DIETS AND DIETARY INGREDIENTS SELECTION BY BROILER CHICKEN: EFFECTS ON GROWTH PERFORMANCE, CARCASS QUALITY AND ECONOMICS OF PRODUCTION

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Received 27 May 1998; Accepted 25, November 1998

ABSTRACT

A total of 90day - old Hypeco broiler chicks were used in a choice-feeding trial to investigate whether meat-type chicken could select adequate nutrients that would support fast growth rate from a choice of imbalanced diet and feed ingredients. Three diets were used: a control diet(diet A = 200g/kg CP, 3031 kcal/kg ME) and two test diets; a low-protein, high-energy diet (diet B = 166g/kg CP, 3021 kcal/kg ME) and a low-protein, low-energy diet (diet C = 168g/kgCP, 2838 kcal/kg ME).The diets were fed singly. The test diets were also used in a choice-feeding with ground maize and soya-bean meal (SBM). The study lasted for 5weeks and the response criteria included growth performance, carcass and organ characteristics, and economics of production.

Weight gain and feed conversion ratio were significantly ($P<0.01$) and $P<0.001$ respectively) influenced. Birds on the control diets had the highest weight gain and best feed conversion ratio. Birds on the low-protein, high -energy diet had performances not significantly ($P>0.05$) lower than the control. The low-protein, low-energy diet depressed performance. Feeding the imbalanced diets(diets B and C) singly produced better performances than feeding them with a choice of dietary ingredients. Birds exhibited selection potentials by selecting the ground maize and SBM to compensate for deficiencies in the imbalanced diets but not at a level adequate enough to improve performances. Only the relative chest weight was significantly($P<0.05$) influenced amongst the carcass and organ weights measured. It decreased with decreasing feed quality. Economics of production showed that low quality and cheaper priced feeds do not necessarily give higher income and profit. the benefits of feeding single balanced diets and the possibility of decreasing the protein content of broiler finisher diets without compromising profits were revealed. It was suggested that broiler chicken appeared to select nutrients for their well-being rather than to maximise economic performance and that feed quality control should be enforced.

Keywords: Broiler chicken, feed quality, ingredient selection, performance, carcass quality.

INTRODUCTION

Nigeria, like many other developing countries is currently faced with the shortage and high costs of conventional feeds for poultry. As early as two decades ago, Fetuga (1977) reported disappointing rate and level of performance in the livestock industry. This was attributed, among other factors, to high cost of feeds arising largely from fluctuations in feed supplies, rising prices of ingredients, poor quality feeds, inefficiency in production and distribution in the feed industry. In recent years, there have been stimulated interests in the use of non-conventional ingredients in feeds. Although the nutritional values of these non-conventional feedstuffs have been extensively reviewed (Aletor, 1986), they are incorporated at levels which result in poor quality feeds of low energy, low protein and/or high fibre. Ogunwolere and Onwuka (1997) assessed the quality of some commercial livestock feeds and reported non-comformity of feed contents with expected/ recommended levels of the nutrients monitored. Since sub-optimum levels of nutrient intake adversely affect the performance of livestock and poultry, simple and inexpensive strategy for meeting nutrient requirements of animals needs exploitation.

Evaard (1914) coined the phrase 'free - choice - feeding' for a method allowing diet selection from different feeds by pigs. Emmans (1979) suggested that if poultry can meet their individual nutrient requirements by selecting from two feeds which differ in composition, there would be overall improvement in the efficiency of growth. Rose and Michie (1982) corroborated this suggestion when they showed that poultry have the ability to meet their apparent requirements and express their potential for growth by using some inherent rules in selecting their diets. Kyriazakis *et al*. (1990) for growing pigs) and Shariatmadari and Forbes (1993) for chicken reported diet selection that allowed growth at a rate similar to those fed a balanced single diet when provided with a choice of low and high protein diets. Reported evolutionary trend in choice -feeding includes selection for long-term survival benefit by chicken (Siegel *et al*., 1997) and distinguishing between feeds which contain toxins and those which are harmless (Moss, 1991; Gill *et al*., 1995)

Raising broilers to marketable weight at short period would be difficult under the Nigerian situation of fluctuating feed quality. Choice -feeding may provide a strategy for improving performance and reducing the need for frequent feed formulation. Therefore, this study was designed to investigate if broilers could select a balanced diet to meet their nutrient requirements when provided with a choice of imbalanced diet and feed ingredients (maize and soya -bean meal). The response criteria were growth performance, carcass characteristics and economics of production.

