THE EFFECTS OF DIETARY ENERGY LEVELS ON THE CARCASS COMPOSITION OF THE BROILERS

H. Kassim[1] and S. Suwanpradit

Department of Animal Sciences, Universiti Pertanian Malaysia, 43400 UPM Serdang, Selangor, Malaysia

Summary

A study was conducted to determine the carcass composition of broilers when fed with three varying levels of dietary energy (3,000, 3,200 and 3,400 kcal/kg ME) at 20% crude protein and 0.79% Total Sulphur Amino Acid. The results showed that there was a significant ($p < 0.05$) increase in the ME intake of the chickens when the ME of the diet increased. Other factors like the protein intake, dressing percentage, weight gain and feed intake were not significantly affected. On the carcass, the increasing dietary ME levels resulted in a significant ($p < 0.05$) increase in the abdominal fat percentage and carcass fat percentage and a significant ($p < 0.05$) decrease in the carcass protein percentage. Similarly, the dietary ME produced a significant ($p < 0.05$) increase in the amount of and fat percentages of breast meat, thigh meat, and drumstick meat with a significant reduction in the protein percentage. There seemed to be an inverse relationship between the percentages of protein and fat. An increase in fat percentages always resulted in similar reduction in the protein content of the meat. These results also showed major differences between the white and red meat of the chicken.

(**Key Words** : Dietary Energy Levels, Carcass, Abdominal, Breast, Thigh, Drumstick, Protein and Fat)

Introduction

The drastic effects of high temperature on the broiler performance are related to the physiological responses to heat stress. In general, the energy requirements of the chickens are inversely related to the environmental temperature. As temperature increases the energy requirements decrease. Concurrently, feed intake will decline proportionately.

It is generally accepted that the regulation of feed intake is related to the energy requirements of the animal (Hill and Dansky, 1954; William, 1956). Birds eat primarily to satisfy their energy requirements, therefore, the consumption of a high energy diet is less than that of a low energy diet. Hill and Dansky (1954) found that the maximum growth at low dietary energy levels was made possible by a marked increase in feed consumption. Boomgaard and Baker (1973) reported that chicken ate to meet their energy requirements, since energy intake was similar at all dietary energy concentration, an increase in dietary concentration resulted in a lower feed per unit of time (Peterson et al., 1960).

Voluntary feed intake could also be depressed when there is a deficiency or imbalance of amino acids (Boorman, 1979). If the imbalance is severe there is a large decline in growth and intake. Carew and Hill (1961) probably were the early investigator to show that an amino acid deficiency could cause an increase in feed intake and the consumption of ME and the increase was not appearing as additional weight gain, since less was deposited as protein and more as fat.

The present experiment was carried out to determine the effects of three different dietary energy levels (3,000, 3,200 and 3,400 kcal ME/kg) on the carcass composition of broilers when the chickens were fed on these diets at a constant 20% crude protein and 0.79% total sulphur amino acids.

Materials and Methods

Animals and management

A total of two hundred seventy 3 week old commercial ISA Vadette male broilers were used. During the first three weeks the chicks were reared together in a

[1]Address reprint requests to Dr. H. Kassim, Department of Animal Sciences, 43400 UPM Serdang, Selangor, Malaysia.

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floor pen and fed on the standard diet containing 3,100 kcal ME and 20% crude protein.

At three weeks of age the birds were weighed and randomly assigned to treatments in such a way that the average starting weight was similar for each replicate. The birds were reared in raised floor cages. Each treatment was applied to three replicate cages of thirty birds each. All birds received feed and water *ad libitum* and were subjected to continuous lighting. Body weight and feed intake data were collected at 28, 35 and 42 days of age. Mortality and ambient temperature (22-29℃) were recorded daily. Feed consumption data were adjusted to account for any deaths on a chick day basis.

Diets

Diets were comprised primarily of ground yellow corn and soybean meal and formulated to be isonitrogenous at 20%, Total Sulphur Amino Acid at 0.79% and adequate in all nutrients as recommended by NRC (1984). The energy levels of the diets were attained by varying the amount of palm oil while different amounts of commerical DL-methionine were supplemented to provide a TSAA of 0.79%. The composition of the basal diets are shown in table 1. The diets differed in the levels of energy (3,000, 3,200 and 3,400 kcal ME/kg) and a constant protein (20%) and TSAA (0.79%) were fed in the mesh form to all the birds until 6 weeks of age.

