# The Effect of Dietary Energy Level and Broiler Body Weight on Abdominal Fat

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*ABSTRACT* Utilizing a moderate rearing temperature regimen, two trials were conducted to determine the effect of dietary energy level on the amount of abdominal fat deposited when broilers are grown to equal body weight by varying growth time. The most abdominal fat (2.29% average of live weight for male and females) was produced by broilers offered a diet calculated to contain 3325 ME kcal/kg. The least amount of abdominal fat (1.92% average of live weight for male and females) was produced by broilers offered diets calculated to contain 3100 and 3175 metabolizable energy (ME) kcal/kg. In one additional day (48 *vs.* 47 days) the growth of the broilers offered diets calculated to contain 3100 and 3175 ME kcal/kg equalled that of broilers offered diets calculated to contain 3250 and 3325 ME kcal/kg. Feed conversion (g feed/g live weight) significantly decreased as dietary energy level increased. Three additional trials were conducted to determine when abdominal fat is deposited in relation to age and weight. It was found that male broilers offered diets calculated to contain 3325 ME kcal/kg had as much abdominal fat when expressed as a percent of body weight at 40 days of age as they did at 53 days of age.

(*Key words:* metabolizable energy, abdominal fat, broilers, body weight)

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## INTRODUCTION

Abdominal fat is highly correlated to total carcass fat (Becker *et al.*, 1979). In human nutrition, consumption of fat is generally discouraged. Feed converted to fat not utilized by the consumer represents inefficiency.

Summers and Leeson (1979) reported that when birds are fed energy in excess of normal metabolic needs, fat deposition results. A considerable proportion of this deposition occurs in the abdominal area. In the review by Mabray and Waldroup (1981), four general nutritional concepts that influence the degree of fatness in broilers were discussed, as follows: 1) narrowing the calorie-to-protein ratio has generally been found to prevent excessive deposition of body fat; 2) an imbalance of amino acids may cause an increase in body fat; 3) the specific effect of dietary fat on carcass composition; and 4) the effects of dietary energy levels on the degree of fatness of broilers conflict. Kubena *et al.* (1974) noted that abdominal fat increased as dietary energy increased and that the fatter broilers generally had heavier body weights than those with the lower fat content. However Griffiths *et al.* (1977) and Coon *et al.* (1981) did not observe an increase in abdominal fat as dietary energy level increased.

Mabray and Waldroup (1981) noted marked differences in broiler carcass weight due to dietary energy level and used an analysis of covariance on fat pad weight to adjust to a common body weight. As dietary energy increased, body weight and fat pad weight increased, but when body weight was adjusted for the difference in body weight using covariance, abdominal fat pad weight differences between the three dietary energy levels appeared less.

Because the broiler industry generally markets to a specified weight rather than age, the objectives of this study were 1) to use differing dietary energy levels, to attempt to equate body weight by varying growth time and to measure the amount of abdominal fat; and 2) to attempt to determine when abdominal fat is deposited in relation to age.

## MATERIALS AND METHODS

Five trials were conducted. Broiler chicks were placed on pine shavings in pens measuring 1.51 × 3.7 m. The feeder and waterer space consisted of two 38.2-cm diameter tube feeders and 244 cm of linear waterer space in each pen. All chicks were brooded and grown at 29 C for the first week, 27 C for the second week, 24 C for the third week, and 21 C from 4 weeks to the end of the experiments.

For the first 3 weeks, all chicks were offered a basal starter diet calculated to contain 22% protein and a metabolizable energy (ME) value of 3200 kcal/kg. All broilers were provided with feed and water *ad libitum*. Feed and body weight data were recorded at 3 weeks of age so that treatment body weights could be equated and feed consumption could be determined during the dietary treatment period. Mortality was recorded as it occurred. After the broilers were killed, the abdominal fat was removed and weighed according to the procedure of Kubena *et al.* (1974).

Analysis of variance was conducted for body weight, grams of feed per gram live weight, and abdominal fat with arc-sin percentage transformation for abdominal fat and expressed as a percentage of body weight in accordance with procedures of Steel and Torrie (1960). Significantly different treatment means were separated by the multiple range test of Duncan (1955).

Two trials, covering the period from November 1980 to April 1981, were conducted with commercial broiler chicks to determine the effect of graded dietary energy levels on the amount of abdominal fat when grown to similar body weights. There were three pens of 40 males and 40 females each per dietary treatment for each trial. The diets fed after 3 weeks of age to the end of experiment consisted of four differing dietary energy regimens (Table 1). All broilers were sacrificed at either 47 or