MATERIALS AND METHODS

Source of materials

One hundred day-old Hypeco broiler chicks were obtained from Mitchell Farm (Nig.) Ltd., Lagos through Chicken House (Ltd.), Akure. Most of the feedstuffs used in feed formulation were obtained from Becharm (Nig) Ltd., Akure. Salt (NaCl) and palm oil were purchased from the local market.

Experimental diets and supplemental feed ingredients

The study involved the use of 3 experimental diets (A, B, and C) which were formulated at the Teaching and Research Farm of the Federal University of Technology Akure, Dietary composition and proximate chemical composition of diets are shown in Table 1. Diet A, which served as the control was a conventional broiler diet. Diet B was isocaloric with Diet A but had about 40g/kg lower content of crude protein (CP). This represented a low-protein, high-energy diet. Diet C was isonitrogenous with Diet B but had lower energy content. This was the low-protein , low-energy diet. Dietary crude fibre content was in increasing order as follows: Diet C>Diet B> Diet A. Maize and soya-bean meal (SBM) were

TABLE 1: COMPOSITION OF EXPERIMENTAL DIETS AND CALCULATED CHEMICAL COMPOSITION

Ingredients(g/kg)	Diets A	B	C
Maize[a]	550.00	570.00	550.00
Soya-bean meal[b]	290.00	210.00	210.00
Fish meal	20.00	-	-
Rice bran	50.00	110.00	210.00
Palm kernel cake	30.00	50.00	2.50
palm Oil	40.00	40.00	10.00
Bone meal	10.00	10.00	10.00
Vit./min.premix[c]	2.50	2.50	2.50
DL-Methionine	2.50	2.50	-
Salt(NaCl)	5.00	5.00	5.00
TOTAL	1000	1000	1000
Calculated chemical composition(g/kg)			
Crude protein	200.90	166.20	168.30
Methionine + cysteine	8.80	7.60	5.40
Lysine	10.80	10.30	8.70
Crude fibre	43.50	47.90	51.80
Metabolizable energy(kcal/kg)	3031.13	3021.35	2838.83
Determined chemical composition (g/kg)			
Crude protein	208.70	167.80	169.20
Crude fibre	46.10	51.30	60.10
Crude fat	81.50	78.10	68.70

[a]Maize:ME = 3350kcal/kg, Crude protein = 89.10g/kg,Crude fibre =23.20g/kg, Crude fat=17.60g/kg.
[b]Soya-bean meal:ME=2230kcal/kg,Crude protein = 448.30g/kg,Crude fiber=112.30g/kg,Crude fat=28.60g/kg
[c]Contained per kg 6000000 IUvit.A, 1600000 IU vit, D_3, 8000mg vit. E,1400mg vit, K, 900mg vit.B_1,2400mg vit B_2,6800mg pantothenic acid, 1200mg vit. B_6,8mg vit.B_{12},16000mg nicotinic acid, 400mg folic acid,32mg biotin + other additives (antioxidant BHT + ethoxyquin mold inhibitor 2500mg; sorbic acid 300mg).

selected as the energy and protein supplements respectively, for choice-feeding.

Experimental treatments and management of chickens

The chicks were brooded for 3 weeks during which they were fed commercial broiler-starter diets *ad-libitum.* At the end of the 3-week brooding period, a total of 90 chicks were selected and randomly assigned to one of the 5 experimental treatments.

