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Niacin Requirement of Broilers Fed on a Diet Based on Maize-Palm Kernel Meal

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ABSTRAK

Tujuh kandang yang sama dipenuhi dengan anak-anak ayam komersil berusia 25 hari diberi makanan bersalai berasaskan makanan sampingan kernel-jagung palma dengan paras niacin yang berubah-ubah supaya catuan mempunyai 15.0, 22.5, 30.0, 37.5, 45.0, 52.5 dan 60.0 mg niacin per kg. Perawatan berjalan selama 42 hari. Keputusannya bergantung pada pertambahan berat, pengambilan makanan, penggunaan nitrogen yang ketara, tenaga metabolisme, kalsium dan posporus serta ciri-ciri karkas. insiden dermatitis dan kecacatan kaki menunjukkan bahawa paras diet niacin 37.5 mg/kg mencukupi untuk menghasilkan penggunaan nutrien yang baik, mengoptimum prestasi pengeluaran dan untuk penjagaan kesihatan.

ABSTRACT

Seven duplicate floor pens with 25 day-old commercial chicks were fed a practical type of broiler diet based on maize-palm kernel meal supplemented with varying levels of niacin so that the rations had 15.0, 22.5, 30.0, 37.5, 45.0, 52.5 and 60.0mg of niacin per kg of feed. The treatments were maintained for a period of 42 days. The results based on liveweight gain, feed intake, apparent utilisation of nitrogen, metabolizable energy, calcium and phosphorus and carcass characteristics, and the incidence of dermatitis and leg deformities showed that dietary niacin level of 37.5 mg/kg feed was adequate for achieving good nutrient utilisation, optimising productive performance and for maintaining good health.

INTRODUCTION

In the Nigerian feed industry, palm kernel meal (PKM) is now widely being used *in lieu* of groundnut cake (GNC) due to the high cost and inadequate supply of the latter. The use of PKM as a substitute for GNC, causes problems on micronutrient requirement of birds due to its characteristically high fibre content and relatively poorer amino acids bioavailability (Nwokolo *et al.* 1977; Oloyo 1991; Best 1993). In this regard, niacin requirement of birds present a rather special problem when fed on PKM-based rations, especially since it has been established that the vitamin requirement is a function of composition and bioavailability of amino acids of the diet (Leeson 1988). Since maize/PKM play an important role in poultry feed formulation in Nigeria, it was felt necessary to estimate the niacin required for optimum productive performance of broilers fed on rations having these ingredients.

MATERIALS AND METHODS

A practical ration based on maize-PKM was formulated (Table 1), analysed for niacin content by the method of Association of Vitamin Chemists (1966) and then supplemented with feed-grade niacin (LONZA, Switzerland) such that the experimental diets contained 15.0, 22.5, 30.0, 37.5, 45.0, 52.5 and 60.0 mg of the vitamin per kg of ration. Each diet was given to a duplicate group of 25 day-old commercial broiler chicks (i.e., 50 birds per treatment) for a period of 42 days. Experimental chicks were housed in 14 deep litter pens, each of 5.5 m2 floor area covered with dry-wood shavings litter. Feed and water were provided in a trough feeder and two 4-litre drinkers and brooding was carried out using 200-W Tungsten filament lamp. Throughout the period of experimentation, feed and fresh clean water were offered at all times, and routine vaccinations were administered.

TABLE 1
Composition of a practical maize-palm kernel meal based diet

Constituent	%
Yellow maize	52.0
Palm kernel meal	20.2
Blood meal	8.2
Fish meal	5.2
Wheat offal	10.3
Oyster shell	1.0
Bone meal	2.0
Vitamin/mineral premix*	0.1
Salt (NaCl)	0.2
Palm kernel oil	1.0
Total	100.0
Analysed Chemical composition	
Crude protein (%)	21.5
Gross energy (Kcal/kg)	3120.4
Calcium (%)	1.21
Phosphorus (%)	0.79
Niacin (mg/kg)	15.0
Tryptophan, calculated (%)	0.25

*Vitamin/mineral premix supplied the following vitamins and mineral elements per kg of feed: Vit. A, 1200 IU; Vit. D, 2500 IU; Vit. E, 10 IU; Menadione sodium bisulphite (Vit. K), 1.5mg; Vit. B1, 2.5mg; Vit. B2, 5mg; Choline chloride, 500mg; Calcium D-pantothenate, 10mg; Vit. B6, 4mg; Vit. B12, 0.02mg; Biotin, 0.2mg; Iron, 50mg; Manganese, 150mg; Copper, 2.5mg; Zinc, 45mg; Cobalt, 0.2mg; Selenium, 0.08mg; Iodine, 1.4mg.

