	33.00	33.00
Wheat offal	9.50	9.75	15.32	15.57
DCP	1.50	1.50	1.50	1.50
Oyster shell	1.00	1.00	1.00	1.00
Methionine	0.20	0.20	0.20	0.20
Lysine	0.10	0.10	0.10	0.10
Premix	0.25	-	0.25	-
Salt	0.25	0.25	0.25	0.25
Oil	2.50	2.50	2.50	2.50
Total	100.00	100.00	100.00	100.00
Calculated Composition				
ME, Kcal/kg	2791	2795	2753	2758
CP %	22.4	22.48	20.59	20.64
Calcium, %	1.00	1.18	1.00	1.18
Phosphorus, %	0.46	0.46	0.46	0.46

ME - Metabolizable Energy; Values calculated DCP – Dicalcium Phosphate; CP -- Crude Protein. Premix - Vitamin A–10,000,000iu, Vitamin D3–2,000iu, Vitamin E–40,000mg, Vitamin K–2,000mg, Vitamin B1–1,500mg, Vitamin B2–4,000mg, Vitamin B6–40,000mg, Vitamin B12–20mgr, Niacin–40,000mg, Panthotenic–10,000mg, Folic–1,000mg, Biotin–100mg, Choline Chloride–300,000mg, Manganese–80,000mg, Zinc–60,000mg, Iron–40,000mg, Copper–80,000mg, Iodine–800mg, Selenium–200mg, Cobalt–300mg, Antioxidant–100,000mg.

Routine medication, vaccination and husbandry practices were administered on the birds. The experimental periods lasted six weeks within which birds were given feeds and water *ad libitum.* The experiment was in a completely randomized design. Feed intake of birds was obtained by subtracting the leftover from the quantity of feed offered daily. Body weight gain and feed conversion ratio were determined by subtracting initial weight from the final live weight and by dividing feed intake by the body weight gain (kg) respectively.

At week 6, two birds per replicate with average weight closest to the mean group weight were purposively selected, tagged, starved of feed overnight, slaughtered, carefully eviscerated and properly dissected into prima cuts after manual scalding sequel to immersion in water at 80^0C for about 30 seconds. The final, bled, defeathered, carcass and eviscerated weights of birds were recorded. The external offal (head, neck and shank); primal cuts (wings, breast, back, thigh and drumstick); and internal offal (liver, heart, abdominal fat, spleen and intestine) were weighed and the weights related to the live weight using the formula:

$$\frac{\text{Weight of primal cut/organ}}{\text{Live weight}} \times 100$$

Data were subjected to analysis of variance in a completely randomized design and means were separated (SAS, 1999) at $\alpha_{0.05}$

RESULTS AND DISCUSSION

Weekly performance indices of starter broilers fed diets with or without VMP are shown in Table 2. In week 1, feed intake ranged from 0.69-0.84 kg for chicks on various treatments and the values were not significantly different (P>0.05). However, effect of treatment on weight gain was significantly (p<0.05) different. The values obtained were 0.26, 0.33, 0.34, 0.39, 0.36, 0.36 and 0.38kg for birds on T1, T2, T3, T4, T5, T6 and T7 respectively. Birds on T4 had the highest weight of 0.39kg while those on T1 had the lowest value of 0.26kg. The FCR is the usual indication of how feed has been efficiently utilised or converted to meat by broiler birds. Thus, the lower the FCR, the better the feed (Ogunwole *et al*., 2014). There were no significant differences (p>0.05) in the feed conversion ratio obtained for birds in week 1 of this study. Birds on T4 however, recorded numerically lowest FCR value of 2.18 and those on T1, highest value of 2.62.

At week 2, feed intake and weight gain decreased significantly (P<0.05) for birds on diet1 which could be a reflection of the withdrawal of VMP from their diets. Similar trends of feed intake and weight gain were obtained for the birds at week 3. Feed intake for birds on T2 was reduced compared to birds on other treatments in the first week. This could be attributed to withdrawal of premixes from their diets at the second week. However, the weight gain was still the same as others with vitamin-mineral diets. This suggests that premix withdrawal did not have immediate effects on the weight gain of birds that was previously placed on vitamin-mineral premixes at the starter phase.

Broiler chickens on T2 and T3 had similar values (P>0.05) of feed intake and weight changes as others on T4, T5, T6 and T7. This could be because birds on T2 and T3 compared to those on T1 had relatively better start with supplemental dietary VMP at least for one or two respective weeks which probably gave them comparative edge in terms of health and the productive apt. The seeming statistical similarities (P>0.05) of FCR values for broilers at week 2 and 3 was due to proportionate lowered feed intake and weight gain of birds without dietary VMP supplements. Vitamins and minerals are established cofactors of virtually all biochemical processes without which any metabolism would not proceed (Wiki books, 2012).