The treatments were:

- T1 - offered Diet A (Control)
- T2 - offered Diet B
- T3 - offered Diet C
- T4 - offered Diet B + choice of ground maize and SBM
- T5 - offered Diet C + choice of ground maize and SBM

There were 3 replicates per treatment and 6 chicks per replicate . The chicks were selected such that there were 3 males and 3 females per replicate and the mean weight per treatment did not vary by more than 20g. Chicks were group penned on deep litter according to replicate and fed the experimental diets. Maize and SBM were provided in separate feeding troughs for chicks on T4 and T5. The feeding troughs had hood that prevented spillage. Feed and water were provide *ad-libitum* until the broilers were 8 weeks old. Daily feed comsumption and weekly weight changes of birds per replicate were recorded.

TABLE 2. PERFORMANCE CHARACTERISTICS OF THE BROILER CHICKEN

	Treatments					Statistical significance
Parameters	**1**	**2**	**3**	**4**	**5**	
Initial live weight (kg/chick)	0.41±0.01	0.40±0.01	0.40±0.02	0.40±0.01	0.41±0.01	NS
Final live weight (kg/chick)	1.92±0.16[a]	1.87±0.11[a]	1.67±0.09[b]	1.73±0.04[ab]	1.59±0.07[a]	*
Weekly weight gain (g/chick)	302.30±29.50[a]	299.90±19.80[ac]	254.11±14.34[a]	265.33±6.43[bc]	237.67±15.65[b]	**
Weekly feed consumption (g/chick)	696.60±44.90[a]	732.60±25.00[ab]	773.00±13.04[a]	726.80±22.00[ab]	708.10±22.80[a]	*
Feed conversion ratio (g feed/g gain)	2.31±0.09[a]	2.51±0.08[ac]	3.05 ±0.12[b]	2.74 ±0.11[c]	2.99± 0.17[b]	***
Calculated nutrient intake/chick						
Crude protein(g/week)	139.95	121.76	130.10	125.73	123.34	
Metabolisable energy (kcal/week)	2111.49	2213.44	2186.69	2109.01	1920.32	
Calorie: Protein	15.09	18.17	16.81	16.77	15.57	

Mean ± SD

NS = not significant, *= P<0.05, ** = P<0.01, *** = P<0.001

Means are for 3 replicates / treatment (6 chicks / replicate)

Means with different superscripts in the same row are significantly different (P<0.05)

Carcass measurements, and chemical, economic and statistical analyses

At the end of the 5week feeding trial. one bird was randomly picked from each replicate, slaughtered, dressed, eviscarated and cut into parts for carcass characteristics and organ measurements. Proximate chemical composition of diets and supplemental feed ingredients were determined by the methods of AOAC (199). Economic analysis was based on the prevalent prices of the dietary ingredients and the chicken as at January 1998. Data were subjected to analysis of variance (ANOVA) using the Minitab (vv.10.2, Minitab Inc) statistical package. Significant differences between treatment means were determined using least significance difference (LSD) as described by Snedecor and Cochran (1974)

RESULTS

The growth performance and calculated nutrient intake measurements are shown in Table 2. Initial live weights of the chicks were not significantly different. The final live weight, weight gain, feed consumption and feed conversion ratio (FCR) were significantly (P<0.05), and (P<0.01) influenced respectively by treatments. Chicken on the control diet (T1) had the best performance , though this was not significantly different fromt those on T2.Weight gain was poorer with choice -

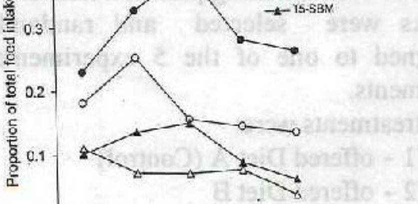

Figure 1. Weekly proportion of feed intake selected as maize and SBM by choice-fed chickens(T4 and T5)

