

EFFECTS OF GENOTYPE AND DIETARY ENERGY ON PERFORMANCE OF BROILERS

AYORINDE, K.L.

Department of Animal Production, University of Ilorin, Ilorin, Kwara State

Received 11 October 1993; Accepted 3 July 1994

ABSTRACT

A 3 X 3 factorial experiment was conducted to study the effect of three dietary energy levels 2800 (LE), 3000 (ME) and 3200 (HE) Kcal/kg feed on the growth, feed and water intake, feed: water ratio feed efficiency, carcass yield and abdominal fat in three commercial broiler strains, Anak (A), Cobb(C) and Shaver (S). Genotype and dietary energy had no significant effect ($P > 0.05$) on body weight and feed intake from 0 to 4 weeks of age. However, weight gain improved and feed intake decreased significantly ($P < 0.05$) with increased dietary energy between 5 and 8 weeks of age. Birds of strain S consumed significantly ($P < 0.05$) more feed than those of A and C. Feed efficiency was not influenced by genotype but improved significantly ($P < 0.05$) with increased dietary energy especially from 5 to 8 weeks of age. Water intake decreased significantly ($P < 0.05$) with increased dietary energy and also differed among the three strains. Water to feed ratios were similar in the three diets and strains. Carcass yield was not significantly influenced by either strain or dietary energy but abdominal fat increased significantly ($P < 0.05$) with increased dietary energy.

Keywords: Broilers, Genotype, Dietary energy, Quantitative traits, Carcass yield, Abdominal fat.

INTRODUCTION

One of the major problems facing broiler production is excessive fat deposit. It has been reported that abdominal fat in broilers is influenced by genetic (Leclercq *et al.*, 1980, Becker *et al.*, 1984, Lecnstra, 1986, Marks, 1990) and environmental factors especially nutrition (Darden and Marks, 1988, Donaldson *et al.*, 1956, Leclercq 1983, Marks, 1980, Marks and

Pesti, 1984). Although the energy levels of diets are usually implicated in high abdominal fat deposit, the situation has not been much investigated for broilers raised in the tropics. The present study was therefore designed to investigate influence of genotype, dietary energy and their interrelationships on the growth, feed and water intake, feed: water ratio, feed efficiency, carcass yield and abdominal fat in three commercial broiler strains raised in Nigeria.

MATERIALS AND METHODS

The experiment was conducted using 180 broiler chicks of each of three commercial strains Anak (A), Cobb (C) and Shaver (S). Sixty chicks of each strain in three replicates of 20 chicks were allocated to each of the three experimental diets (Table 1). The dietary energy levels of the diets were as recommend (ME) for broilers raised in the tropics (NRC , 1984) or 200 Kcal/kg feed above (HE) or below (LE) this recommended level. Feed and water were supplied *ad libitum*.

Weekly records of body weight, feed intake, water intake and mortality were kept for each replicate. Water intake was corrected for evaporative losses from two drinkers placed in an empty pen in the same house. At the end of the 8th week, five birds from each replicate were slaughtered after weighing, having been kept off feed overnight. Each Bird was manually defeathered and cut into various parts after removing the abdominal fat. The weights of the cut-up parts and abdominal fat were taken individually.

Statistical Analysis.

Data collected were subjected to analysis of variance based on a 3 x 3 factorial arrangement using a fixed model to compare the effects of genotype (A,C,S) and energy level, E(HE, ME, LE) and to determine the interrelationships, G x

GENOTYPE VS ENERGY ON BROILERS' PERFORMANCE

E, between the two variables.

The model used was of the form:

$$Y_{ijkl} = \mu + G_i + E_j + R_k + GR_{ik} + ER_{jk} + GER_{ijk} + e_{ijkl}$$

where:

- μ = Mean
- G_i = Effect of i^{th} genotype (A,C,S)
- E_j = Effect of j^{th} energy level (HE, ME, LE)
- R_k = Effect of replication
- GE_{ij} = Interaction of i^{th} genotype with j^{th} energy level
- GR_{ik} = Interaction of i^{th} genotype with k^{th} replicate
- ER_{jk} = Interaction of j^{th} energy level with k^{th} replicate
- GER_{ijk} = effect of i^{th} genotype fed diet containing j^{th} energy level in the K^{th} replicate
- e_{ijk} = random error