Slaughtering procedure and carcass sectioning

At six week of age, 4 birds per replicate were randomly selected and fasted for 12 hours. These birds were weighed and slaughtered. After scalding the carcasses were defeathered after which the head and feet were removed. The carcasses were eviscerated and frozen in shrinkable plastic bags for subsequent dissection. Before the commencement of analysis each carcass was thawed at room temperature and free fluid were drained off. The eviscerated carcass weight was obtained to calculate the dressing percentage. Then the abdominal fat was removed and weighed according to the procedure of Kubena et al. (1974). The amount was calculated as a percentage of live body weight. The carcasses were then sectioned into breast, drumstick and thigh portions as described by Hudspeth et al. (1974). The breast portion was sectioned by cutting on each side of the vertebral column to severe the breast from the back portion. The thigh portion was cut through the joint formed by the femur, tibia and fibula. The last portion below the thigh consisting of the meat covering the tibia-fibula bone is called the drumstick. Bones were removed from each cut and separate weights were recorded for meat (with skin removed). The various tissues were frozen at −22℃ to await analysis for moisture, protein and fat content.

Meat preparation

Meat samples from the same portion within replicate were pooled, chopped and homogenised in a Warring blender before drying in the oven at 60℃ for 72 hours (Sibbald and Fortin, 1982). The dried samples were ground using mortar and pestle and kept in sample bottles before being analysed for moisture, protein and fat.

Proximate analysis

The dry homogenised samples were allowed to equilibrate with atmospheric moisture prior to chemical analysis and air dry weight was measured. There were numerous dry matter measurements of controlled variations due to changes in moisture concentration of the air dried samples. The proximate analysis for crude protein and crude fat were carried out as suggested by AOAC (1980). Fat content in the thigh meat was determined gravimetrically following the extraction with chloroform methanol (2:1) (Folch et al., 1957).

Statistical analysis

All the data were subjected to analysis of variance using Statistical Analysis System (SAS), 1982. The differences between treatment means were determined by using Duncans new multiple range test (Steel and Torrie, 1980).

Results and Discussion

The performances of the birds fed on various ME levels are shown in table 2. Dietary energy levels had no significant effect ($p < 0.05$) on body weight gain, feed intake, protein intake and dressing percentage. However birds fed on higher energy diets tended to consume more ME ($p < 0.05$) although there was a decline in feed intake. Protein intake showed a slight decrease as reflected by lower feed intake. The weight gain, however, improved with the increasing energy level or an increase in the fat content of the body.

The levels of dietary energy used in this study were based on the study by Farrell et al. (1973) who indicated that diets with ME levels in the range of 3,200 to 3,400 kcal/kg (12.6 to 14.2 MJ/kg) were necessary to support maximal growth rate and efficiency of conversion of ME to weight gain in the broilers. However, from this study it appeared that the dietary energy levels of 3,000, 3,200 and 3,400 kcal/kg of the diets were not severe enough to produce a statistical significant response of the performance.

Although it had long been accepted concept that chicken ate to meet the energy requirement and that as a consequence, the energy content of the diet was the most important factor regulating intake (Hill and Dansky, 1954; and Farrell et al., 1973), however, the feed intake under the different ME levels appeared to be constant. On the other hand, ME consumption was significantly higher in each dietary energy level (table 2). Increasing dietary ME increased the ME intake and this is in agreement with those reported by Jackson et al. (1982) and Summers et al. (1992). In contrast, Reece and McNaughton (1982) demonstrated that energy intake in warm temperature (26.7℃) did not change appreciably although the dietary energy changed.

TABLE 1. COMPOSITION OF GROWER BASAL DIETS

Ingredients	ME (kcal / kg)		
	3,000	3,200	3,400
Ground yellow corn	49.35	49.35	49.35
Soybean meal (44%)	35.70	35.70	35.70
Palm oil	6.63	9.04	11.45
Premix (vitamins & minerals)[1]	0.25	0.25	0.25
Salt	0.50	0.50	0.50
Coccidiostat	0.05	0.05	0.05
Limestone	1.30	1.30	1.30
Dicalcium phosphate	1.40	1.40	1.40
Kaolin clay	4.82	2.41	–
Total	100.00	100.00	100.00
Calculated analysis			
Protein (%)	20.07	20.07	20.07
ME (kcal/kg)	3,000	3,200	3,400
Calcium (%)	0.90	0.90	0.90
Available phosphours (%)	0.41	0.41	0.41
Lysine (%)	1.16	1.16	1.16
Methionine (%)	0.33	0.33	0.33
Cystine (%)	0.32	0.32	0.32
TSAA	0.65	0.65	0.65

[1] Vitamin & mineral premix contain the following per kg diet. Vit. A 10,000 IU, D_3 2,000 IU, E 15 IU, K_3 1.5 mg, B_2 5 mg, B_6 2 mg, B_{12} 10 μg, Pantothenic acid 12 mg, Biotin 10 μg, Niacin 25 mg, Choline Chloride 900 mg, Folic acid 0.5 mg, Cu 10 mg, Mn 52.5 mg, Zn 60 mg, Fe 100 mg, I 1.5 mg, Co 0.25 mg.

