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Comparative Efficacy of Three Commercial Vitamin and Trace Mineral Premixes for Rearing Broiler Chickens at Starter and Finisher Phases

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ABSTRAK

Enam kumpulan 45 anak ayam panggang Hubbard belum berjantina yang berusia satu hari telah dibandingkan secara rambang mengikut kesamaan pada fasa permulaan (0-5 minggu) kepada tiga diet isoklorik dan diet iso nitrogenus yang dilindungi pada paras yang dicadangkan kepada para pengeluar dengan tiga vitamin komersil dan pracampuran mineral surih yang diperolehi dipasaran tempatan dan dilabel sebagai pracampuran A, U dan Z. Pada fasa penamat (6-9 minggu) anak-anak ayam beralih tempat dibahagi kepada tiga kumpulan rawatan penamat dengan masing-masing dua replika tiap-tiap satu. Satu kumpulan rawatan, berterusan menerima pracampuran yang sama seperti semasa fasa permulaan, sementara dua kumpulan yang lain bersama pracampuran yang selebihnya yang tidak diberi pada fasa permulaan untuk kumpulan rawatan tertentu. Jenis pracampuran yang diberi makan pada fasa permulaan menampilkan perbezaan (P > .0.05) dalam pengambilan protein, tambahan berat min dan tambahan berat per unit protein yang diambil oleh burung. Pengambilan protein dan tambahn berat bagi pengambilan per unit protein tidak ketara perbezaannya (P < 0.05) pada fasa penamat. Urik serum dan panas kreatinin serum menunjukkan bahawa burung yang diberi makan pracampuran Z pada fasa permulaan menggunakan protein pengimbang dengan lebih berkesan berbanding yang diberi makan dua pracampuran yang lain. Nilai-nilai perubah di perolehi untuk metabolit serum pada fasa penamat. Kesimpulanya, pracampuran yang untuk para pemanggang yang terdapat di Nigeria berbeza dari segi kandungan dan kesan pemakanan protein ayam pemanggang. Adalah dicadangkan bahawa sekiranya kombinasi pracampuran hendak digunakan dalam menternak ayam pemanggang, perhatian perlu ditekankan untuk memberi makanan pracampur yang berkualiti pada fasa permulaan.

ABSTRACT

Six groups of 45 unsexed day-old Hubbard broiler chicks were randomly assigned in duplicate at the starter phase (0-5 weeks) to three isocaloric and iso-nitrogenous diets which were fortified at manufacturers' recommended levels with three commercial vitamin and trace mineral premixes purchased locally and labelled as premix A, U and Z. At the finisher phase (6 -9 weeks) the birds were shuffled and subdivided into three finisher treatment groups of two replicates each. One treatment group continued to receive the same premix as during the starter phase, while the other two groups were assigned the remaining premixes not given at the starter phase for that particular treatment group. Thus nine premix combinations were used at the finisher phase. The premix type fed at the starter phase led to differences (P > 0.05) in the protein intake, mean weight gain and weight gain per unit protein intake of the birds. Protein intake and weight gain per unit protein intake were not significantly different (P < 0.05) at the finisher phase. The serum uric and serum creatinine levels indicate that birds fed premix Z at the starter phase utilized the dietary protein more efficiently than those fed the other two premixes. Variable values were obtained for the serum metabolites at the finisher phase. It was concluded that available premixes for broilers in Nigeria vary in their content and their effect of protein nutriture of broiler chickens. It is recommended that if combinations of premixes are to be used in rearing broilers, care should be taken to feed a proven premix of good quality at the starter phase.

INTRODUCTION

Optimal use of protein is essential in any practical feeding system. The extent of protein utilization in the diet of broilers is an important factor in determining the rate of growth.

It is well recognized that the nutritive value of the protein content of a diet is affected by the presence and availability of vitamins and minerals that accompany the protein in a diet. Results of an earlier study (Oduguwa and Ogunmodede 1995) indicated that locally available premixes have differing capabilities in supporting the growth of broiler chickens when used as a single premix at two physiological growth stages. It was further noted that the effect of the premix profiles gradually diminished as the birds matured.

The availability of premixes tends to be inconsistent due to the unpredictable economic situation in Nigeria. This necessitates the consideration of employing a combination of premixes for rearing broilers. The present study seeks to explore the complemental effects of using premixes either from a single source throughout or from different sources at the starter and finisher phases.

