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PERFORMANCE OF BROILERS FED VARYING LEVELS OF BIOTIN AND PALM KERNEL OIL

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ABSTRACT

A total of four hundred and eighty day-old commercial broiler chicks were assigned to 12 dietary treatments in a 2 x 6 factorial experiment to study the effects of biotin and palm kernel oil supplementation on their performance and carcass characteristics. Measurements of average daily weight gain, average daily feed intake, carcass weight, dressing percentage, total edible meat weight and total bone weight showed that a minimum of 120 mcg biotin per kg of feed was needed by broiler chicks for optimum performance. All carcass characteristics examined except total bone expressed as percentage of carcass weight were positively correlated with dietary biotin level, although none was significant ($P>0.05$). Supplementation of diet with 2% palm kernel oil significantly ($P<0.05$) reduced average daily feed intake and average weight gain but did not affect feed efficiency (gain/feed intake) and carcass characteristics of broilers.

INTRODUCTION

The significance of producing carcass of desirable quality in the realisation of monetary profit from broiler production enterprise cannot be over-emphasized. The role of acetyl CoA carboxylase, a biotin-dependent enzyme in the rate determining step of fatty acid synthesis (Bortz *et al.*, 1963) and the consequent alteration of the fatty acid pattern with a shift to the unsaturated side in adipose tissue of biotin-deficient chicks (Roland and Edwards, 1971) were responsible for the flabby greyish adipose tissue of the vitamin-deficient chicken (Tagwerker, 1983). Harms and Simpson (1975) and Tagweker (1983) have also related the high level of such unsaturated fatty acids in the adipose tissue of biotin-deficient chicken to the production of skin that was less resistant to abrasions and breast blisters. Streiff *et al.* (1977) related dietary biotin level to the consistency of body fat and it was found that the degree of unsaturation and softness of fat increased with decreasing biotin intake. Since hard adipose fat of poultry carcass is preferred over soft fat, it was suggested that biotin is required for desirable carcass quality.

It has however been shown that alteration in fatty acid composition of the tissue varied with the type of dietary fat, and that addition of polyunsaturated fatty acids to a fat-free, biotin-deficient diet increased the severity of dermal lesions, whereas addition of a saturated oil decreased the severity of these lesions (Roland and Edwards, 1971).

It seemed therefore that the type of oil used in ration formulation for broilers will influence their biotin requirement for desirable carcass characteristics. Information is also lacking on the influence of dietary biotin on carcass characteristics such as carcass weight, dressing percentage, total edible meat, total bone weight and meat to bone ratio. The objective of the research reported herein therefore, was to study the effect of biotin and palm kernel oil supplementation on feed utilisation and carcass characteristics of broilers fed practical rations.

MATERIALS AND METHODS

Four hundred and eighty day-old commercial broilers were randomly allotted to twelve treatment groups with two replicates consisting of 20 birds each. The experimental design was 2 x 6 factorial, the dietary factors being oil levels (0 and 2%) and biotin levels (40, 80, 120, 160, 200, and 240 mcg/kg feed). Experimental diets were obtained by formulating a basal biotin-deficient diet each with or without added palm kernel oil such that two basal rations with similar metabolisable:crude protein ratios were obtained (Table 1). Both diets were then supplemented with biotin in the form of Rovinmix H-2 (a *Roche* product) such that six graded levels of the vitamin were obtained. Chicks were raised in 24 floor pens, each of 4.2 m^2 floor area and containing dry wood shavings as litter material; two 4-litre plastic drinkers, a trough feeder and a 100 W tungsten filament lamp. Birds were maintained on the respective treatments for a period of 6 wks during which feed and water were provided *ad libitum* and routine vaccinations administered. Body weights and feed intake were recorded weekly. At the end of the trial, two birds were randomly selected from each replicate and fasted for 8 h, after which they were weighed, exsanguinated, scalded, picked and decapitated. A cut was made in the abdominal region with a sharp knife and the intestine, gizzard and crop were removed. The carcasses were weighed and dressing percentage calculated. Bones in the carcasses were carefully removed and the edible meat 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 meat to bone ratio calculated. Meat and bone were also expressed as percentage of carcass weight.