The improvement of suboptimal body weight and/or feed efficiency through increased dietary energy was well accepted fact (Donaldson et al., 1956; Deaton et al., 1983 and Yo and Tawfik, 1990). Although, no significant differences were found in body weight gain of the chickens due to energy levels of the diets, however, the significant increased in the ME intake for each level of dietary ME tended to result in small improvement in the body weight gain.

Abdominal fat and carcass fat content showed a significant variations under the dietary ME levels (table 3). The increase in fat content indicated that the excessive amount of energy consumed. It was possible that the reason for the higher fat content of the carcass could be due the widening of calorie:protein ratio. Carcass fat content was reduced by narrowing the energy:protein ratio through either decreasing dietary energy level while maintaining the protein content or by maintaining the energy level while increasing the protein level (Yamashita et al., 1975 and Shen et al., 1985). It had been well documented that increasing the calorie:protein ratio resulted in the increased body fat and that the response was probably the result of an increased rate of fatty acid synthesis (Bartov, 1979). Furthermore, the data of Donaldson (1985) suggested that dietary energy:protein ratio affected not only the lipogenic activity of the liver but also the substrate flux through the fatty acid synthesis pathway and, hence, the resulting body fat content.

TABLE 2. EFFECT OF DIETARY ME ON PROTEIN, ME, FEED INTAKE, DRESSING PERCENTAGE AND WEIGHT GAIN OF BROILERS

ME	Protein intake (g/b/d)	ME intake (kcal/b/d)	Dressing %	Weight gain (g/b/d)	Feed intake (g/b/d)
3,000	22.76	341.34[a]	65.09	53.47	113.78
3,200	23.19	371.10[b]	65.07	55.13	115.97
3,400	22.14	376.28[c]	65.87	54.83	110.67

Different superscripts in the same column show significant differences ($p < 0.05$).

Increasing dietary energy levels resulted in a significant increase in yield of breast and thigh meat. There was no change in the yield of drumstick meat (table 4). The results also showed a significant increase in the fat contents of these three meats, with the most fat in the thigh meat and the least in the breast meat. The thigh fat was mainly found in between the muscle fibres. However, the increased in fat content of thigh, breast and

TABLE 3. EFFECTS OF DIETARY ME ON BODY COMPOSITION OF BROILERS

ME	Abdominal fat %	Carcass		
		Moisture %	Protein (% DM)	Fat (% DM)
3,000	1.84[a]	64.84	54.26[a]	35.92[a]
3,200	2.19[b]	63.51	53.81[b]	36.36[b]
3,400	2.51[c]	63.42	52.18[c]	38.47[c]

Different superscripts in the same column show significant differences ($p < 0.05$).

drumstick resulted in a decrease in the protein content of these organs as the ME of the diet increased. The increase in the weights of breast, thigh and drumstick meast was mainly due to the fat content. Comparing the protein contents among these three cuts, it was found that the breast meat contained the highest protein while the thigh meat had the lowest. The thigh meat has the highest fat content compared to the other parts and the breast meat has the lowest fat content. This reflects the different ability of different parts to accumulate the fat and thus suggest that there was a difference between the white and red meat in terms of protein and fat content.

TABLE 4. EFFECTS OF DIETARY ME ON BREAST MEAT, DRUMSTICK MEAT AND THIGH MEAT OF BROILERS

ME	Breast meat			Thigh meat			Drumstick meat		
	% BW	Protein (% DM)	Fat (% DM)	% BW	Protein (% DM)	Fat (% DM)	% BW	Protein (% DM)	Fat (% DM)
3,000	9.79[a]	86.15[a]	8.82[a]	6.77[a]	61.23[a]	34.74[a]	6.65	78.39[a]	17.16[a]
3,200	10.05[b]	84.47[b]	10.41[b]	7.17[b]	57.32[b]	38.67[b]	6.56	77.74[b]	18.37[b]
3,400	10.69[c]	83.83[c]	11.23[c]	7.43[c]	57.12[b]	38.86[b]	6.66	74.52[c]	21.02[c]

Different superscripts in the same column show significant differences ($p < 0.05$).

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