The analysis was carried out using the General Linear model Procedure of the Statistical Analysis System (SAS Institute, 1985). Significant differences between means were compared using the Duncan's Multiple Range Test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Body weight gain between 0 and 4 weeks of age (Table 2) was not significantly ($P > 0.05$) affected by dietary energy level, genotype and their interaction. The low energy diet within the three strains appeared to favour fastest growth rate while the medium energy diet, except in strain A, tended to result in lowest weight gain. Between 5 and 8 weeks of age, the high and medium energy diets resulted in significantly ($P < 0.05$) higher weight gains than the low energy diet except for strains S where only the medium energy diet resulted in significantly ($P < 0.05$) higher weight gain than low energy diet. Birds of strain A on the high energy diet had significantly ($P < 0.05$) higher weight gain than birds of strain S on the same diet. There was significant ($P < 0.05$) G x E interaction between 5 and 8 weeks of age.

Mean daily weight gains to 8 weeks of age on the various energy levels for A birds were 32.58g (HE), 31.43g (ME) and 29.26g (LE). Weight

gains for strain C were 31.35g (HE), 30.92g (ME) and 29.58g (HE) and 29.65g (HE), 30.52g (ME) and 29.02g (LE) for strain S.

The slightly better weight gain of birds with the low dietary energy level between 0 and 4 weeks of age agrees with the observation of Farrell (1974) that diets with very high energy concentrations may reduce performance as a result of the reduced availability of metabolizable energy to the birds. The data on weight gain in the three strains indicate that birds on LE diet were able to utilize the diet better than when placed on HE or ME diets.

Feed intake Table (2) between 0 and 4 weeks of age was not significantly ($P > 0.05$) affected by genotype, dietary energy and their interaction. Birds of strains A on the high energy diet consumed slightly ($P > 0.05$) more feed than their mates on medium and low energy diets. Birds of strain S on the medium energy diet also had the lowest feed intake. This is contrary to the observation of Omar *et al.* (1973) that primary factor influencing voluntary feed intake in young chicks appears to be the need for energy. The present result indicated that between 0 and 4 weeks of age chicks of strains A and S were not very sensitive to dietary energy concentration in the diet.

Feed intake between 5 and 8 weeks of age decreased significantly ($P < 0.05$) with increased dietary energy level in the three strains. Birds of strain S on the LE diet also had significantly ($P < 0.05$) higher feed intake than their A and C counterparts on same diet indicating genetic differences. There was a decrease in feed intake by 181.17g for every 100kcal increase in dietary energy for birds of strain A. Similar figures for C and S were 179.59g and 211.89g respectively. The overall feed intake values between 5 and 8 weeks of age, indicated that S birds consumed significantly ($P < 0.05$) more feed than A birds. Total feed intake between 0 and 8 weeks of age was significantly ($P < 0.05$) higher in S than A and C by 583 and 886g respectively

Feed efficiencies were significantly ($P < 0.05$) higher for LE than HE diets in the A strain between 0 and 4 weeks of age (Table 2). There

was no significant ($P > 0.05$) dietary effect on feed efficiency in C and S at this initial age. During the 5th to 8th weeks of age, feed efficiencies were significantly ($P < 0.05$) influenced by dietary energy but not by genotype or genotype X diet interaction (Table 2). In the A strain, feed efficiency improved significantly ($P < 0.05$) with dietary energy. Feeding the HE diet resulted in significantly ($P < 0.05$) higher efficiencies than ME and LE in the C strain and than only LE diet in the S strain. The present data support the hypothesis that differences in feed efficiency in addition to feed intake may play an important role in the observed differences in body weights between genetic stocks (Darden and Marks, 1988). Feed efficiencies from 0 to 8 weeks of age were 0.60 (HE), 0.57 (ME) and 0.54 (LE) for strain A, 0.64 (HE), 0.57 (ME) and 0.54 (LE) for C and 0.59 (HE), 0.56 (ME) and 0.55 (LE) for S (Table 2).

Water intake (Table 3) was significantly ($P < 0.05$) affected by dietary energy, genotype and their interaction during 0 to 4 weeks of age in strains C and S and in the three strains during 5 to 8 weeks of age. Water intake decreased significantly ($P < 0.05$) with increased dietary energy probably as a result of decreased feed intake which accompanied increasing the energy concentration of the diets.