Table 1. Composition of the basal biotin-deficient diets

	%	
	I	II
Yellow maize	54.0	49.5
Palm kernel meal	18.0	18.0
Blood meal	10.0	10.5
Fish meal	2.5	2.5
Brewer's grain	12.2	12.2
Oyster shell	1.0	2.0
Bone meal	2.0	3.0
Vitamin/Mineral premix (UNI-VIT 15)*	0.1	0.1
Salt (NaCl)	0.2	0.2
Palm kernel oil	0.0	0.0
TOTAL	100.0	100.0
<u>Calculated analysis:</u>		
Crude protein (%)	21.26	21.25
Metabolizable energy, ME (Kcal/Kg)	2741.92	2751.82
ME/CP	128.73	129.48
Fat (%)	3.50	5.50
Linoleic acid (%)	1.40	1.33
Biotin (mcg/kg)	38.90	36.20

*UNI-VIT 15 supplied the following vitamins and mineral elements per kilogram of feed: Vitamin A, 8.000 I.U.; Vit.D_3, 1,500 I.U.; Vit.E, 3 I.U.; Menadione sodium bisulphate (Vit.K), 1.5 mg; Vit.B_2, 2.5 mg; Calcium d-pantothenate, 3 mg; Nicotinic acid, 8 mg; Vit.B_6, 0.3 mg; Vit.B_{12}, 0.008 mg; Iron, 15 mg; Manganese, 125 mg; Copper, 2.5 mg; Zinc, 10 mg; Iodine, 0.3 mg.

Results obtained were subjected to statistical analyses (analysis of variance, regression and correlation analysis) in accordance with the procedure of Steel and Torrie (1960). Analysis of variance was conducted following angular transformation for parameters expressed as a percentage of body weight or carcass weight. Significantly different treatments were separated by the multiple range test of Duncan (1955).

RESULTS

Performance and carcass characteristics of experimental broilers are presented in Table 2. Average daily feed intake and average weight gain (growth rate) were significantly affected by the biotin and oil main effects ($P<0.05$). Birds on up to 80 mcg of the vitamin consumed significantly less feed and had significantly poorer weight gain (P<0.05) than those given higher dietary levels of biotin. Both feed intake and body weight gain were also significantly less (P<0.05) when diets were supplemented with 2% palm kernel oil.

There was no significant oil effect (P>0.05) on any of the carcass characteristics measured. Carcass weight, dressing percentage, total edible meat, and total bone weight were significantly affected by biotin level (P<0.05), where up to 80 mcg of the vitamin seemed not adequate for these carcass charateristics. All the carcass charateristics except total bone expressed as percentage of carcass weight were positively correlated, though not significantly (P>0.05), with dietary biotin level. The regression equation showing the relationship between the carcass charateristics and dietary biotin is shown in Table 3.

Table 2. Effect of palm kernel oil and biotin on performance of broilers

Parameter	Oil main effects+		Biotin main effects++						
	Oil Levels		Biotin levels (mcg/kg feed)						
	0%	2%	40	80	120	160	200	240	±SEM
Daily feed intake/bird (g)	39.37[e]	36.56[f]	36.42[b]	34.88[b]	39.39[a]	38.96[a]	40.34[a]	39.54[a]	0.86
Daily weight gain/bird (g)	11.04[e]	9.84[f]	9.46[b]	9.25[b]	11.85[a]	10.91[a]	10.95[a]	10.66[a]	0.40
Feed efficiency (gain:feed ratio)	0.28[e]	0.27[f]	0.26[b]	0.27[b]	0.30[a]	0.28[a]	0.27[a]	0.27[a]	0.01
Carcass weight (g)	311.90	292.46	270.54[b]	258.59[b]	332.36[a]	314.54[a]	343.40[a]	323.66[a]	14.10
Dressing percentage	66.08	67.12	63.52[c]	64.46[bc]	68.92[a]	66.62[ab]	69.23[a]	67.86[a]	0.96
Total edible meat (g)	199.49	88.88	175.34[b]	165.61[b]	212.85[a]	206.23[a]	230.58[a]	209.51[a]	10.03
Meat (% of carcass weight)	65.36	64.49	64.91	63.46	63.88	65.71	66.88	64.70	0.51
Total bone (g)	102.86	101.65	94.49[bc]	91.78[c]	116.16[a]	106.08[ab]	111.83[a]	113.23[a]	4.18
Bone (% of carcass weight)	34.07	34.83	34.11	36.01	35.10	33.84	32.77	34.90	0.46
Meat : Bone ratio	1.93	1.89	1.85	1.81	1.84	1.95	2.05	1.84	0.04

+ Oil main effect means in the same row with no common subscripts differ significantly (P<0.05).
++ Biotin main effect means in the same row with no common subscripts differ significantly (P<0.05).