Table 2: Performance indices of starter broiler chicks fed diets with or without vitamin-mineral premixes

Parameters	T1	T2	T3	T4	T5	T6	T7	SEM
week 1								
Feed intake (Kg)	0.69	0.84	0.84	0.84	0.84	0.80	0.84	0.05
Weight gain (Kg)	0.26^{d}	0.33^{c}	0.34^{c}	0.39^{a}	0.36^{cab}	0.36^{cab}	0.38^{ab}	0.02
Feed conversion	2.62	2.58	2.51	2.18	2.33	2.33	2.24	0.17
Week 2								
Feed intake (Kg)	0.98^{b}	1.73^{a}	2.03^{a}	1.80^{a}	1.80^{a}	1.85^{a}	1.88^{a}	0.12
Weight gain (Kg)	0.56^{b}	1.03^{a}	1.05^{a}	1.02^{a}	0.99^{a}	1.00^{a}	0.90^{a}	0.07
Feed conversion	1.75	1.67	1.94	1.77	1.82	1.86	2.22	0.18
week 3								
Feed intake (Kg)	2.26^{b}	3.18^{a}	3.22^{a}	3.33^{a}	3.27^{a}	3.35^{a}	3.35^{a}	0.16
Weight gain (Kg)	0.91^{b}	1.43^{a}	1.44^{a}	1.33^{a}	1.55^{a}	1.34^{a}	1.35^{a}	0.12
Feed conversion	2.48	2.22	2.24	2.51	2.11	2.50	2.48	0.45

a,c Means within rows with the same superscript are not significantly ($p>0.05$) different. T1 (control Diet without premix), T2 (birds with access to premix for 1 week), T3 (birds with access to premix for 2 weeks), T4 (birds with access to premix for 3 weeks), T5 (birds with access to premix for 4 weeks), T6 (birds with access to premix for 5 weeks), T7 (birds with access to premix for 6 weeks), SEM: standard error of the mean.

Plate. 1: Picture of broiler chickens fed on diets without vitamin-mineral premix at the 2nd week

Plate 1 showed that birds fed without dietary VMP supplementation from 14 - 21 days of age became emaciated, weak with poorly developed feathers, twisted legs on sitting posture and they looked ill. This was probably due to deficiency of minerals and gross dietary avitaminosis as documented by authors (Oduguwa and Ogunmodede, 1995; Oduguwa *et al*., 2000; Steven, 2015). Plate 2 revealed that broiler chick on diet T1 at 28 days of age had watery discharge from eyes. Also, milky white, cheesy material accumulated in birds' eyes

making sightedness virtually impossible; an indication of xerophthalmia, probably due to vitamin A avitaminosis.

Within the first two weeks of the experiment, birds on T1 recorded five mortalities which translated to 1.7% mortality at the end of two weeks of brooding period. At day 28, 100% mortality was experienced in birds on T1 which clearly revealed that broiler starter required dietary VMP supplement to survive. At day 35, five mortality was recorded in birds on T2 and 34.44% at day 42.

Plate 2: Picture of the eye of broiler chickens fed diets without supplemental vitamin-mineral premix at the 4th week

Table 3: Performance indices of finishers' broiler chickens fed diets with or without vitamin-mineral premixes

Parameters	T1	T2	T3	T4	T5	T6	T7	SEM
Week 4								
Feed intake (Kg)	1.98^{b}	3.92^{a}	4.13^{a}	4.20^{a}	4.30^{a}	4.25^{a}	4.25^{a}	0.12
Weight gain (Kg)	0.32^{c}	0.80^{b}	1.02^{ab}	1.11^{a}	1.15^{a}	1.05^{ab}	1.10^{a}	0.09
FCR	6.18^{a}	4.90^{b}	4.05^{c}	4.85^{b}	3.65^{d}	4.05^{c}	3.86^{d}	0.77
Week 5								
Feed intake (Kg)	-	3.00^{b}	4.73^{a}	4.34^{ab}	4.28^{ab}	4.38^{ab}	4.75^{a}	0.45
Weight gain (Kg)	-	1.00^{b}	1.78^{ab}	1.53^{ab}	1.74^{ab}	1.69^{ab}	1.85^{a}	0.22
FCR	-	3.00	2.66	2.84	2.46	2.63	2.57	0.50
week 6								
Feed intake (Kg)	-	2.59^{b}	3.03^{a}	3.01^{a}	3.01^{a}	3.02^{a}	3.09^{a}	0.12
Weight gain (Kg)	-	0.65^{c}	0.94^{b}	1.05^{ab}	1.21^{a}	1.04^{ab}	1.06^{ab}	0.08
FCR	-	3.98^{a}	3.22^{ab}	2.87^{b}	2.49^{b}	2.90^{b}	2.92^{b}	0.25