Water intake was significantly ($P < 0.05$) greater for A birds than C birds from day old to 4 weeks of age and in A and C birds than S birds on same diets from 5 to 8 weeks of age. Although Marks (1980) reported that water intake generally increases with increased body weight, data from the present work indicated that water intake is more related to increased dietary energy concentration and reduced feed intake than the increased body weight.

Water to feed ratio was similar ($P > 0.05$) between genotype and diets. Irrespective of dietary energy (Table 3), water to feed ratio within each strain decreased with age. This is in agreement with the observation of Marks (1990) that water to feed ratios were generally higher immediately following hatch and decreased with

age. Across diets, A birds had higher water to feed ratio than C and S birds during 0 to 4 weeks of age while C birds had the highest ratio during the 5th to 8th weeks of age.

The dressing and eviscerated percentages as well as the cut up parts except abdominal fat (Table 4) were not significantly ($P > 0.05$) affected by any of the sources of variation.

Genotype did not affect abdominal fat weights in the three strains. This is contrary to the reports of Nordstrom *et al* (1978), Leclercq *et al.* (1980), Becker *et al* (1984) and Leenstra (1986) that abdominal fat is influenced by both genetic and environmental factors. However abdominal fat increased significantly ($P < 0.05$) as the dietary energy increased (Table 4). There were no significant ($P > 0.05$) differences in the percent mortality either as a result of strain or dietary energy differences. The mortality in the various groups was very low varying from 0 to 1.75% in the three strains.

The results indicated that feeding the birds on high energy diets significantly ($P < 0.05$) improved weight gain and feed efficiency reduced water intake but led to increased abdominal fat weight in broilers.

ACKNOWLEDGEMENT

The data collection by Miss A.A. Oke and Mr. Bakare, W.A. is greatly appreciated.

REFERENCES

- BECKER, W.A., SPENCER, J.A. MINOSH, L.W. and VERSTRATE, J.A. (1984). Genetic variation of abdominal body weight and carcass weight in a female broiler line, Poultry sci. 63: 607-611.
- DARDEN, J.R. and MARKS, H.L. (1988). Divergent selection for growth in Japanese quail under split and complete nutritional environments. 2. Water and feed intake patterns and abdominal fat and carcass lipid characteristics. Poultry Sci. 67: 1111-1122.
- DONALDSON, W.E. COMBS, G.F. and ROMOSER, G.L. (1956) Studies on energy levels in poultry rations. 1. The effect of calorie-protein ratio of the ration on growth, nutrient utilization and body composition of chicks. Poultry Sci. 35: 1100 - 1105

GENOTYPE VS ENERGY ON BROILERS' PERFORMANCE

- FARREL, D.J. (1974). Effects of dietary energy concentration on utilization of energy by broiler chickens and on body composition determined by carcass analysis and predicted using tritium. *Brit. Poultry Sci.* 15:25-41
- LECLERCQ, B. (1983) The influence of dietary protein content on the performance of genetically lean or fat growing chickens. *Br. Poultry Sci.* 24:581-587
- LECLERCQ, B., BLUM, J.C. and BOYER, J.P. (1980). Selecting broilers for low or high abdominal fats: Initial observations. *Br. Poult. Sci.* 21: 107-113
- LEENSTRA, F.R. (1986). Effect of age, sex, genotype and environment on fat deposition in broiler chickens. A review. *World's Poult. Sci. J.* 42:12-25
- MARKS, H.L. (1980). Water and feed intake of selected and non-selected broilers under *ad libitum* and restricted feeding regimes. *Growth* 44:205-219
- MARKS, H.L. (1990). Genotype by diet interactions in body and abdominal fat weight in broilers. *Poultry Sci.* 69: 879-886
- MARKS, H.L. and PESTI, G.M. (1984). The roles of protein level and diet forms in water consumption and abdominal fat pad deposition of broilers. *Poultry Sci.* 63:1617-1625
- NATIONAL RESEARCH COUNCIL, (1984). *Nutrient Requirements of Poultry.* National Academy Press, Washington D.C.
- NORDSTORM, J.O., TOWNER, R.H., HAVENSTAIN, G.B. and WALKER, G.L. (1978). Influence of genetic strain, Sex and dietary energy level on abdominal fat deposition in broilers. *Poultry Sci.* 57: 1176 (Abstr).
- OMAR, E.M., EL-ABBADY, M.R., EL-KOTOURY, M.I. and HAMADA, M.R. (1973). The effect of dietary supplementation of cotton seed oil on the growth and performance of Balad White chicks. *Nutr. Abs. and Rev.*, 43(3): 2139
- SAS Institute, (1985). *SAS (R) User's Guide: Statistics, version 5 Edition.* SAS Inst. Inc. Cary, NC
- STEEL, R.G.D. and TORRIE, J.H. (1980). *Principles and procedures of statistics: A biometric approach.* 2nd edition. Mc Graw-Hill Book Co. New York, NY

