POTENCY OF TWO PROPRIETARY MICRONUTRIENT PREMIXES FOR BROILER CHICKENS AT MARGINALLY DEFICIENT PROTEIN CONTENTS

EFICACIA DE DOS ADITIVOS CON MICRONUTRIENTES PARA BROILERS CON NIVELES DE PROTEÍNA MARGINALMENTE DEFICIENTES

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ADDITIONAL KEYWORDS

Vitamin. Trace mineral.

PALABRAS CLAVE ADICIONALES

Vitaminas. Minerales traza.

SUMMARY

An experiment was conducted to determine the potency of two proprietary micronutrient premixes for broiler chickens at marginally deficient protein contents.

Four isocaloric rations were prepared such that each containing one of two locally purchased vitamin and trace mineral premixes (labelled PPA and PPZ) were formulated to contain 22 or 20 percent crude protein.

320 unsexed day old Hubbard broiler chicks were randomly alloted to the four dietary treatments. Each treatment had 2 replicates of 40 birds each. Performance, metabolic trials, carcass evaluation and levels of some blood metabolites were determined in an experiment that lasted 35 days.

PPZ fed at 22 percent crude protein content produced birds with higher live weight and weight gains than those fed PPA at the same crude protein content. No difference was observed ($p>0.05$) between the final live weight of the birds fed PPZ or PPA at 20 percent crude protein content. Birds fed PPZ and 20 percent crude protein did not eat more ($p>0.05$) than those on the same premix but on 22 percent crude protein. So also those on PPA and 20 percent had similar ($p<0.05$) feed intake with those on the same premix at 22 percent crude protein. The best efficiency of feed utilization values was obtained for birds on PPZ at 22 percent crude protein. Generally, birds that received PPZ at either of the crude protein contents had better relationships between protein intake and body weight gain than those fed PPA.

The dietary treatment did not significantly affect the nitrogen digestibilities and the retention of the birds. Birds fed each premix type at higher protein level had higher live weight before slaughter than those fed at the lower protein contents. Birds fed at 22 percent crude protein had higher ($p<0.05$) contents of total proteins and its albumin fractions in their serum than those fed the same premix type but at 20 percent crude protein. The uric acid, creatine and creatinine in the serum of birds fed the various dietary treatments did not vary significantly. It was concluded that a good premix profile such as PPZ fed at adequate protein content (22 percent) gave satisfactory results. The superiority of the profile was however not distinct when a lower (20 percent) protein content was employed.

RESUMEN

Se realizó un experimento para determinar la potencia de dos correctores de micronutrientes sobre broilers marginalmente deficientes en proteína.

Fueron preparadas cuatro raciones isocalóricas, ajustadas a 22 o 20 p.100 de proteína bruta, que contenían uno o dos correctores con vitaminas y minerales traza (PPA y PPZ) adquiridos en el mercado local.

Trescientos pollos Hubbard, de un día de edad y sin sexar, fueron distribuidos al azar en cuatro tratamientos alimenticios, cada uno con dos repeticiones de 40 pollos cada una. En un experimento que se prolongó durante 35 días se llevaron a cabo determinación del rendimiento, ensayos metabólicos evaluación de la canal y niveles de algunos metabolitos sanguíneos.

En una dieta con el 22 p.100 de proteína bruta el aditivo PPZ dio lugar a pollos con mayor peso vivo y ganancias de peso que el PPA con el mismo nivel de poroteína. No se encontró (p>0,05) diferencia entre el peso vivo final de las aves con uno u otro aditivo cuando consumían 20 p.100 de proteína bruta. La cantidad de alimento ingerido por los animales tratados con PPZ o PPA fue similar con 20 o 22 p.100 de proteína bruta. La mayor eficacia de utilización alimenticia se logró con animales a los que se administró PPZ con 22 p.100 de proteína. En general el aditivo PPZ, a cualquier nivel de proteína, indujo mejor relación entre la ingestión de proteína y el peso vivo.