MATERIALS AND METHODS

Experimental Birds and their Diets

Six groups of 45 unsexed day-old Hubbard broiler chickens were each randomly assigned in duplicate at the starter phase (0-5 weeks) to three isocaloric and isonitrogenous diets. These diets were fortified at manufacturers' recommended levels with three commercial vitamin and trace mineral premixes purchased locally and labelled as premix A, U and Z. At the finisher phase (6-9 weeks) the birds were shuffled and subdivided into three finisher treatment groups of two replicates each. One treatment group continued to receive the same premix as during the starter phase, while the other two groups were assigned the remaining premixes not given at the starter phase for that particular treatment group. (Note that the manufacturer of premix A provided different premixes for starter and finisher stages while the manufacturers of premixes U and Z had only one type of premix for both starter and finisher stages) (Table 1).

The composition of the experimental diets at the starter and finisher phases is shown in Table 2. Feed and water were provided freely. Weekly feed intake and growth rate of the birds were recorded; other parameters were calculated from these records. All birds in each replicate were weighed together and the average weight calculated.

Housing

The experimental birds were reared in tiered brooder cages for the first four weeks of their life before being transferred to a deep litter house. Each compartment in the brooder cages was heated by a 100-watt tungsten filament bulb (white light). The compartments were covered with perforated papers to prevent excessive ventilation and cold. The compartments of the brooder cages (housing 45 birds each) provided adequate drinking and feeding space.

After four weeks, birds were moved into a deep litter house with a short side wall about 1 m high topped with wire mesh, providing uniform-sized pens of about 3.1 m × 1.12 m (for 15 birds). Each pen was equipped with a fountain drinker (3-l capacity) and a rectangular wooden trough feeder. No additional heat or light was provided in the pens after the birds were moved. The ambient temperature of the house during the experiment was 26-32°C.

Nitrogen Retention

Nitrogen retention was determined at 5 and 9 weeks in specially designed metabolic cages equipped with separate watering

TABLE 1
Blood metabolites of the experimental birds at 5 and 9 weeks of age

Parameters	Phase 0-5 weeks (starter)	Premix A			Premix U			Premix Z			S.E.X.
Serum total protein (g/dl)		7.10			6.51			5.46			0.55
Serum albumin (g/dl)		6.63^{a}			5.64^{a}			2.44^{b}			0.26
Plasma total protein (g/dl)		7.81^{a}			6.49^{a}			6.59^{b}			0.10
Plasma albumin (g/dl)		6.63			6.21			6.32			0.21
Serum uric acid (mg/dl)		2.08^{a}			1.91^{b}			1.70^{c}			0.02
Serum creatine (mg/dl)		2.42^{a}			1.70^{b}			1.43^{b}			0.07
	6-9 weeks (finisher)	A	U	Z	A	U	Z	A	U	Z	
Serum total protein (g/dl)		6.08^{b}	6.00^{b}	6.75^{a}	5.92^{b}	5.71^{b}	5.74^{b}	5.03^{c}	5.38^{bc}	4.80^{c}	0.72
Serum albumin (g/dl)		4.05^{b}	3.99^{b}c	4.50^{a}	3.94^{b}c	3.86^{c}	3.86^{bc}	3.25^{d}	3.95^{bc}	3.20^{d}	0.06
Plasma total protein (g/dl)		6.82^{a}	6.04^{a}b	6.69^{a}	6.18^{a}b	5.83^{bc}	5.80^{bc}	5.52^{bc}	5.34^{c}	5.21^{c}	0.26
Plasma albumin (g/dl)		5.00^{a}	4.04^{bc}	5.33^{a}	4.92^{a}	4.18^{b}	4.06^{bc}	3.86^{bc}	3.84^{bc}	3.68^{c}	0.13
Serum uric acid (g/dl)		1.43^{d}	1.45^{a}	1.75^{b}	1.25^{e}	1.39^{de}	1.49^{cd}	2.01^{a}	1.62^{bc}	1.62^{bc}	0.04
Serum creatine (mg/dl)		2.45^{e}	2.12^{e}	2.80^{b}	1.88^{f}	2.08^{e}	2.24^{d}	3.02^{a}	2.44^{c}	2.43^{c}	0.03

abcd Values with different superscripts on the same row were significantly different ($P < 0.05$)

troughs and feeders. For each metabolic trial, two birds were randomly selected from each replicate and housed together in a compartment.