TABLE 1. *Composition of diets*

| Ingredient | Diet number 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| | (%) | | | |
| Yellow corn | 72.711 | 70.009 | 67.336 | 65.009 |
| Soybean meal (48.5% protein) | 18.027 | 19.209 | 20.328 | 20.741 |
| Animal fat (7716 kcal/kg) | .372 | 2.439 | 4.490 | 6.363 |
| Dicalcium phosphate (22% Ca, 18.5% P) | 1.079 | 1.085 | 1.091 | 1.098 |
| Limestone | .808 | .792 | .775 | .763 |
| Salt | .408 | .408 | .409 | .409 |
| Broiler trace element premix[1] | .250 | .250 | .250 | .250 |
| MHA - Ca, 93%[2] | .155 | .187 | .219 | .245 |
| Coban (45 g/ton)[3,4] | .100 | .100 | .100 | .100 |
| Pro-pak (62% protein)[5] | 5.000 | 5.000 | 5.000 | 5.000 |
| Corn gluten meal (61% protein) | 1.090 | .521 | ... | ... |
| L-Lysine-HCl | ... | ... | .002 | .022 |
| Total | 100 | 100 | 100 | 100 |
| Calculated analysis: | | | | |
| Protein, % | 18.70 | 18.70 | 18.70 | 18.70 |
| Metabolizable energy, kcal/kg | 3100 | 3175 | 3250 | 3325 |
| Lysine, % per Mc (kg) | .308 | .308 | .308 | .308 |
| Met + cys-cys, % per Mc (kg) | .256 | .256 | .256 | .256 |
| Lysine, % | .96 | .98 | 1.00 | 1.02 |
| Met + cys-cys, % | .80 | .81 | .83 | .85 |
| Calcium, % | .90 | .90 | .90 | .90 |
| Available phosphorus, % | .45 | .45 | .45 | .45 |
| Sodium, % | .20 | .20 | .20 | .20 |
| Calorie:protein | 165.8 | 169.8 | 173.8 | 177.8 |

[1] The broiler premix furnished the following amounts of other ingredients per kilogram of feed: vitamin A, retinyl acetate form, gelatin coated, 6614 IU; vitamin $D_3$, 2205 ICU; vitamin E, DL-alpha-tocopherol acetate, 3.31 IU; riboflavin, 4.96 mg; niacin, 27.6 mg; d-pantothenic acid, 8.82 mg; folic acid, 276 $\mu$g; vitamin $B_{12}$, 11 $\mu$g; choline chloride, 496 mg; ethoxyquin, 55 mg; menadione dimethylpyrimidinol bisulfite, 1.65 mg; pyridoxine, 1.10 mg; selenium, 10 mg; manganese (oxide form), 55 mg; zinc (oxide form), 50 mg; iodine, 1.25 mg; iron (sulfate form), 40 mg; copper (sulfate form), 4.0 mg.

[2] Methionine hydroxy analogue.

[3] Coccidiostat containing monensin.

[4] Mention of a trade name, proprietary product, or specific equipment does not constitute a guarantee or warranty by the US Department of Agriculture and does not imply its approval to the exclusion of other products that may be suitable.

[5] Blended animal protein supplement.

48 days of age and amounts of abdominal fat recorded.

In an attempt to determine effect of age on the abdominal fat deposition, three trials with male broilers were conducted from May 1981 to November 1981. Eighty broilers were started in each trial in each of five pens. After 3 weeks of age and until the male broilers were sacrificed at 40, 43, 46, 49, or 53 days of age, they were fed diet 4 (Table 1). At the specified age of either 40, 43, 46, or 49 days of age, each pen of broilers was weighed to be certain body weight was similar for each trial and then the pen of broilers to be sacrificed was randomly selected. All broilers in a pen, rather than a sample of broilers from each pen, were sacrificed to be certain that a sampling error would not occur within each pen. When sampling from a pen of broilers, the tendency may be to select the larger birds.

## RESULTS AND DISCUSSION

In one additional day (48 days *vs.* 47 days of age) the broilers offered diets calculated to contain 3100 and 3175 ME kcal/kg weighed approximately the same as broilers offered diets calculated to contain 3250 and 3325 ME kcal/kg (Table 2). For the males, the broilers offered the diet calculated to contain 3325 ME kcal/kg had more abdominal fat than any other treatment group (Table 2). Also for the males, the broilers offered the diet calculated to contain 3250 ME kcal/kg had more abdominal fat than the broilers offered the diets calculated to contain 3175 and 3100 ME kcal/kg (Table 2).

For the females, the most abdominal fat numerically was produced by the group of broilers offered the diet calculated to contain 3325 ME kcal/kg. Statistically ($P \leqslant .05$) this percent abdominal fat level did not differ from the female group of broilers offered the diet calculated to contain 3250 ME kcal/kg, but both groups showed significantly greater amounts of fat than the females offered the diets calculated to contain 3100 and 3175 ME kcal/kg (Table 2). Within each dietary treatment, the abdominal fat in females was a higher percentage of body weight than in the males (Table 2). This fact has previously been documented by Kubena *et al.* (1974).