a , b, c, : Means within rows with the same superscript are not significantly (p>0.05) different. T1 (control Diet without premix), T2 (birds with access to premix for 1 week), T3 (birds with access to premix for 2 weeks), T4 (birds with access to premix for 3 weeks), T5 (birds with access to premix for 4 weeks), T6 (birds with access to premix for 5 weeks), T7 (birds with access to premix for 6 weeks), SEM: standard error of the mean.FCR= Feed conversion ratio

Performance indices of broiler finishers from week 4 to 6 fed diets with or without VMP are shown in Table 3. At week 4, there was an observed marginal increase in the feed intake of most birds across all treatments which did not imply appreciably on the abysmal weight gain compared to corresponding values in week 3. This resulted in increased FCR values across all treatments with birds on T1 (6.18) having significantly higher (P<0.05) FCR compared to those on T2 (4.9), T4 (4.85) T3 (4.05) and T6 (4.05). The lowest FCR for this week was recorded in broilers on T5 (3.65) and T7 (3. 86). The sharp drop in intake of birds without supplemental VMP supported early documentation (Christmas *et al.*, 1995) that feed consumption declined when vitamin premix was removed from broilers diet which also, invariably, resulted in lowered efficiency of feed utilization by broiler chicks. This could also be traced to the fact that birds could not produced nutrient at the level required for growth or those produced could not sustain them through finishers phase as posited (Skinner *et al*., 1992). The picture of a typical bird on T1 at day 28 is shown in Figure 3. The birds appeared ill, poor feathered, grew slowly and seemingly anaemic. At the first two weeks, they doubled their weight with bright eyes, healthy and very active

At week 5, there was observed significant increase (P<0.05) in both the feed intake as well as weight gain of birds from T2 to T7 which however did not translate to any significant variation (P>0.05) in the FCR of birds. This observation also, underscored the earlier supposition and reports (Skinner *et al*., 1992; Alahyari-Shahrasb *et al*., 2012) that VMP could be withdrawn at week 5 of broiler production without any detrimental implications on performance indices. Conversely at week 6, there were significant variations (P<0.05) in all indices of performance. Feed intake (kg) was significantly lower (P<0.05) for only birds on T2 (2.59) compared to others. Weight gain (kg) was significantly higher (P<0.05) for birds on T5 (1.21) among others. The FCR decreased significantly (P<0.05) from birds on T2 to T7. The values were 3.98, 3.22, 2.87, 2.49, 2.90 and 2.92 for birds on T2, T3, T4, T5, T5, T6 and T7, respectively, an indication of improved utilization of feed with increased weeks of VMP supplementation. Better performance occurred in birds on T5 with the value of 2.49 FCR and 1.21kg weight gained. This indicated that excess inclusion of premix to diet after 28-35 days did not have effect on the FCR as earlier reported (Christmas *et al.*, 1995) that vitamin-mineral premixes are added to broiler finishers feed when they are not needed. Conversely, report by Maiorka *et al*. (2002) revealed that vitamin withdrawal from broiler finisher's diet for the same period decreased weight gained.

Plate 3: Picture of broiler chickens fed diets without supplemental vitamin-mineral premixes at the 4th week.

Table 4: Carcass, prima cuts, external offal and organs weight of broiler chickens fed diets with or without vitamin-mineral premixes