A 4-day acclimatization period was allowed prior to a 3-day collection period. The weight of feed given to each group was recorded and the feeds were maintained at low levels in the trough in order to avoid spillage. During the collection of excreta, 1% boric acid solution was sprayed on the droppings regularly to prevent the escape of nitrogen. The total droppings voided from each replicate were then thoroughly mixed together in separate basins. Weighed representative samples for each were then taken in well labelled aluminum foil packets. These labelled packets containing

TABLE 2
Composition of experimental diets

Ingredients g/kg of diet	Starter Rations Premix A	Premix U	Premix Z	Finisher Rations Premix A	Premix U	Premix Z
Yellow corn	560.0	560.0	560.0	558.0	558.0	558.0
Groundnut meal	214.0	214.0	214.0	186.9	186.9	186.9
Spent grain	68.0	68.0	68.0	120.1	120.1	120.1
Menhaden fish meal	40.0	40.0	40.0	35.0	35.0	35.0
Blood meal	45.0	45.0	45.0	30.0	30.0	30.0
Palm oil	20.0	20.0	20.0	15.0	15.0	15.0
Bone meal	35.0	35.0	35.0	35.0	35.0	35.0
Oyster shell	10.0	14.0	12.5	10.0	14.0	12.5
Salt	3.0	3.0	3.0	5.0	5.0	5.0
*Vitamin/mineral premix	5.0	1.0	2.5	5.0	1.0	2.5
	1000	1000	1000	1000	1000	1000
Determined Analysis						
Crude protein (g/kg diet)	221.8	231.2	228.6	199.6	203.5	202.4
Crude fibre (g/kg diet)	47.7	49.4	48.7	51.2	50.0	48.8
Ether extract (g/kg diet)	54.3	57.6	59.7	54.7	51.6	53.1
Ash (g/kg diet)	75.2	66.8	90.3	69.2	71.8	72.3
Calculated Analysis						
Energy (ME) Kcal/kg	3024.5	3024.5	3024.5	2998.0	2998.0	2998.0

wet droppings were dried in the oven at 65° to determine the moisture content, and hence the dry matter, for each. Collection was on a daily basis so the above procedure was repeated for the other two collection days. Dry droppings from the same replicates were then thoroughly pooled and ground. The dried, pooled and ground samples were stored in well labelled and covered glass bottles for laboratory analyses. The nitrogen retention was calculated by the formula

Percentage nitrogen N2 in feed N2 in droppings
Retention = N2 in feed

Blood Metabolites

Blood samples were collected and analysed for serum total protein, serum albumin, serum acid creatinine, plasma total protein and plasma albumin when the birds were five and nine weeks old. Six birds were randomly selected from each replicate and two sets of blood samples were collected from the birds in each replicate. Samples of blood (4 ml) were taken by a careful puncture of the jugular vein. Samples for serum analyses were decanted after centrifugation while EDTA was added to the blood samples and used for plasma analysis, which was carried out within four hours of collection. The decanted serum samples were stored in a freezer for subsequent analysis.

Serum and plasma total protein were determined by the biuret method of Reinhold (1953) while the determination of serum and plasma albumin was by bromocresol green binding reagent method of Doumas and Briggs (1972). The phosphotungstate method of Caraway

(1963) was used to determine uric acid. Serum creatinine determination was by folin Wu filtrate method. The data obtained were subjected to analyses of variance and significant differences between means were evaluated using Duncan's multiple range test (Gomez and Gomez 1984). All statements of statistical significance were based on $P < 0.05$.

RESULTS AND DISCUSSION

The premixes varied in the number and quantity of the vitamins and trace minerals present (Table 3). The differences observed between dietary treatments were probably due to these differences since the premixes were the only variable.

At the starter phase, birds on the diet fortified with premix Z gained more weight than those fed on diets containing the other two premixes (Table 4). The weight gain is an expression of the effect of the intake and utilization of protein. Table 3 shows that premix Z contains adequate levels of all the vitamins and trace minerals listed by NRC (1984). Premix A lacks micronutrients such as vitamin B12, zinc, biotin, folate, vitamin K, pantothenate, cobalt and thiamin. Vitamin B12, zinc and folate (Akesson *et al.* 1982) are all known to play important roles in the metabolism of protein, and their absence in premix A would have impaired protein utilization by the birds fed this premix. This is evident from the fact that the birds fed premix A diet ate as much as those on premix Z diet but gained less at the starter phase. Premix U probably could not stimulate enough protein intake to allow the broilers to fully express their genetic potential. The utilization of protein

TABLE 3
Micronutrients in various premixes (per kilogram of feed)

Premix	A	A	U	Z	*NRC requirement (per kg of feed)
	Starter		Finisher		
Vitamin A(IU)	18000	15000	8000	12500	1500
Vitamin D(IU)	2500	2500	1500	2500	200
Vitamin E(IU)	14	11	3	40	10
Vitamin B_2 (mg)	12	10	2.5	6	3.6
Vitamin B_3(mg)	44	40	8	35	27
Vitamin B_6(mg)	28	20	0.3	3.5	3.0
Choline chloride (mg)	480	400	–	300	1300
Manganese (mg)	120	120	10	100	60
Iron (mg)	70	70	5	50	80
Copper (mg)	10	10	0.2	2.0	8.0
Iodine (mg)	2.2	2.2	0.15	1.55	0.35
Selenium (mg)	0.2	0.2	0.01	0.10	0.15
Vitamin K_a (mg)	–	–	3	2.5	0.50
Calcium pantothenate (mg)	–	–	3	10	10
Vitamin B_{12} (mg)	–	–	0.008	0.025	0.009
Zinc (mg)	–	–	4.5	45	40
Cobalt (mg)	–	–	0.02	0.225	–
Vitamin B_1 (mg)	–	–	–	2.0	1.80
Biotin (mg)	–	–	–	0.05	0.15
Folio acid (mg)	–	–	–	1.00	0.55

