Niacin requirement of broilers fed maize - palm kernel meal based diets

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Abstract

A total of 350 day-old commercial broiler chicks were used in a trial aimed at estimating niacin requirement of broilers fed practical ration based on maize - palm kernel meal. The test diet was supplemented with varying levels of niacin so that the rations had 15.0, 22.5, 30.0, 37.5, 45.0, 52.5 and 60.0 mg of the vitamin per kg of feed and were fed to 7 duplicate floor pens with 25 chicks each. The treatments were maintained for a period of 42 days. Estimation of live weight 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.

Keywords: Broiler chicken, niacin, maize, palm kernel meal

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. But on use of PKM as a substitute for GNC, some problems on micronutrient requirement of birds arose due to its characteristically high fibre content and its 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 more especially 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

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 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 and containing dry-wood shaving litter, two 4-litre plastic drinkers, a trough feeder and 200W Tungsten filament lamp. Throughout the period

of experimentation, feed and fresh clean water was offered at all times, and routine vaccinations were administered.

The chicks were weighed individually at the commencement of the experiment 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 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,

1990) 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 were calculated as the difference between the amount of the constituent in the diets and the excreta sample collected.

At the end of the experimentation, 4 replicate samples of birds were selected from each treatment group in the floor pens, starved of feed for 6 hours, after which they were weighed, slaughtered and dressed for carcass characteristic evaluation. The carcasses were weighed and dressing percentages were 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

Table 1 *Composition of practical diet supplemented with varying levels of niacin*

Constituent	g kg ⁻¹
Yellow maize	520
Palm kernel meal	202
Blood meal	82
Fish meal	52
Wheat offal	103
Oyster shell	10
Bone meal	20
Vitamin/mineral premix*	1
Salt (NaCl)	2
Palm kernel oil	10
	1000
<i>Chemical composition (analysis)</i>	
Crude protein g kg ⁻¹	215
Gross energy (MJ kg ⁻¹)	13.06
Calcium g kg ⁻¹	12.1
Phosphorus g kg ⁻¹	7.9
Niacin mg kg ⁻¹	150
Tryptophan, calculated g kg ⁻¹	2.5

*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.

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prevent loss of meat to 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, 1980) 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 with the aid of synthetic diet, but the use of experimental ration formulated with actual feed ingredients lends the results obtained to practical application. Studies by Childs *et al.*, 1952, Fisher, 1955, Patterson 1956 and NRC *et al.*, 1984 revealed that 18-33mg 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 symptom, 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; Waldroup *et al.*, 1985 and Oloyo and Ogunmodede, 1998). 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 diet 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 30mg niacin/kg consumed significantly less feed, had poorer weight gain and weigh less at 42 days than those given 37.5 - 60mg niacin/kg. Reduced feed consumption by birds given 15 - 22.5mg

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 to 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; 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 the 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 result indicated that while a minimum of 37.5mg niacin/kg was needed for promotion of better feed utilisation for growth, a lower level of 30mg 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 result of 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.

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Table 2 Feed utilisation, health performance and apparent nutrient utilisation of broilers fed varying levels of the vitamin