TABLE 1 COMPOSITION OF EXPERIMENTAL DIETS

INGREDIENT	STARTER DIETS			FINISHER DIETS		
	LE	ME	HE	LE	ME	HE
Maize	43.80	37.78	33.16	53.80	47.08	42.46
Soyabean Meal	40.60	42.58	43.99	31.60	32.58	33.99
Fish Meal	2.00	2.00	2.00	2.00	2.00	2.00
Rice Bran	7.75	6.79	5.00	7.05	7.79	6.00
Oyster Shell	2.00	2.00	2.00	2.00	2.00	2.00
Bone Meal	3.00	3.00	3.00	3.00	3.00	3.00
Salt	0.30	0.30	0.300	30	0.30	0.30
Min-Vit. Premix	0.25	0.25	0.25	0.25	0.25	0.25
D-L Methionine	0.20	0.20	0.20	0.00	0.00	0.00
Lysine	0.10	0.10	0.10	0.00	0.00	0.00
Palm Oil	0.00	5.00	10.00	0.00	5.00	10.00

Calculated Analysis (per kg)

CP (%)	24.00	23.99	24.00	21.26	21.23	21.14
ME(kcal)	2761.90	2883.0	3192.9	2753.05	2988.27	3195.73

Min-Vit Premix supplied (per tonne of feed)

Vit A 8, 000IU., Vit.D 1, 2001.U, Vit E. 131U, Vit. K3 2mg Riboflaving 3mg, Nicotinic acid 10mg. Pantothenic acid. 7mg, Choline 900mg, Cobalamin). 08mg, Folic acid 1.5mg, Biotin 0.25mg, Antioxidant 125mg. Fe 25mg, Mn. 80mg, Zn, 50mg, Cu. 2mg Co. 0.2mg Se 0.1mg.

Table 2 MEAN BODY WEIGHT GAIN (G), FEED INTAKE(G) AND FEED EFFICIENCY BY GENOTYPE, DIET AND AGE (WKS).

STRAIN	WEIGHT GAIN DIET	WEIGHT GAIN		FEED INTAKE		FEED EFFICIENCY	
		0 - 4	5 - 8	0 - 4	5 - 8	0 - 4	5 - 8
A	HE	441.90 ^a	1382.35 ^a	701.5 ^a	2332.4 ^a	0.62 ^c	0.59 ^a
	ME	456.86 ^a	1303.10 ^a	669.1 ^a	2849.5 ^b	0.68 ^a	0.46 ^b
	LE	481.80 ^a	1156.95 ^b	674.9 ^a	3134.4 ^c	0.71 ^a	0.37 ^c
	Mean	460.20	11280.80	681.9	2772.1	0.67	0.47
	SE	10.80	64.00	10.10	88.6	0.04	0.01
C	HE	466.95 ^a	1288.80 ^a	642.0 ^a	2358.0 ^a	0.73 ^a	0.55 ^a
	ME	458.67 ^a	1273.11 ^a	649.8 ^a	2999.1 ^b	0.71 ^a	0.42 ^b
	LE	483.11 ^a	1188.60 ^b	690.1 ^a	3152.94 ^c	0.70 ^a	0.38 ^b
	Mean	469.58	1250.17	660.6	2836.7	0.72	0.45
	S.E	6.40	68.10	7.8	63.8	0.02	0.01
S	HE	463.43 ^a	1197.05 ^{ab}	671.0 ^a	2447.0 ^a	0.69 ^a	0.49 ^a
	ME	448.45 ^a	1260.85 ^a	663.9 ^a	2959.6 ^b	0.69 ^a	0.43 ^{ab}
	LE	478.43 ^a	1146.60 ^b	722.9 ^a	3385.0 ^c	0.66 ^a	0.34 ^b
	MEAN	463.43	1201.50	685.9	2930.5	0.68	0.42
	S.E.	6.80	72.50	12.9	111.5	0.02	0.01