* NRC 1984

TABLE 4
Mean protein intake growth rate and nitrogen retention of experimental birds at starter and finisher phases

Parameter	Phase	Premix A			Premix U			Premix Z			S.E.X.
	0-5 weeks (starter)										
Protein intake (g/day)			10.06[a]			8.33[b]			10.71[a]		0.53
Weight gain (g/day)			14.04[b]			10.58[c]			16.81[a]		1.71
Weight gain/ protein intake			1.40[a]			1.27[b]			1.58[a]		0.16
Nitrogen retention (%)			50.27			49.43			42.96		8.25
	6-9 weeks (finisher)	A	U	Z	A	U	Z	A	U	Z	
Protein intake (g/day)		20.26	19.15	20.05	18.52	20.00	21.95	18.67	19.50	21.58	1.00
Weight gain (g/day)		26.01[ab]	26.21[ab]	27.79[ab]	25.30[b]	23.31[c]	26.04[ab]	25.70[ab]	25.95[ab]	30.11[a]	1.78
Weight gain/ protein intake		1.28	1.39	1.39	1.37	1.17	1.19	1.38	1.33	1.40	0.1
Nitrogen retention (%)		47.53[b]	48.93[b]	57.12[ab]	60.54[ab]	71.87[ab]	64.40[ab]	65.83[ab]	59.42[ab]	70.07[a]	4.70

abc Values with different superscripts in the same row were significantly different ($P < 0.05$)

by birds fed on the diet containing this premix was the lowest among the three treatment groups as indicated by the values for weight gain and the weight gain per unit protein intake.

There was no difference ($P>0.05$) between treatments in protein intake at the finisher phase (Table 4). The complemental effects of a combination of the premix profiles was probably an important factor in stabilizing the protein intake at this phase. Endogenous secretion of vitamins (thiamin, niacin and pyridoxine) which are known to affect protein appetite in maturing birds should also be recognized as an important factor in stabilizing protein consumption. Birds fed premix U diet at both phases weighed less than those fed diets containing premix A or Z in both phases. There was no difference in nitrogen retention value between treatments at the starter phase. The high nitrogen retention values of birds fed premix U diet in both phases was not reflected in their live weight.

Birds fed premix A diet at the starter phase had consistently high protein levels in the plasma and serum fractions. This is consistent with findings of an earlier study (Oduguwa and Ogunmodede 1995). High levels of transaminating enzymes causing high dietary vitamin B6 (Chen and Marlatt 1975; Saroka and Combs 1986) was the reason adduced for the high protein level in the serum of birds fed on the diet with premix A. Birds given premix A diet at the starter phase and finished with premix Z diet had the highest values for serum total proteins and albumin fractions. In fact, treatment birds started with premix A diet and finished with any of the premix types had relatively high levels of both serum and plasma total protein and albumin fraction than treatment birds that were started with other premix types.

Uric acid metabolism is influenced by the amount of protein and amino acids in the diet. Serum uric acid (Morgensten *et al.* 1960) and creatinine (Eggum 1970) can be used as an indirect measure of protein adequacy. Treatment birds were fed iso-nitrogenous and isocaloric diets, but the group that received premix Z gained more weight at the starter phase and also had the lowest levels of uric acid in their serum. This indicates that more nitrogen/protein was incorporated into the body protein and less was excreted as uric acid. The same deduction could be made on the low creatinine levels obtained for the group of birds. Those fed with premix U diet at the starter phase and finished with premix A diet had consis tently low levels of serum uric acid and serum creatinine but the birds did not have the highest mean weight gains. The interaction of the various micronutrients in the combination of premix profiles in the bird at this stage (finisher phase) might have affected the metabolite levels which did not show in the weight changes.

The results of the study indicated that the available premixes for broilers in Nigeria vary widely in their content and thus their effects on the protein nutrition of broiler chickens, and that younger birds tend to be more sensitive to the vitamin and trace mineral profile fed to them. Therefore if combinations of premixes are to be used in rearing broilers, care should be taken to feed a proven premix of good quality at the starter phase.

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