The chicks were weighed individually at the commencement of the experiment (i.e. at day-old) and weekly thereafter until they were 6 weeks when the trial was terminated. Weekly records were kept of feed intake, weight gain, feed efficiency (gain/feed intake) and per cent incidence of dermatitis and of leg bone deformities.

In the last three weeks of experimentation, metabolic studies were conducted on 4 replicate samples of experimental chicks randomly selected from each group (i.e. 2 birds/replicate/treatment) at the beginning of the fourth week. In accordance with the total collection procedure, excreta were collected daily from each treatment group on 14 successive days during the fifth and sixth week for nutrient analysis. Feed and excreta were analysed for nitrogen and phosphorus (AOAC, 1980) and calcium (Perkin-Elmer Inc., 1973). Gross energy values were determined with a ballistic bomb calorimeter and apparent metabolizable energy values of diets were calculated. Apparent retention of nitrogen, phosphorus and calcium was calculated based on the difference between the amount of the constituent in the diets and excreta samples collected.

At the end of the experimentation, 4 replicate samples of birds were selected from each treatment group (i.e. 2 birds/replicate/treatment) in the floor pens. They fasted for 6 hours, after which they were weighed, slaughtered and dressed for carcass characteristic evaluation. The carcasses were weighed and dressing percentage calculated. The abdominal fat pad was carefully excised and weighed. Bones in the carcasses were carefully removed and the edible meat was separated. Care was taken to prevent loss of meat to the bones. Every effort was made to dress all the carcasses as identically as possible. Total edible meat and total bone from each of the carcasses were weighed and the meat to bone ratio was calculated. Meat and bones were also expressed as percentages of carcass weights.

All data obtained in the study were subjected to analysis of variance (Steel and Torrie, 1960) and significantly different treatment means were compared using the multiple range test of Duncan (1955).

RESULTS AND DISCUSSION

Establishment of niacin requirement of broiler chicken could be undertaken using synthetic diet, but the use of experimental ration formulated with actual feed ingredients would be beneficial for practical application. Studies by Childs *et al.* 1952; Fisher *et al.* 1955; Patterson *et al.* 1956 and NRC 1984 revealed that 18-33 mg niacin/kg of purified diet containing adequate amounts of tryptophan (0.14-0.24%) was required by chicks for normal growth and prevention of deficiency symptoms, whereas higher amounts of the vitamin (30-100 mg/kg feed) were needed by the chicks when fed practical rations (Fisher *et al.* 1955; Czarnecki *et al.* 1983 and Waldroup *et al.* 1985). Variation in the vitamin requirement of birds/and or supplementation levels was due to the types of ingredients used in the diets, niacin bioavailability in diets and tryptophan content of diets. Practical diet based on maize/PKM and containing 0.25% tryptophan (Table 1) was supplemented with varying levels of niacin and then constituted the test diets for this study.

Data on feed utilisation for growth and health performance of broiler chicks shown in Table 2 indicated that those on up to 30 mg niacin/kg consumed significantly less feed, had poorer weight gain and weighed less at 42 days than those given 37.5-60 mg niacin/kg. Reduced feed consumption by birds given 15-22.5 mg niacin/kg might be due to the high incidence in the groups of leg bone deformities (bowing, twisting, and crippling) and development of dermal lesions in the feet, which resulted in reduction in free movement of the birds. Types of skin lesions and leg deformities that developed in these groups of birds were characteristic of niacin deficiency in young chickens (Gries and Scott 1972; Summers *et al.* 1984; Cook *et al.* 1984 and Leeson 1988) and that these symptoms appeared within the first 2 weeks of the feeding trial. In affected birds, vision was impaired because the edges of the eyelids became granular and contracted. Skin lesions of varying degree appeared around the corners of the mouth and nostrils. Dermal lesions occurred on the feet and toes with pronounced haemorrhagic fissures on the bottom of the feet to the extent that the affected birds had locomotory problem. The results indicated that while a minimum of 37.5mg niacin/kg was needed for promotion of better feed utilisation for growth, a lower level of 30 mg niacin/kg was required for the prevention of occurrence of dermatitis and for normal leg bone development.

Results in Table 2 showed significant treatment effect on apparent nutrient utilisation in broiler chicks, where higher dietary niacin levels resulted in remarkable improvement in the utilisation of nitrogen, metabolizable energy, calcium and phosphorus. This observation is in agreement with earlier report on the physiological function of niacin and its effect on the utilisation of metabolizable energy and dietary nitrogen (Lockhart *et al.* 1966). LONZA (1984) reported poor utilisation of calcium and phosphorus, which are required for normal bone formation in niacin-deficient chickens. The results of the present study indicated that while dietary level of 30mg niacin/kg seemed adequate for better utilisation of nitrogen, metabolizable energy and calcium, it was inadequate for phosphorus utilisation.