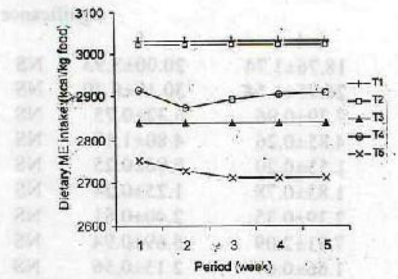

Figure 2. Cumulative Trend in dietary metabolisable energy intake

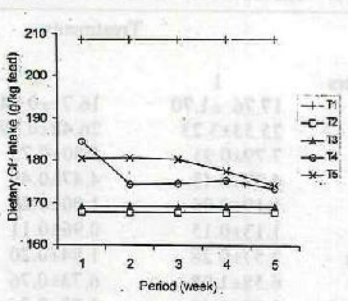

Figure 3. Cumulative Trend in dietary crude protein intake

fed birds compared with those fed the respective imbalanced single diet (T2 v.T4 and T3 v.T5), though this was not significantly (P>0.05) different. Chickens fed the control diet had the highest CP intake. FCR followed the order T1<T2<T4<T5<T3. Calorie to protein ratio was lower with birds on choice-feeding (T4 and T5) than those on the respective single imbalance diets (T2 and T3).

Supplemental feed ingredient selection pattern by chicks on T4 and T5 are depicted in Figure 1. It showed a tendency by chicks to select proportionately more maize than SBM. Chicks on T5 showed higher affinity to select more of the dietary ingredients that those on T4. Cumulative trends in energy and CP intake are shown in Figures 2 and 3 respectively. Energy intake followed a trend similar to the metabolisable energy (ME) content of the single -diet offered and a dilution effect of the choice-fed ingredients. Chicks on T 4 and T5 showed a tendency to increase their protein intake compared to those fed the single imbalance diet (T2 and T3)

Carcass characteristics and relative organ weights are shown in Tables 3 and 4 respectively. The results showed that of all

TABLE 3. CARCASS CHARACTERISTICS OF THE BROILER CHICKENS

	Treatments					Statistical significance
Parameters	**1**	**2**	**3**	**4**	**5**	
Dressed weight(%)	91.56±0.62	91.97±0.28	91.46±1.03	91.03±0.53	91.63±0.31	NS
Eviscerated weight(%)	77.98±1.04	77.94±2.97	79.26±2.60	78.39±0.41	76.77±2.00	NS
Thigh(g/kg body weight)	49.72±1.46	52.01±3.32	54.62±2.33	53.79±5.76	48.74±5.53	NS
Drumstick(g/kg body weight)	52.17±3.76	53.05±6.45	55.15±4.68	52.83±2.15	52.41±4.98	NS
Shank(g/kg body weight)	21.71±2.63	24.51±2.67	25.74±3.08	23.00±1.34	24.02±1.45	NS
Chest(g/kg body weight)	167.67±11.36[a]	158.06±13.80[a]	131.07±14.65[b]	166.73±12.20[a]	137.62±7.98[b]	*
Back(g/kg body weight)	64.32±6.89	76.83±7.28	75.65±13.49	64.46±6.84	59.78±3.01	NS
Wing(g/kg body weight)	44.04±2.19	43.86±1.39	44.76±5.41	41.79±3.41	42.20±1.68	NS
Neck(g/kg body weight)	57.33±5.56	57.42±3.70	54.63±3.94	60.50±7.50	58.54±2.80	NS
Head(g/kg body weight)	26.81±2.22	27.55±2.72	28.40±1.00	29.02±2.32	26.16±1.36	NS
Belly fat(g/kg bodyweight)	16.34±9.04	20.63±4.71	18.93±3.87	13.85±5.03	17.70±9.82	NS