Mean within strain and diet with no common superscripts (a,b,c,) are significantly different (P < 0.05)

Table 3: MEAN WATER INTAKE (ml) AND WATER: FEED RATIO AS INFLUENCED BY DIETARY ENERGY IN THREE BROILER STRAINS

STRAIN	DIET	WATER INTAKE		WATER: FEED RATIO	
		0 - 4	5 - 8	0 - 4	5 - 8
A	HE	2835.05 ^a	7600.01 ^a	4.04 ^a	3.26 ^a
	ME	2767.70 ^a	7809.94 ^b	4.14 ^a	2.74 ^a
	LE	2827.44 ^a	7954.97 ^c	4.19 ^a	2.54 ^a
	Mean	2820.06	7621.64	4.12	2.79
	SE	112.2	236.0	0.14	0.11
C	HE	2545.71 ^a	7656.31 ^a	3.97 ^a	3.37 ^a
	ME	2725.68 ^b	7775.52 ^{ab}	4.19 ^a	2.59 ^a
	LE	2811.57 ^b	7856.55 ^b	4.07 ^a	2.49 ^a
	Mean	2694.32	7762.79	4.08	2.82
	SE	136.6	318.10	0.13	0.10
S	HE	2700.02 ^a	6949.95 ^a	4.02 ^a	2.84 ^a
	ME	2754.12 ^{ab}	7374.96 ^b	4.20 ^a	2.49 ^a
	LE	2819.93 ^b	7599.97 ^c	3.90 ^a	2.25 ^a
	Mean	2755.02	7308.29	4.04	2.53
	SE	123.5	257.10	0.12	0.09

Means within strain and diet with no common superscripts (a,b,c,) differed significantly (P < 0.05).

GENOTYPE VS ENERGY ON BROILERS' PERFORMANCE

Table 4 MEAN BODY WEIGHT (G) AND PERCENT CARCASS YIELD OF THREE BROILER STRAINS AS INFLUENCED BY DIETARY ENERGY AT 8 WEEKS OF AGE.

PARAMETER	STRAIN A			STRAIN C			STRAIN S		
	HE	ME	LE	HE	ME	LE	HE	ME	LE
Body wt.	1682.5	1787.5b	1555.1c	1688.4a	1673.8a	1585.8a	1415.2a	1815.0b	1510.8a
DP	88.3a	89.4a	88.4a	88.7	88.2	88.8	88.3a	88.6a	88.8a
EP	73.4a	68.6a	72.4a	71.5a	70.6a	72.0a	68.9a	72.1a	70.9a
Blood	5.5a	5.6a	5.3a	5.6a	5.4a	5.3a	5.7a	5.2a	5.2a
Feather	6.2a	5.0a	6.3a	5.5a	5.8a	5.9a	6.0a	6.2a	6.0a
Abdominal Fat	3.1a	2.2ab	2.1b	2.8a	2.4ab	2.1b	2.6a	2.4ab	1.6b
Shank	4.9a	5.1a	5.2a	5.1a	4.8a	5.0a	5.1a	5.1a	5.1a
Drumstick	10.2a	8.2a	9.1a	9.4a	9.3a	9.5a	9.8a	10.0a	8.0a
Thigh	10.9a	9.9a	11.2a	10.6a	10.7a	10.7a	10.8a	11.2a	10.2a
Neck	5.2a	5.1a	5.1a	5.3a	4.9a	5.4a	4.5a	4.8a	4.0a
Back	14.3a	13.6a	13.9	13.7	13.9	13.3	12.4	13.2	13.3
Breast	16.9	16.8	17.1	16.9	16.4	17.2	16.3	17.2	18.1
Wings	9.1a	7.7	8.0a	8.4a	8.7a	8.3a	8.7a	8.5a	8.9a
Gizzard	2.1a	2.0a	2.0a	2.5a	2.2a	2.3a	2.5a	2.6a	2.3a
Heart	0.57a	0.50a	0.51a	0.53a	0.52a	0.46a	0.43a	0.52a	0.43a
Liver	1.9a	2.0a	1.9a	1.9a	1.9a	1.9a	1.8a	2.1a	2.0a
Kidney	0.16a	0.15a	0.13a	0.14a	0.15a	0.13a	0.13a	0.12a	0.12a

Means within strain and diet with no common superscripts (a,b,c) are significantly different ($P < 0.05$).