En general, los tratamientos alimenticios no afectaron a la digestibilidad y retención del nitrógeno por las aves. En los dos tratamientos (PPZ y PPA), los animales alimentados con mayor nivel de proteína arrojaron mas peso al sacrificio que lo que recibieron nivel más bajo. Asimismo, las aves dentro de un determinado aditivo que ingirieron los niveles más altos de proteína, mostraron, mayor nivel (p<0,05) de proteína total y su fracción albúmina en el suero. Ninguno de los tratamientos alimenticios indujo variación en los niveles séricos de ácido úrico, creatina y creatinina. Se concluyó que un aditivo adecuado como el PPZ suministrado junto a un nivel suficiente de proteína (22 p.100), producía resultados satisfactorios. Sin embargo la superioridad de este aditivo no era manifiesta cuando el nivel de proteína disminuye a 20 p.100.

INTRODUCTION

Vitamins and minerals that accompany protein in a diet play important roles in determining the extent of utilization. Vitamin B_{12} is intimately involved in the methionine forming system (Akesson *et al.*, 1982) and leucine synthesis from B-leucine (Ward *et al.*, 1988). Pyridoxine (Lehninger, 1987) is also known to play a central role in amino acid metabolism. Zinc supplementation enhanced nitrogen retention (Tanatarov, 1986) and the mineral has regulatory roles in protein synthesis in the liver as a component of both nucleic acid and RNA polymerase (Church and Pond, 1988).

The opinion that studies involving combination of several nutrients will tend to produce more valuable information than will experiments involving single factors is not new. When studying the inter-relationship between some vitamins of group B and methionine, Sibbald *et al.* (1962) mused that it was apparent that effects of nutrients were largely inter-dependent and they suggested that multiple combinations rather than individual factors should be studied when estimating nutrient requirements.

In a series of studies, the efficacy of commercial vitamin and trace mineral profile for rearing broiler chicks solely or in combinations at the starter and finisher phases were evaluated (Oduguwa and Ogunmodede 1995; Oduguwa *et al*., 1996). It was obvious that the premixes have differing capabilities for supporting the growth of broilers up to market weight. It was also suggested 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. However, in most developing countries, protein contents of diets are the first to be affected when there is general scarcity or escalating prices of ingredients.In this study an additional lower protein content was employed for two chosen premixes. These premixes were found to give best results when the efficacy of commonly used premixes was assessed in earlier studies (Oduguwa and Ogunmodede, 1995; Oduguwa *et al*., 1996). The lower protein level was employed so as to determine the ability of a proven premix profile to sustain good performance and/or maintain superiority at marginally deficient protein contents.

MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research Farm of the Faculty of Agriculture and Forestry, University of Ibadan, where the prevailing climate is humid tropical.

320 unsexed day-old Hubbard broiler chicks were randomly allotted to four treatment groups of two replicates each (40 birds per replicate). Four isocaloric rations were prepared such that each containing one of two locally purchased vitamin and trace mineral premixes (labelled PPA and PPZ) were formulated to contain 22 or 20 percent crude protein **(table I)**. Feed and water were provided freely except 10 hours before weighing of the birds. Experiment lasted 35 days.

The birds were housed in a deep litter house with a short sidewall that provided pens of about 3.0m by 2.0m in dimension. Each pen was heated with a 100-watt tungsten filament bulb white light and equipped with two 3-litre conical fountain drinkers and two small sized conical feeders. Weekly feed intake, body weight, feed to gain ratio and weight gain per protein intake were determined.

METABOLIC TRIALS

Metabolic trials were carried out when the birds were twenty eight days of age. This was done in specially designed metabolic cages fitted with excreta collection trays, separate watering and feeding troughs. Two birds were selected from each replicate and housed individually. A 3-day acclimatization period was allowed prior to a 3-day collection period. Dropping voided by each bird was collected on a daily basis weighed and dried in the oven at 65 °C to determine the dry matter. The dry samples were milled and stored in labelled and covered bottles for laboratory analysis.

Digestibilities of dry matter and nitrogen and the retention of nitrogen by the birds were calculated. The

Table I. *Percentage composition of experimental diets.* (Composición porcentual de las dietas experimentales).