Parameters	T2	T3	T4	T5	T6	T7	SEM
Live weight (kg)	1.02[b]	1.14 [b]	1.21 [b]	1.49 [a]	1.47 [a]	1.52 [a]	0.07
Bled weight (kg)	0.95 [b]	1.08 [b]	1.12 [b]	1.14 [a]	1.38 [a]	1.43 [a]	0.07
Defeathered weight	0.86 [b]	1.02 [b]	1.05 [b]	1.34 [a]	1.33 [a]	1.34 [a]	0.07
Eviscerated weight	0.76[c]	0.90[c]	0.96[cb]	1.17[ab]	1.25 [a]	1.20[ab]	0.06
Dressing percentage (%)	68.64[b]	75.41[ab]	73.36[ab]	79.34[ab]	84.24[a]	76.84[ab]	3.32
Head	4.04[c]	3.94[c]	4.19[cb]	4.76[ab]	5.03 [a]	4.76[ab]	0.20
Neck	5.19[b]	5.49 [b]	5.83 [b]	7.71[a]	8.35 [a]	8.14 [a]	0.54
Shank	4.83[d]	5.80[cd]	6.64[cb]	7.91 [a]	7.10[ab]	7.30[ab]	0.41
Primal cuts							
Breast	16.85[b]	18.41[ab]	16.80 [b]	19.21[a]	18.75[ab]	20.18 [a]	0.65
Back	13.09 [b]	13.60[ab]	14.40[ab]	14.05[ab]	15.30 [a]	14.06[ab]	0.56
Drumstick	10.13 [b]	10.33[b]	10.34 [b]	10.49 [b]	11.69 [a]	10.88[ab]	0.36
Wing	8.71 [b]	9.15[ab]	9.60[ab]	9.93[ab]	10.36 [a]	9.73[ab]	0.44
Thigh	9.31	9.74	9.43	10.35	10.36	10.23	0.33
Organs weight.							
Bile	0.14	0.13	0.15	0.12	0.11	0.11	0.02
Intestine	5.32[ab]	5.77 [a]	6.00 [a]	5.10[ab]	5.02[ab]	4.44[b]	0.37
Gizzard	2.43[ab]	2.35[ab]	2.45[ab]	2.17 [b]	2.87 [a]	1.94 [b]	0.17
Lungs	0.73 [a]	0.69 [a]	0.66 [a]	0.48 [b]	0.52 [b]	0.45 [b]	0.05
Liver	1.67	1.85	1.76	1.61	1.72	1.62	0.02
Spleen	0.11	0.09	0.09	0.09	0.10	0.08	0.01
Abdominal fat deposit	0.37	0.44	0.40	0.42	0.38	0.44	0.04

a, b: Means within rows with the same superscript are not significantly (p>0.05) different. T1 (control Diet without premix), T2 (birds with access to premix for 1 week), T3 (birds with access to premix for 2 weeks), T4 (birds with access to premix for 3 weeks), T5 (birds with access to premix for 4 weeks), T6 (birds with access to premix for 5 weeks), T7 (birds with access to premix for 6 weeks), SEM: standard error of the mean.

Carcass, prima cuts, external offal and organs weight of broiler chickens fed diets with or without VMP are shown in Table 4. Significantly increased live weight (P<0.05) was observed as the length of inclusion of the VMP increased and there were no differences (P>0.05) as from T5 to T7. This implied that supplemental VMP could be withdrawn from birds at 35-42days without any significant effect on weight. This could be related to the availability of vitamins and minerals in the body for further growth and other metabolic processes, as nutrients in these supplements usually exceeds two or three times the requirements for broiler finshers chicken as earlier reported (Skinner *et al*., 1992). Alahyari-Shahrasb *et al*. (2012) also, reported that VMP reduction and withdrawal from 29 d of age did not impair body weight during the final period of broilers (29-42d). There was no difference in weights among birds on T2, T3 and T4 in both bled and eviscerated weights. This could be due to inadequate stage of withdrawal to effect any significant difference when compared to the control. However, the bled, eviscerated and dressing weights followed a normal trend which supported earlier report (Ikeme, 1990) that birds with higher pre-slaughter weight were expected to produce higher bled weight.

Relative weights (g) of breast, back, drumstick and wing varied significantly (P<0.05). Birds on T5 and T7 had the highest weights (g)

(19.21 and 20.18 respectively) of breast while those on T6 had the highest weights (g) of back (15.30), drumstick (11.69) and wing (10.36), which revealed the implications of dietary VMP on these primal cuts as there was no significant increment ($P<0.05$) in the weights of any of them after week 5 of broiler production.

Dietary VMP supplement did not have significant effect ($P>0.05$) on the relative weights of internal offals' like bile, liver, spleen and abdominal fat. Conversely, there were effects on the weights of head, neck and shank which varied significantly ($P<0.05$). The external offal's weight decreased proportionately ($P<0.05$) from T2 to T7 and could be due to increased relative utilization and development of other parts compared to external offal's as the duration of supplemental dietary VMP increased.

CONCLUSION

In this study, it was concluded that profitable production of broiler chickens could not be undertaken without dietary supplement of VMP. Also, vitamin mineral premix withdrawal did not have effects on the internal and external offal of birds. However, withdrawal of vitamin mineral premix from broiler chickens diets from 35-42days did not impact negatively on performance, carcass characteristics and organs weight of broilers and therefore could be withdrawn safely from broiler chickens diets from days 35 to 42.

CONFLICT OF INTEREST

The authors declare that there is no known conflict of interest as regards the conduct of this study and the data reported in this work.

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