Table 3. Estimated line showing relationship between biotin and the parameter

Parameter	r-value+	t-value	Regression line++
Carcass weight (g)	0.35	0.74	Y = 218.71 + 0.11X
Dressing percentage	0.33	0.70	Y = 61.75 + 0.0099X
Total edible meat (g)	0.38	0.82	Y = 136.52 + 0.08X
Meat (% of carcass weight)	0.70	1.96	Y = 61.96 + 0.0074X
Total bone (g)	0.24	0.50	Y = 77.68 + 0.23X
Bone (% of carcass weight)	-0.60	-0.49	Y = 36.44 - 0.0693X
Meat : Bone ratio	0.57	1.37	Y = 1.77 + 0.00296X

+ Not significant (P>0.05).
++ Y = Biotin (mcg/kg feed); X = Parameter

DISCUSSION

Improved growth in chicken due to biotin supplementation of practical rations has been demonstrated. Estimated requirements of 0.09 mg biotin/kg feed (Wagstaff *et al*, 1961), 0.15 mg biotin/kg feed (Anderson and Warnick, 1970; Agricultural Research Council, 1975) and 0.17 mg biotin/kg feed (Whitehead and Bannister, 1978) have been given for chick growth. Ogunmodede (1978) reported that while 0.12 mg biotin/kg was the minimum growth requirement for chicks fed corn-groundnut cake ration, 0.15 mg biotin/kg was required for chicks fed guinea corn-groundnut cake ration. Results from these trials showed that 120 mcg was the lowest dietary level needed for optimum feed consumption and growth rate.

The significantly lower consumption of rations containing 2% palm kernel oil by broilers is in agreement with the report of Rand *et al.* (1959), Maner *et al.* (1962) and Mateos *et al.* (1982) who reported that a higher oil level in the diet increased transit time of ingesta in the gastrointestinal tract, hence reduced intake of feed by birds. The significantly less weight gain in birds given rations supplemented with 2% palm kernel oil than in those given rations without oil supplementation is contrary to the reports of Yacowitz (1953) and Rossard and Combs (1961) who demonstrated that chicks fed low fat diets had slightly lower gain than chicks that received higher fat levels.

Growth rate and feed consumption in broiler chickens may be influenced by the relationship between the productive energy content and crude protein level of the ration (Combs and Rosomer, 1955). Leong *et al.* (1955), Combs and Rosomer (1955) and Sunde (1956) attributed the poor performance of broiler chicks fed high fat rations to the failure to provide sufficient amino acid and perhaps other essential nutrients required in the higher energy ration. Combs and Rosomer (1955) observed very rapid growth in broiler chicks fed 15% added fat by supplementing the diet with required levels of amino acids in proportion to their higher energy content. Biely and March (1954) found that the addition of fat to a 19% protein ration depressed growth and feed conversion in chicks but did not adversely affect growth and feed conversion when added to rations containing 24 to 28% protein. Marion and Woodroof (1955) reported that body weights and feed efficiency were greater at higher levels of protein when fat was added to the diet. It has been suggested by Rand *et al.* (1958) that beneficial effects of supplemental fat in the diets of chicks on feed utilization is due to the improvement in the utilisation of metabolisable energy calories and protein. Fouchburn and Naber (1966) and Jensen *et al.* (1970) also observed an "extra caloric" effect for supplemental fat and suggested that wider calorie-protein ratios for poultry rations with additional fat can be used for maximum gains and feed efficiency. Rand *et al.* (1958) reported that higher protein levels were needed when fat was used in the feed formulation, due to the reduction in total feed intake. Since the two basal diets used in this study had similar metabolisable energy values and protein contents

(Table 1), the extra caloric effect of the added palm kerneloil in the second basal diet might have raised the protein requirements of the birds for maximum gain and feed efficiency. Consequently, the significantly lower body weight gain in groups given 2% palm kernel oil may be attributed to the lower dietary nutrient intake.

While there is ample information on the biotin requirement for growth in broilers, information is lacking on the vitamin requirements for carcass characteristics such as carcass weight, dressing percentage, total meat, total bone and meat to bone ratio. Results from this study showed that good carcass quality required biotin as evident from the correlation and regression equations (Table 3), as well as poor carcass charateristics obtained in birds given up to 80 mcg biotin/kg feed. It therefore appeared that 120 mcg of the vitamin seemed to be the minimum dietary level required for optimum carcass quality.

Supplementation of fat in diets of broilers did not significantly affect the taste of edible carcass (Leong *et al.*, 1957), dressing percentage (Essary *et al.*, 1965), development of breast blister condition (Stephenson *et al.*, 1960), and storage quality of meat (Quarles *et al.*, 1968). It however improved meat tenderness (Quarles *et al.*, 1968). In this study carcass characteristics studied were not significantly affected (P>0.05) by dietary palm kernel oil supplementation at 2% level.

It may therefore be concluded that biotin is not only required for growth, but also for optimum broiler carcass characteristics, and that a minimum of 120 mcg of the vitamin per kg of feed was needed for efficient feed utilisation and desirable carcass quality.

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