Premix	PPA		PPZ	
Protein level	22	20	22	20
Maize	55.5	54.70	55.5	54.7
Groundnut cake	21.4	18.0	21.4	18.0
Brewer's grain	6.8	13.8	6.8	13.80
Blood meal	4.1	1.55	4.1	1.55
Fish meal	4.0	4.0	4.0	4.0
Oil	1.0	1.0	1.0	1.0
Bone meal	3.5	3.5	3.5	3.5
Oyster shell	2.9	2.65	3.15	2.85
Salt	0.3	0.3	0.3	0.30
Vitamin/mineral mixture	0.5	0.5	0.25	0.25
Total	100	100	100	100
Determined analysis (percent)				
Crude protein	22.13	20.41	21.87	19.50
Crude fibre	3.91	4.22	5.07	4.89
Ether extract	3.91	3.65	3.85	4.11
Ash	8.02	7.40	8.42	8.00
*ME Kcal/kg (estimated)	2947.02	2928.93	2892.41	2917.89

*Estimated using the formula by Pauzenga (1985) i.e.:
ME(kcal/kg)= (37 X percent protein) + 81.8 percent fat + 35.5 X percent NFE

nitrogen analysis of feed and dropping were by the methods of A.O.A.C (1984). The analysis of faecal nitrogen for nitrogen digestibility determination was based on the extraction of uric acid from poultry dropping by the use of uranyl acetate. This chemical extraction corrects for the non-faecal nitrogen constituents in nitrogen digestibility determination for poultry as first described by Ekman Fransson (1949).

COST ANALYSIS

Feed cost per kilogram diet was calculated using the prevailing market price of feed ingredients.

The unit cost of each premix type and the cost of premix per kilogram of feed was also calculated. Feed cost per kilogram weight gain was derived by multiplying the feed to gain ratio i.e. (efficiency of feed utilization) with the feed cost of the respective diets.

CARCASS ANALYSIS

Carcass evaluation was done at the end of the experiment. Four (4) birds whose weight were nearest to the average of that group were selected from each replicate, weighed, slaughtered, bled and defeathered. The head and shanks were removed. The birds were then opened up, the intestine and the giblets were separated and weighed individually. The dressed weights were obtained. The dressed carcasses were further cut into parts to obtain the weights of wings, thigh, drumstick, back and breast. These weights were expressed as percentages of dressed weights (PDW). The carcasses were stored in freezer for further evaluation. Bones in the carcasses were carefully removed and edible meat separated to obtain the weight of the total edible meat for each carcass. Meat to bone ratios were then calculated. The total edible meat weight were further expressed as percentages of the respective dressed weights.

BLOOD METABOLITES

At the end of experimental period, blood samples were taken for analysis of serum metabolites. About 3mls of blood were carefully extracted through the brachial vein from each of the four birds randomly selected per replicate. The serum total proteins were determined by the biuret method of Reinhold (1953) while serum albumin was determined by the method of Doumas and Briggs (1972). The differences between the total serum protein and serum albumin gives the serum globulin. Creatine and Creatinine were determined by the Folin Wu Filterate methods and uric acid determination was by the phosphotungstate method of Caraway (1963).

The data generated were analysed statistically using the analysis of variance technique (Steel and Torrie 1980).

RESULTS AND DISCUSSION

PPZ fed at 22 percent crude protein content produced birds with higher final live weight than those fed PPA at the same protein content. This confirms the superiority of PPZ over PPA (Oduguwa *et al.*, 1996) and this superiority stems mainly from the balanced and complete vitamin and trace mineral profile in PPZ as compared to PPA **(table II)**. No difference was observed between the final liveweight of the birds fed PPA or PPZ at 20 percent crude protein content **(table III)**. This shows that a balanced vitamin and mineral profile can ensure an efficient utilization of the various feed components better than an unbalanced one but in situation where the feed component is in short supply, the profile is limited in its ability to cause any appreciable induction of improvement in growth.

The observation that birds fed PPZ and 22 percent crude protein had higher live weight gain than birds on the same premix but 20 percent C.P. Content is understandable. Protein forms the structure of most body organs and tissues, if less protein is present in the ration, then less quantity will be deposited in the body. A low protein diet was found to significantly reduce the capacity for protein synthesis in tissues such as liver and skeletal muscles (Vonder Decken and Andersson, 1972). There is need to mention here however, that added protein was efficiently used for growth. Conversely, birds that recceived PPA and 22 percent C.P. did not have significant superiority in terms of growth rate over those fed at lower C.P. content with the same premix profile. This reveals a reduced ability of the profile to utilise the added protein to a significant advantage, an indication of a physiological wastage of the protein.