TABLE 2

Performance, deficiency symptoms and apparent nutrient utilisation of broilers fed varying levels of niacin

Parameter	Dietary niacin levels (mg/kg)							
	15.0	22.5	30.0	37.5	45.0	52.5	60.0	±SEM**
Performance:								
Body weight at 42 days (g)	1099.2c*	1204.1b	1279.5b	1590.4a	1552.8a	1569.6a	1578.0a	96.85
Body weight gain (g/bird/day)	25.1b	27.6b	29.4b	36.8a	35.9a	36.3a	36.5a	2.31
Feed intake (g/bird/day)	86.4b	88.0b	91.2b	117.0a	112.6a	113.8a	116.4a	6.60
Feed efficiency (g gain/g feed)	0.29	0.31	0.32	0.31	0.32	0.32	0.31	4.949E-03
Deficiency symptoms:								
Incidence of dermatitis (%)	10a	4b	0c	0c	0c	0c	0c	1.77
Incidence of leg deformities (%)	6a	2b	0c	0c	0c	0c	0c	1.05
Nutrient Utilisation:								
Nitrogen retention (%)	53.7b	54.8b	65.6a	67.8a	66.2a	66.7a	65.5a	2.76
Metabolizable energy (Kcal/kg)	2750.0b	2774.2b	2884.6a	2865.5a	2890.4a	2876.0a	2882.8a	27.04
Calcium retention (%)	65.4b	67.4b	72.9a	72.6a	74.8a	73.2a	73.7a	1.65
Phosphorus retention (%)	55.2c	58.6c	64.8b	74.1a	72.5a	72.6a	73.4a	3.62

*Mean values in a row bearing different subscripts differ significantly at $P<0.05$

**SEM, standard error of the mean

TABLE 3
Carcass characteristics of broilers fed varying levels of niacin

Parameter	Dietary niacin levels (mg/kg)							
	15.0	22.5	30.0	37.5	45.0	52.5	60.0	±SEM**
Carcass weight (g)	687.0b*	759.8b	835.5b	1094.2a	1073.0a	1087.7a	1084.1a	82.64
Dressing percentage	62.5b	63.1b	65.3ab	68.8a	69.1a	69.3a	68.7a	1.38
Total edible meat (g)	434.2c	484.0bc	566.5b	745.2a	732.9a	735.3a	737.2a	62.69
Meat (% carcass weight)	63.2b	63.7b	67.8a	68.1a	68.3a	67.6a	68.0a	1.03
Total bone (g)	224.6b	246.9b	243.1b	326.0a	317.6a	330.6a	323.0a	21.62
Bone (% carcass weight)	32.7a	32.5a	29.1b	29.8b	29.6b	30.4b	29.8b	0.67
Meat : bone ratio	1.93b	1.96b	2.33a	2.29a	2.31a	2.22a	2.28a	0.08
Abdominal fat pad (g)	28.2a	28.9a	25.9ab	23.0b	22.5b	21.8b	23.9b	1.31
Abdominal fat (% carcass weight)	4.1a	3.8ab	3.1b	2.1c	2.1c	2.0c	2.2c	0.41

* Mean values in a row bearing different subscripts differ significantly at $P<0.05$
** SEM, standard error of the mean

The significance of producing carcass of desirable quality for a profitable broiler production enterprise emphasized the importance of evaluation of carcass characteristics of the experimental chicken. With the exception of fat deposition in the abdominal region of chickens, information is lacking on the niacin requirement for all the parameters of carcass quality examined in this study. A higher niacin level is required for desirable carcass characteristics as evident from the significant dietary treatment effect on the parameters (Table 3). A level of 30 mg niacin/kg appeared to be adequate for both meat and bone expressed as per cent of carcass weight and meat to bone ratio. It was only marginal for dressing percentage and abdominal fat pad and seemed inadequate for carcass weight, total edible meat and bone weights.

The significant depression in abdominal fat deposition in chickens at higher dietary levels of niacin is in agreement with earlier report (Waldroup *et al.* 1984) and it is a desirable feature. Excessive abdominal fat in broiler carcasses from the consumerís view point can be objectionable and undesirable because it resulted in reduced processing yield and greater cooking losses, and from the production economicsí view point, it is wasteful as it is an uneconomical conversion of dietary energy (Bartov *et al.* 1974). The problem associated with disposal of fat contaminated water at poultry processing plants (Kubena *et al.* 1972, 1974) adds further to the undesirability of the presence of excessive abdominal fat in broiler chickens.

From the foregoing results, therefore, it may be concluded that a dietary niacin level of 37.5 mg/kg feed in a maize-PKM based diet was adequate for optimum feed and nutrient utilisation, prevention of dermatitis and leg deformities, and production of desirable carcass quality in chicken.

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