Measurement	Dietary niacin levels (mg/kg)						
	15.0	22.5	30.0	37.5	45.0	52.5	60.0
<i>Feed Utilisation</i>							
Body weight at 42 days (g)	1099.2 ^c	1204.1 ^b	1279.5 ^b	1590.4 ^a	1552.8 ^a	1569.6 ^a	1578.0 ^a
Body weight gain (g/bird/day)	25.1 ^b	27.6 ^b	29.4 ^b	36.8 ^a	35.9 ^a	36.3 ^a	36.5 ^a
Feed intake (g/bird/day)	86.4 ^b	88.0 ^b	91.2 ^b	117.0 ^a	112.6 ^a	113.8 ^a	116.4 ^a
Feed efficiency (g gain/g feed)	0.29	0.31	0.32	0.31	0.32	0.32	0.31
<i>Health Performance</i>							
Incidence of dermatitis (%)	10 ^a	4 ^b	0 ^c	0 ^c	0 ^c	0 ^c	0 ^c
Incidence of leg deformities (%)	6 ^a	2 ^b	0 ^c	0 ^c	0 ^c	0 ^c	0 ^c
<i>Nutrient Utilisation</i>							
Nitrogen retention (%)	53.7 ^b	54.8 ^b	65.6 ^a	67.8 ^a	66.2 ^a	66.7 ^a	65.5 ^a
Metabolizable energy (Kcal/kg)	2750.0 ^b	2774.2 ^b	2884.6 ^a	2865.5 ^a	2890.4 ^a	2876.0 ^a	2882.8 ^a
Calcium retention (%)	65.4 ^b	67.4 ^b	72.9 ^a	72.6 ^a	74.8 ^a	73.2 ^a	73.7 ^a
Phosphorus retention (%)	55.2 ^c	58.6 ^c	64.8 ^b	74.1 ^a	72.5 ^a	72.6 ^a	73.4 ^a

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

SEm = standard error of the mean

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Table 3 *Carcass characteristics of broilers fed varying levels of the vitamin*

Measurement	Dietary niacin levels (mg/kg)							±SEM*
	15.0	22.5	30.0	37.5	45.0	52.5	60.0	
Carcass weight (g)	687.0 ^{b*}	759.8 ^b	835.5 ^b	1094.2 ^a	1073.0 ^a	1087.7 ^a	1084.1 ^a	82.64
Dressing percentage	62.5 ^b	63.1 ^b	65.3 ^{ab}	68.8 ^a	69.1 ^a	69.3 ^a	68.7 ^a	1.38
Total edible meat (g)	434.2 ^c	484.0 ^{bc}	566.5 ^b	745.2 ^a	732.9 ^a	735.3 ^a	737.2 ^a	62.69
Meat (% carcass weight)	63.2 ^b	63.7 ^b	67.8 ^a	68.1 ^a	68.3 ^a	67.6 ^a	68.0 ^a	1.03
Total bone (g)	224.6 ^b	246.9 ^b	243.1 ^b	326.0 ^a	317.6 ^a	330.6 ^a	323.0 ^a	21.62
Bone (% carcass weight)	32.7 ^a	32.5 ^a	29.1 ^b	29.8 ^b	29.6 ^b	30.4 ^b	29.8 ^b	0.67
Meat : bone ratio	1.93 ^b	1.96 ^b	2.33 ^a	2.29 ^a	2.31 ^a	2.22 ^a	2.28 ^a	0.08
Abdominal fat pad (g)	28.2 ^a	28.9 ^a	25.9 ^{ab}	23.0 ^b	22.5 ^b	21.8 ^b	23.9 ^b	1.31
Abdominal fat (% carcass weight)	4.1 ^a	3.8 ^{ab}	3.1 ^b	2.1 ^c	2.1 ^c	2.0 ^c	2.2 ^c	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 in the realisation of monetary profit from broiler production enterprise has made important the evaluation of carcass characteristics of experimental chicks. In agreement with earlier findings by Oloyo and Ogunmodede (1998), results of present study (Table 3) showed that production of carcass with desirable characteristics required the vitamin as evident from the significant dietary treatment effect on the parameters. Whereas 30mg 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. This same dietary niacin level 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 the vitamin is in agreement with earlier report (Waldroup *et al.*, 1984) and it is a desirable feature. Excessive abdominal fat in broiler carcasses from the consumer's view point can be objectionable and undesirable because it resulted in reduced processing yield and greater cooking losses and from the production economics' 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 therefore, it may be concluded that a dietary niacin level of 37.5 mg/kg feed was adequate for promotion of good feed and nutrient utilisation, prevention of dermatitis and legdeformities, and production of desirable carcass quality in areas where maize and PKM are used as feed ingredients for broiler rations.

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