The fact that birds fed PPZ and 22 percent crude protein did not eat more (p>0.05) than those on the same premix but on 20 percent crude protein and the fact that those fed PPA at 22 percent C.P did not eat more than birds fed PPA at 20 percent C.P. Showed that the higher protein level did not induce a higher feed consumption rate. The efficiecy of feed utilization EFU relates feed intake and the body weight gain. The values reported in this study (2.90 –3.5) were poor compared with those of Sautuer *et al.* (1982) (1.69 – 1.74) who also worked with broilers. The difference could be as a result of the difference in strains of birds or the

Table II. *Amounts of micro-nutrients present in the premix profiles per kilogram of the feed.* (Cantidades de micronutrientes en el aditivo, por kg de peso).

	** PPA			*N.R.C.
	Starter	Finisher	PPZ	Requirements per kg of feed
Vitamin A (I. U)	18000	15000	12500	1500
Vitamin D3 (I. U)	2500	2500	2500	200
Vitamin E (I.U)	14	11	40mg	10
Vitamin B2 (mg)	12	10	6	3.6
Vitamin B3 (mg)	44	40	35	27
Vitamin B6 (mg)	28	20	3.5	3.0
Choline chloride (mg)	480	400	300	1300
Manganese (mg)	120	120	100	60
Iron (mg)	70	70	50	80
Copper (mg)	10	10	20	8.0
Iodine (mg)	2.2	2.2	1.55	0.35
Selenium (mg)	0.2	0.2	0.10	0.15
Vitamin K3 (mg)	-	-	2.5	0.50
Calcium pantothenate (mg)	-	-	10	10
Vitamin B12 (mg)	-	-	0.025	0.009
Zinc (mg)	-	-	45	40
Cobalt (mg)	-	-	0.225	-
Vitamin B1 (mg)	-	-	2.0	1.80
Biotin (mg)	-	-	0.05	0.15
Folic acid (mg)	-	-	1.00	0.55

*N.R.C. (1984)
**Manufacturers of PPA had designated premixes for starter and finisher broilers while manufacturers of PPZ provided only one premix for the starters and finishers.

condition under which the experiments were carried out. The best EFU values were obtained for birds fed PPZ and 22 percent crude protein, while the worst was for the group fed the same premix and 20 percent crude protein. In line with earlier observations, birds fed PPZ at 22 percent C.P, utilized protein in the feed better than their counterparts fed PPA at the same content of protein. Generally birds that received PPZ at either of the C.P. contents had better relationship between protein intake and body weight gain than those fed PPA. A look at the composition of the premixes in **table II** showed that although PPA contains very high amount of some vitamins and minerals, its outright lack of some micronutrients should be a cause for concern more so that among those that were absent are known to play marked roles in protein utilization (Vitamin B12. Ward *et al.* 1988, Boitin, Sweetman and Nyhan 1986, Zinc, Ogunmodede 1974, Church and Pond 1988).

The dietary treatments did not significantly affect the nitrogen digestibility and the retention of the

Table III. *Performance, cost analysis, dry matter digestibility and nitrogen utilization by broiler chicks fed two premixes and two levels of protein.* (Eficacia, análisis de costes, digestibilidad de la materia seca y utilización del nitrógeno por broilers alimentados con dos aditivos y a dos niveles de proteína bruta).