Mean ± SD
NS = not significant, *= P<0.05,
Means are for 3 chickens / treatment

TABLE 4. RELATIVE ORGAN WEIGHTS (G/KG BODY WEIGHT) OF THE BROILER CHICKEN

	Treatments					Statistical significance
Parameters	1	2	3	4	5	
Liver	17.76 ±1.70	16.71±0.84	18.18±1.44	18.76±1.74	20.00±3.93	NS
Gizzard	25.53±3.23	26.48+0.89	29.20±1.62	26.75±1.54	30.19±6.40	NS
Kidney	7.79±0.91	5.80±0.73	6.65±0.46	7.29+0.96	6.32±0.75	NS
Heart	4.37±0.43	4.47±0.49	4.25±0.43	4.85±0.26	4.80±1.18	NS
Bursa	1.19±0.06	1.00±0.20	1.32±0.37	1.55±0.20	0.96±0.25	NS
Spleen	1.13±0.15	0.96±0.11	0.99±023	1.83±0.78	1.25±0.24	NS
Pancreas	2.57±0.28	1.84±0.20	1.70±0.76	2.39±0.35	2.40±0.61	NS
Lungs	6.58±1.08	6.73±0.76	5.94±0.75	7.31±2.09	5.69±0.94	NS
Gall bladder	1.09±0.45	1.83±0.26	1.50±0.43	1.66±0.67	2.13±0.56	NS

Mean + SD
NS = not significant
Means are for 3 chickens / treatment
No two means are significantly different (P<0.05)

TABLE 5. ECONOMICS OF PRODUCTION OF THE BROILER CHICKEN

Treatments					
Parameters	1	2	3	4	5
Total no. of chicken	18	18	18	18	18
Av.total wt. gain (kg)	1.51	1.47	1.27	1.33	1.18
Av.total diet consumed(kg)	3.48	3.66	3.87	2.76	2.15
Av.total maize consumed(kg)	-	-	-	0.61	1.05
Av.toatl SBM consumed	-	-	-	0.25	0.36
Cost of diet[a](N)	69.46	58.62	52.81	44.20	29.34
Cost of miaze[a] (N)	-	-	-	6.10	10.50
Cost of SBM[a] (N)	-	-	-	7.50	10.80
Income[b](N)	5436	5292	4572	4788	4248
Production cost[c] (N)	1250	1055	951	1040	912
Profit(N)	4185	4236	3621	3747	3336

[a]Calculated on the basis of the prices of the feed ingredients as at January 1998 (Diet A = N19960/tonne; Diet B = N16016/tonne; Diet C = N13646/tonne; maize = N10000/tonne and SBM = N30000/tonne)
[b]Calculated on the assumption that birds are sold at N200/kg live weight
[c]Excludes the cost of day-old chicks, housing, labour, drugs and vaccines

the carcass traits measured, only the relative weight of the chest was significantly (P<0.05) influenced by treatments. Chicks on low energy, low-pretein diet with or without supplement feed ingredients (i.e T3 and T 5) had significantly (P<0.05) reduced relative chest weight.

Table 5 shows the data on the economics of producing the chicken. The cost of production generally increased with increasing levels of dietary energy and protein concentrates in the diets. However, income, computed on the basis of live weight gain increased in similar manner. Profits were in increasing order: T2>T1>T4>T3>T5.

DISCUSSION

The performance data, in terms of final live weight, weight gain, feed consumption and FCR showed the advantage of feeding a balanced single diet compared to feeding the low-protein, high-energy or low-protein, low-energy diets. Thus, the broiler chick can attain its potential growth rate and weight gain when sufficient and high quality feed is available for it. Differences in the final live weight and weight gain of birds on T1 and T2 were not significant despite the large difference in the dietary calorie to protein ratio (15 and 18 for diets A and B respectively). This suggests a scope for reducing protein content of broiler finisher diets while maintaining the energy content. Intake of the low protein -high energy diet was higher than that of the control.This is in agreement with the findings of Tobin and Boorman (1979) that there is higher intake of low protein feed by chickens. Further increase in intake was observed when birds were fed the low-protein, low-energy single diet (T3) .This may be attributable to the low energy and higher fibre contents of diet C compared to those of diets A and B .This corroborated the results of Hill and Dansky (1954) that birds would eat primarily to satisfy their energy and essential amino acid requirements. Recently, Oyewole and Salami (1997) showed uniformity in the feed intake of broiler chickens when diets had similar calorie and protein contents. Feed intake of the single diet fed birds also increased with increasing dietary fibre content. Similar increase due to increased dietary fibre content has been reported by Nwokolo *et al.*(1985)