No known reason exists for the significant difference in body weight and abdominal fat level between trials (Table 2). The strain cross was the same for each trial. Even though differences in body weight existed between trials at the specified age, there was no significant diet × trial interaction (Table 2). The feed conversion (grams of feed per gram live weight) significantly increased as dietary energy level decreased (Table 2). Mortalities from 480

TABLE 2. *Effect of dietary energy level on amount of abdominal fat when average body weights are equated for each sex*

| Dietary energy ME | Trial | Age | Body weight male | Abdominal fat | Body weight female | Abdominal fat | Feed/ live weight (mixed sexes) |
|---|---|---|---|---|---|---|---|
| (kcal/kg) | | (days) | (g) | (%) | (g) | (%) | (g/g) |
| 3100 | 1 | 48 | 1910 | 1.57 | 1617 | 1.77 | 2.07 |
| 3100 | 2 | 48 | 2043 | 1.98 | 1698 | 2.25 | 2.04 |
| | Average | | 1977[a] | 1.78[a] | 1658[a] | 2.01[a] | 2.06[a] |
| 3175 | 1 | 48 | 1929 | 1.59 | 1637 | 1.90 | 2.00 |
| 3175 | 2 | 48 | 2071 | 1.94 | 1718 | 2.30 | 1.99 |
| | Average | | 2000[a] | 1.77[a] | 1678[a] | 2.10[a] | 2.00[b] |
| 3250 | 1 | 47 | 1958 | 1.73 | 1622 | 2.10 | 1.98 |
| 3250 | 2 | 47 | 2023 | 2.07 | 1689 | 2.57 | 1.96 |
| | Average | | 1991[a] | 1.90[b] | 1656[a] | 2.34[b] | 1.97[c] |
| 3325 | 1 | 47 | 1924 | 1.88 | 1623 | 2.34 | 1.95 |
| 3325 | 2 | 47 | 2024 | 2.28 | 1694 | 2.64 | 1.93 |
| | Average | | 1974[a] | 2.08[c] | 1659[a] | 2.49[b] | 1.94[d] |

[a,b,c,d]Within each column, differing letters denote significant difference ($P \leqslant .05$).

TABLE 3. *Effect of broiler age on abdominal fat deposition (males only)*

| Age | Trial | Body weight | Abdominal fat | Feed/ live weight |
|---|---|---|---|---|
| (days) | | (g) | (%) | (g/g) |
| 40 | 1 | 1573 | 2.38 | 1.78 |
| | 2 | 1583 | 2.67 | 1.84 |
| | 3 | 1591 | 2.41 | 1.83 |
| | Average | 1582[a] | 2.49[a] | 1.817[a] |
| 43 | 1 | 1749 | 2.20 | 1.82 |
| | 2 | 1754 | 2.63 | 1.87 |
| | 3 | 1743 | 2.46 | 1.85 |
| | Average | 1749[b] | 2.43[a] | 1.847[b] |
| 46 | 1 | 1945 | 2.28 | 1.85 |
| | 2 | 1886 | 2.60 | 1.90 |
| | 3 | 1932 | 2.58 | 1.89 |
| | Average | 1921[c] | 2.49[a] | 1.880[c] |
| 49 | 1 | 2064 | 2.22 | 1.86 |
| | 2 | 2059 | 2.53 | 1.94 |
| | 3 | 2124 | 2.58 | 1.92 |
| | Average | 2082[d] | 2.44[a] | 1.907[c] |
| 53 | 1 | 2310 | 2.55 | 1.95 |
| | 2 | 2279 | 2.44 | 1.97 |
| | 3 | 2329 | 2.54 | 2.00 |
| | Average | 2306[e] | 2.51[a] | 1.973[d] |

[a,b,c,d,e]Within each column, differing letters denote significant difference ($P \leq .05$).

broilers each were 26, 19, 24, and 24, respectively, for diets containing 3100, 3175, 3250, and 3325 ME kcal/kg for the two trials.

These data (Table 2) support the work of Kubena *et al.* (1974) that dietary energy level influences the amount of abdominal fat deposited.

The results obtained with the study to determine the effects of age on abdominal fat deposition are presented in Table 3. On a percent-of-body-weight-basis, there was as much abdominal fat in broilers at 40 days of age as there was at 53 days (Table 3). No significant differences existed in percent abdominal fat at 40, 43, 46, 49, and 53 days of age (Table 3). As age increased, both body weight and feed conversion (gram feed/gram live weight) increased (Table 3). Of 240 broilers each, mortalities were 6, 10, 12, 7, and 12 for the pens sacrificed at 40, 43, 46, 49, and 53 days of age, respectively, for the 3 trials. This work to determine if age or weight could be considered in a marketing program to possibly reduce some of the abdominal fat as it relates to broiler market weight with the use of the high energy diet (diet 4, Table 1), showed that on a percent of body weight basis, there was as much abdominal fat for a 1580-g broiler as there was for a 2300-g broiler (Table 3). This negates the consideration of age or weight in a marketing program to reduce abdominal fat as it relates to broiler market weight.

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