Premix	PPA		PPZ		Std. error
Protein level	22	20	22	20	of Mean
Performance					
Average feed intake (g)	32.301^{bc}	31.84^{c}	35.56^{c}	33.84^{ab}	1.46
Final live weight (g)	402.5^{b}	395.32^{b}	486.46^{a}	407.81^{b}	36.92
Average daily weight gain (g)	10.22^{bc}	10.06^{b}	12.69^{a}	10.45^{b}	1.07
Efficiency of feed utilization	3.15^{bc}	3.31^{ab}	2.90^{c}	3.52^{a}	0.23
Protein efficiency ratio	1.67^{bc}	1.47^{c}	1.85^{a}	1.76^{b}	0.14
*Cost analysis					
Unit cost of premix (N\kg)	280	280	700	700	-
Premix cost\kg of feed (N)	1.4	1.4	1.75	1.75	-
Cost per kg feed (N)	26.89	25.35	27.26	25.71	-
Feed cost/kg weight gain (N)	84.70^{b}	83.91^{b}	79.05^{c}	90.50^{a}	2.10
Nutrient utilization (percent)					
Dry matter digestibility	65.68	63.48	62.12	59.50	3.10
Nitrogen retention	59.29	57.78	54.62	54.03	3.58
Nitrogen digestibility	84.96	86.96	83.19	81.83	2.33

Means on the same row with different superscripts were significantly different ($p < 0.05$)
*1 US $= N 98.00

birds **(table III)** but the birds fed PPZ and 22 percent, gained more weight than the other treatments. This might indicate that these coefficients probably have lower sensitivities for measuring response in broiler chikcs. The fate of the digested end products, in this case amino acids, is very important in determining the extent to which the digested protein is put to use. What was observed indicated that the premix did not exert much influence on digestion but their effects became pronounced afterwards and this led to the differences observed.

COST ANALYSIS

The unit cost of PPZ was 2.5 fold higher than that of PPA **(table III)** But the cost of premix per kg of feed

Table IV. *Carcass characteristics and relative organ weights of starter chicks fed two premixes and two levels of protein.* (Características de la canal y peso relativo de los órganos de pollitos que consumieron dos aditivos y dos niveles de proteína bruta).

Premix	PPA		PPZ		Std.
Protein level	22	20	22	20	error
Carcass traits					
Live weight before slaughter (g)	564.3[a]	477.5[b]	566.9[a]	501.8[b]	9.16
Dressed weight (g)	393.0	338.8	338.0	338.6	17.14
Dressing percentage (percent)	69.6	71.0	67.5	67.5	2.00
Total edible meat (g) (TEM)	217.7	204.1	227.5	216.3	8.51
(PDW)*	55.4	60.3	59.3	63.9	0.60
Flesh to bone ratio	1.6[b]	2.2[a]	2.5[a]	2.4[a]	0.06
Cut parts *(PDW)					
Neck	8.2	7.2	8.6	8.0	0.31
Thigh	14.4	13.8	15.0	14.6	0.26
Drumstick	14.0	13.9	13.7	13.0	0.21
Breast	17.4	16.6	18.3	17.2	0.36
Wing	11.5	12.2	11.4	11.8	0.18
Back	18.8	19.7	17.6	19.3	0.35
Abdominal fat	1.3	1.0	1.3	1.0	0.10
Organs (PDW)					
Gizzard	4.9	4.9	5.0	6.1	0.29
Liver	5.3	4.3	5.3	4.5	0.26
Heart	1.0	0.9	1.0	1.0	0.02
Lungs	1.2	0.9	1.3	1.0	0.07
Spleen	0.3	0.2	0.3	0.3	0.01
Kidney	1.1	1.1	1.8	1.6	0.18

*PDW= Percentage of dressed weight.
Means on the same row with different superscripts were significantly different ($p<0.05$).

Table V. *Mean values of some blood metabolites of starter broiler chicks fed two premixes at two protein levels.* (Valores medios de algunos metabolitos sanguineos de pollos alimentados con dos aditivos a dos niveles de proteína bruta).

Premix	PPA		PPZ		Std.
Protein level	22	20	22	20	error
Serum total protein (g/dl)	3.57[a]	2.62b[c]	2.99[ab]	2.08[c]	0.13
Serum albumin (g/dl)	1.34[a]	0.98[b]	1.26[a]	0.78[b]	0.52
Serum globulin (g/dl)	2.23[a]	1.64[b]	1.73[ab]	1.42[b]	0.12
Serum glucose (mg/dl)	28.7	31.5	33.5	28.6	1.74
Serum uric acid (mg/dl)	1.31	1.5	1.6	1.3	0.08
Serum creatinine (mg/dl)	1.7	1.9	2.0	1.8	0.10
Serum creatine (mg/dl)	1.2	1.4	1.4	1.2	0.08

Means on the same row with different superscript were significantly different ($p<0.05$).

for PPZ was only 1.25 fold higher than that of PPA. This was because the recommended level of inclusion of PPA was double (0.5 percent) that of PPZ (0.25 percent).