Growth performance and efficiency of utilisation of feed for weight gain was poorer and feed consumptiion was lower with chicks on choice-feeding (T4 and T5) compared with those fed the respective imbalanced single diet (T2 and T3). Although these treatments (T4 and T5) represented extreme cases of choice - feeding, the results are contradictory to previous reports (Holcombe et al., 1976 ; Shariatmadari and Forbes, 1993) showing similar growth rate between chickens fed a choice of low and high protein diets and those on the single balanced diet. However, it was observed that the birds on T4 and T5 selected the diets and dietary ingredients in order to reduce their calorie to protein ratio compared to those on T2 and T3. This is also evident in Figure2 where energy intake followed a trend similar to the energy content of the single diet but in Figure 3. The choice -fed birds increased their intake of protein compared to those fed the single imbalanced diets. Therefore, these observations corroborated previous reports showing selection potentials of chickens to meet dietary protein (essential amino acids) requirements (Holcombe *et al.*, 1976; Shariatmadari and Forbes , 1993) but not at a level to maximise growth (Siegel *et al.*, 1997). Birds on T5 selected proportionately more of the dietary ingredients than those on T4 (Figure 1) .This may be attributed to the ability of the chicken to try to compensate for dietary nutrient deficiences since diet C which was offered in choice feeding to birds on T5 had lower energy content than diet B, and lower protein content than diet A.

Data on the carcass characteristic showed that there were no significant differences in percent dressed weight, percent eviscerated weight and relative weights of the thigh, drumstick, shank, back, wing, neck, head belly fat and the various organs (Liver, gizzard, skidney, heart, bursa, spleen, pancreas, lung and gall bladder). This observation suggests that the experimental treatments produced identical influence on these carcass and organ traits. The low-protein, low-energy diet with or without supplemental feed ingredients (T3 and T5) significantly ($P<0.05$) reduced the relative chest weight. This suggest the inadequacy of this diet (Diet C) to support live weight gain (Table 2) and breast muscle development at a similar level of feeding diet A and B.

The results of the economics of production showed that low nutrient and cheaper- priced feeds were not the most profitable. Feed cost normally accounts for more than 70% of production cost in intensive poultry business . Feed cost tends to increase with increasing protein and energy contents, and marginally decrease with increasing fibre content. This explains why diet A was the most expensive, followed by diet B, and diet C was cheapest. However, intake of the high quality feeds by chickens is reduced, weight gain is improved and feed efficiency is also improved. These accounted for higher income and gross profit recorded for birds on T 1 and T2

However, the marginally higher gross profit of rearing the chickens on diet B (T2) compared to diet A (T1) suggests the need to re-evaluate the protein content of broiler finisher diets in a bid to reducing it to a level which optimally improves production, reduces production cost and increases gross profit.

CONCLUSIONS/ COMMERCIAL VALUE

The extreme choice-feeding treatments in this study were evaluated because they represent the simplest option for meeting nutrient requirements of fast growing meat - type chickens fed commercial low quality feed. It however showed the limitation of chickens to adequately select between diet and dietary ingredients which could support fast growth rate necessary to reach early marketable weight. Although selection preferences were evident, the results corroborated the reports of Siegel *et al.* (1997) that dietary or nutrient selection by chicken are for long-term survival benefits in its domestic environment rather than to maximise growth with the economic benefit of early marketing. These results suggest the benefit of feeding single balanced diets to broilers. It also revealed the need for research to re-evaluate the protein content of broiler finisher diets with the aim of reducing it.

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