The impact of the type of premix profile used on the overall feed cost was minimal obviously because of the very little percentage of vitamin and mineral premix used in the gross composition. However, this difference may become pronounced if the scale of production goes to so many tonnes.

It was very glaring that protein content of the diet exerted greater impact on the overall cost of the feed because for both PPA and PPZ, the diet containing 22 percent C.P was more expensive.

The data on feed cost per kg weight gain showed that the diet that contained PPZ at the higher protein level i.e. (22 percent C.P) was most efficient ($p<0.05$) even though the diet was the most expensive (i.e. N27.26/kg).It is note worthy that at the lower protein content this premix profile i.e. PPZ did not maintain this superiority thus corroborating earlier observation made on performance on birds.

Carcass Characteristics

Carcass characteristics and relative organ weight of birds fed the dietary treatments are shown in **table IV**. Birds fed each premix type at higher C.P. level had higher live weight before slaughter than those fed at lower protein. This is because protein forms the structure of organs and tissues and an adequate protein in the diet if properly utilized will more likely lead to more deposition of protein in such tissues that increased weights. Birds fed PPA and 22 percent protein had lower total edible meat expressed as percentage of dressed weight and flesh to bone ratio than those birds fed PPZ at the same protein level. This indicates that the vitamin mineral profile of PPZ had higher capabilities of inducing more meat yeild than those of PPA. The dressed weight, dressing perentage and the total edible meat did not vary significantly with the dietary treaments. The observation that the relative cut part weights did not vary significantly with the dietary treatments agreed with ealier findings(Oduguwa and Ogun modede 1995). The finding also supports the belief that the proportion of cut parts seldom vary with dietary treatments even when meat yields of the various group differ. Fencher and Jensen (1989) obtained breast yield weights that were not affected by the composition of the diets.

ORGAN WEIGHTS

Birds fed at lower protein content for each premix profile did not produce lower relative weight of all the organs determined. Two reasons can be adduced for this obersation. The protein content fed are so close that the effect of the difference may not be felt. This further underlines the importance of these organs in the body such that a slight change in the nutriture of the birds would not immediately affect their relative weight so that their functions were not impaired, a situation which might lead to a more serious consequence for the birds. The lack of effect of dietary protein content on the organ weight might also be due to an adaption to the high protein diets as observed by Featherston and Schols (1968). They reported that liver weight expressed on body weight basis was significantly increased in chicks fed a high protein diet for the first two days after which the differences between the two groups largely disappeared.

BLOOD METABOLITES

Table V shows some serum metabolites of the experimental birds. Eggum (1989) observed a close relationship between dietary and serum protein concentrations. The higher ($p<0.05$) amount of total protein and its albumin fractions in the serum of birds fed 22 percent crude protein content over those fed 20 percent crude protein content on the same premix type is not unexpected. Investigators have shown that serum protein and albumin responded positively to increase in intake of protein from either animal or vegetable sources (Graham *et al.*, 1996).

The uric acid concentration in the serum of birds did not vary with the dietary treatments. Although uric acid metabolism is influenced by the amount of protein in the diet (Ward *et al.*, 1974). Studies have shown that the removal of uric acid from the blood is normally efficient such that the content rarely exceed a given content of the chicken blood (Scot *et al.*, 1976). Thus it is difficult to determine the actual amount of this metabolite excreted into the blood at a particular point in time. Serum creatine and creatinine levels apart from being useful as an indirect measure of protein utilization (Eggun 1989) can also be used as an index of muscle wastage (Martin *et al.*, 1981). No difference was observed in the serum creatinine contents of the group of birds fed the various treatments. It was concluded that a good premix profile such as PPZ fed at adequate protein content (22 percent) gave satsfactory results. The superiority of the profile was however not distinct when a lower (20 percent) protein content was employed.

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